ANNALES

Piran 2012

du 19e CONGRÈS

de l'ASSOCIATION INTERNATIONALE
pour l'HISTOIRE du VERRE

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Editor
Irena LAZAR

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(Piran, 17th – 21st September 2012)

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Cover photo: Glass beads from prehistoric graves in Novo Mesto – Kapiteljska njiva; Dolenjski muzej Novo mesto, Slovenia (see Križ, Guštin in this volume, p. 48).

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Sylvia FÜNFSCHILLING

PREFACE

Every third year our members and colleagues gladly await the newest annales of the AIHV congresses. Finally, we can yet again hold another volume, the annales of the 19th congress of our society. Our many thanks go to the authors, the scientific committee, the editors and the countless helping hands who took part in developing this publication. Special thanks go to Irena Lazar: her tireless efforts on all levels of the organisation could already be felt during the congress and the post-congress-tour.

The 19th congress of the AIHV took place from the 17th to 21st of September 2012 in Piran/Slovenia. The University of Primorska Science and Research Centre and Institute for Mediterranean Heritage was a wonderful host. Thank-you to the city of Piran for making it possible to hold our congress in such a lovely environment as the Trevisini Palace and for the cordial welcome by the city mayor. Countless institutions that supported the congress should be mentioned: the Slovenian Research Agency, the National Museum of Slovenia in Ljubljana, the Dolenjska Museum in Novo Mesto, from Croatia the Archaeological Museum Zagreb and the Museum of Applied Arts and Crafts in Zagreb, the Archaeological Museum of Split, the Zavicajni Museum in Biograd, the Museum of Ancient Glass in Zadar and the National Archaeological Museum of Aquileia in Italy. We are also grateful to all sponsors and beneficiaries who supported the success of the congress both financially and with their expertise.

Seventy-eight papers were given in two parallel sessions, complemented by seventy-four posters. It was extremely interesting to discover the diversity of the excavations and the material of our colleagues on the Balkan Peninsula, made easily accessible due to the translations into English. The publications about materials from the Balkans are far too poorly known amongst the neighbouring countries in Europe and even less so on other continents due to various reasons, such as language, availability etc. It was therefore a particular pleasure to have the rich results of recent research projects “served on a plate”. Of course, the other regions brought new aspects in antique, Islamic and medieval/ modern glass as well.

The interesting papers and posters were ideally complemented by the post-congress tour and the in-congress tours that took us from one highlight to another. The hosting city of Piran, with its winding alleyways, was shown to us in the most loveable way. Very interesting and comprehensive was the museum in Aquileia filled with its most special collection and the impressive basilica with its mosaics. The museums in Slovenia and Croatia presented amongst other things prehistoric pearls (Novo Mesto), glasses from antiquity to the modern age (Ljubljana, Zagreb), finds from shipwrecks (Biograd), as well as form-blown vessels with production signatures (Split), rich burial finds and square bottles with relief on the bottom (Zadar). The reception at each museum was very warm.

The time period of the glass discussed spans from the first millennium BC to the modern age, with the focus, as mentioned earlier, on the Balkans, Greece, Turkey and neighbouring regions. Some papers treated pearls and inlay; many new results were presented about glass- and vessel-production. In all the different periods, the analytical discussion included the subjects of the composition of the glass, its origins and colour. The variety of subjects and the number of given papers indicates the extremely lively discussion that is going on in current research on glass.

The volume at hand contains 69 contributions that span the complete chronological period from the beginning of glass production to the modern age. Starting with the glass in Bronze Age, the papers continue through the Hellenistic period and enlighten especially the Roman period. Several contributions are dedicated to the Byzantine and Islamic glass, although the Middle Ages and the 17th to 20th century AD are well represented. Not only glass vessels are discussed but also pearls and window glass, special colours and decorations, as well as glass as a grave good and its production sites and, of course, the composition and origin of the raw material.

During the general assembly, the board was renewed. Anastasios Antonaras is the new general secretary; Maria Grazia Diani and Karol Wight have become new board members. Huib Tijssens, our merited treasurer was re-elected. Marie Dominique Nenna proposed myself as her successor as president of the society. The executive committee consists now of Erwin Baumgartner and Caroline Jackson, as well as the re-elected members Yoko Shindo, Marianne Stern and Lisa Pilosi. There were no changes among the presidents of the national committees, board members too. We would like to thank the whole board for their on-going commitment, especially Marie-Dominique Nenna, who still contributes the largest part of the newsletter after Daniel Keller had to announce his retirement from this assignment.

With great grief, we had to take notice of the deaths of Hubert Cabart, Birgit Klesse, David Whitehouse and Dunja Zobel-Klein.

The preparations for the 20th congress are in full swing. It will take place from the 7th to 11th September in Fribourg and Romont (Switzerland) (www.aihv2015.ch). The focus will be laid on medieval and modern glass. The members of ICOM-Glass will meet at the same time in Fribourg, which hopefully will encourage collaboration between the two institutions.

Translation Simone Mayer

Sylvia FÜNFSCHILLING

AVANT-PROPOS

Tous les trois ans, nos membres et collègues ont le plaisir de recevoir les actes des congrès de l'AIHV: ça y est, nous tenons l'exemplaire du 19ème congrès entre nos mains. Nous adressons un grand merci aux auteur(e)s, au comité scientifique, aux éditeurs ainsi qu'aux nombreux auxiliaires, qui ont contribué à la publication. Il faut évoquer en particulier Irena Lazar : son engagement insatiable sur tous les plans de l'organisation se laissa déjà remarquer durant le congrès et pendant le tour post-congrès.

Le 19ème congrès de l'AIHV a eu lieu du 17 au 21 septembre 2012 à Piran, en Slovénie. L'université Primorska Science and Research Centre and Institute for Mediterranean Heritage s'est avéré être un hôte très accueillant. Il nous faut aussi remercier la ville de Piran : Nous avons pu organiser notre congrès dans un très bel endroit, le palais Trevisini, et avons été reçus chaleureusement par le maire. Il faut nommer également de nombreuses institutions, qui ont soutenu le congrès : la Slovenian Research Agency, le Musée National de Slowenie à Ljubljana, le Dolenjska Museum de Novo Mesto, en Croatie le Musée Archeologique de Zagreb et le Musée des arts appliqués à Zagreb, le Musée archéologique de Split, le musée Zavicajni de Biograd, le Musée du Verre Antique à Zadar ainsi que le National Archaeological Museum de Aquileia en Italie. Nous remercions finalement tous nos mécènes et contributeurs, qui ont contribué financièrement ou par leur savoir-faire au succès du congrès.

En deux sections parallèles, nous avons écoutés 78 exposés. Ceux-ci ont été complétés par 74 contributions sur poster. Cela a été grandement intéressant de pouvoir découvrir les fouilles variées de nos collègues des Balkans ainsi que leur matériel, et ça avec un accès facilité grâce aux traductions en anglais! Les publications concernant les Balkans sont, de façon générale dans les pays voisins d'Europe ou sur d'autres continents, trop peu prises en compte – à cause de plusieurs facteurs, comme la langue, la disponibilité des publications, etc. C'était par conséquent un d'autant plus grand plaisir de recevoir des résultats complets « tout frais ». A côté de ça, les autres régions ont également permis de porter un nouveau regard sur le verre antique, islamique et médiéval/ d'époque moderne.

Les exposés et posters intéressants ont été complétés au mieux par l'excursion d'après le congrès ainsi que par les excursions durant la semaine, qui nous ont menés de point fort en point fort. La ville hôte de Piran avec ses petites rues tortueuses nous a été présentée avec un soin particulier. Aquilée, avec son musée comprenant une collection exceptionnelle ainsi que l'impressionnante basilique, s'est montrée une ville très intéressante et complète. Les musées en Slovénie et en Croatie présentèrent entre autres des perles préhistoriques (Novo Mesto) ainsi que des verres de l'Antiquité jusqu'à l'époque moderne (Ljubljana, Zagreb), des objets d'épaves de navires (Biograd) ainsi que des récipients formés par moule avec signatures des producteurs (Split) et de riches objets de tombes ainsi que des bouteilles carrées avec marques sur les fonds (Zadar). Les accueils dans les musées respectifs ont été très chaleureux.

La période du verre traité couvrait du premier millénaire av. J.-C. jusqu'à l'époque moderne. L'attention était portée, comme déjà évoqué, sur les Balkans, la Grèce, la Turquie et les régions limitrophes. Certaines contributions ont traité des perles ainsi que des travaux d'incrustation, de nombreuses découvertes concernant la production du verre et de récipients ont pu être mises en valeur. En complément, des questions sur la composition du verre, de son origine et de sa couleur ont pu être analysées à travers tous les âges. La thématique variée et le nombre des contributions montrent clairement que la recherche du verre est remarquablement foisonnante.

Le rapport ci-joint comprend 69 contributions, qui comportent l'entier de la chronologie, des débuts de production du verre jusqu'à l'époque moderne. Ils commencent au verre de l'âge du Bronze, touchent à l'époque hellénistique et mettent l'accent particulièrement sur l'époque romaine. Plusieurs contributions sont consacrées au verre byzantin et islamique, mais l'époque médiévale ainsi que les 17e au 20e siècles sont bien représentés. Autant des récipients en verre que des perles et du verre de fenêtres sont thématisés, mais aussi du verre comme offrande de tombe, des ateliers et naturellement la composition et l'origine des matériaux bruts.

Durant l'assemblée générale, le conseil a été renouvelé. Anastasio Antonaras est nouvellement secrétaire général, Maria Grazia Diani et Karol Wight sont nouveaux membres du conseil. Huib Tijssens, notre méritant trésorier, a été à nouveau élu. Marie Dominique Nenna a proposé ma personne en tant que successeur de la présidence. Erwin Baumgartner et Caroline Jackson sont nouveaux membres du comité exécutif; les places des autres représentants, Yoko Shindo, Marianne Stern et Lisa Pilosi, ont été confirmées. Pour ce qui concerne le président des comités nationaux (eux aussi membres du conseil), aucun changement n'est à noter. Nous adressons nos remerciements à tous, en particulier à Marie-Dominique Nenna pour son engagement, qui se fait toujours sentir par sa gestion de la plus grande partie de la newsletter, après que Daniel Keller a annoncé son retrait de cette fonction.

Nous avons avec le plus grand chagrin pris connaissance des décès de Hubert Cabart, Birgit Klesse, David Whitehouse ainsi que de Dunja Zobel-Klein.

Les préparations pour le 20ème congrès battent leur plein. Celui-ci aura lieu du 7 au 11 septembre à Fribourg et à Romont (Suisse) (www.aihv2015.ch). L'attention sera centrée sur le verre médiéval et moderne. Les membres de l'ICOM-glass se rencontreront parallèlement à Fribourg, afin de consolider le travail en commun entre les deux institutions.

Traduction Johann Savary

Sylvia FÜNFSCHILLING

VORWORT

Alle drei Jahre freuen sich unsere Mitglieder sowie Kollegen auf die Akten der Kongresse der AIHV: nun ist es wieder soweit, wir halten den Band des 19. Kongresses unserer Gesellschaft in Händen. Den Autorinnen und Autoren, dem wissenschaftlichen Komitee, den Editoren sowie den zahlreichen helfenden Händen, die an der Entstehung der Publikation mitbeteiligt waren, ist höchster Dank auszusprechen. Besonderer Erwähnung bedarf Irena Lazar: ihr unermüdlicher Einsatz auf allen Ebenen der Organisation war bereits während des Kongresses und während der Post-Kongress-Tour spürbar.

Der 19. Kongress der AIHV fand vom 17.-21. September 2012 in Piran/Slowenien statt. Die Universität Primorska Science and Research Centre and Institute for Mediterranean Heritage war ein wundervoller Gastgeber. Dank auszuprechen ist der Stadt Piran, wir durften in einer sehr schönen Umgebung, im Trevisini Palace, unseren Kongress abhalten und wurden vom Bürgermeister herzlich empfangen. Zahlreichen Institutionen ist zu danken, die den Kongress unterstützt haben: der Slovenian Research Agency, dem Slowenischen Nationalmuseum in Ljubljana, dem Dolenjska Museum in Novo Mesto, dem Archäologischen Museum Zagreb, dem Archäologischen Museum Split, dem Zavičajni Museum Biograd in Biograd na moru, dem Museum für antikes Glas in Zadar sowie dem Nationalen Archäologischen Museum in Aquileia/Italien. Zu Dank verpflichtet sind wir den Sponsoren und Gönnern, die finanziell und mit know-how das Gelingen des Kongresses unterstützt haben.

In zwei parallelen Sektionen hörten wir 78 Vorträge. Ergänzt wurden diese durch 74 Beiträge auf Postern. Es war ausserordentlich interessant, die vielfältigen Ausgrabungen und deren spannendes Material unserer Kollegen auf dem Balkan entdecken zu können, mit erleichtertem Zugang durch die Übersetzungen ins Englische! Die Publikationen den Balkan betreffend werden – aufgrund mehrerer Ursachen, wie Sprache, Verfügbarkeit usw. – in den benachbarten Ländern Europas oder gar auf anderen Kontinenten oft wenig zu Kenntnis genommen. Es war deshalb ein besonderes Vergnügen, die reichhaltigen und spannenden Ergebnisse „frisch auf den Tisch" zu bekommen. Aber auch die übrigen Regionen boten neue Einblicke in antikes, islamisches sowie mittelalterlich/neuzeitliches Glas.

Die interessanten Vorträge und Poster wurden auf's Beste ergänzt durch die Postcongress-Tour sowie Ausflüge während der Woche, die uns von Höhepunkt zu Höhepunkt führten. Die Gastgeberstadt Piran mit seinen verwinkelten Gassen wurde uns besonders liebevoll nahegebracht. Sehr interessant und reichhaltig zeigte sich Aquileia, das Museum mit seiner ausserordentlichen Sammlung wie auch die eindrückliche Basilika mit ihren Mosaiken. Die Museen präsentierten u.a. prähistorische Perlen (Novo Mesto) sowie Gläser von der Antike bis zur Neuzeit (Ljubljana, Zagreb), Funde aus gestrandeten Schiffen (Biograd) ebenso wie formgeblasene Gefässe mit Herstellersignaturen (Split) und reiche Grabfunde sowie vierkantige Flaschen mit Bodenmarken (Zadar). Die Empfänge in den jeweiligen Museen waren sehr herzlich.

Die zeitliche Spanne des behandelten Glases reichte vom ersten Jahrtausend vor Chr. bis zur Moderne. Der Fokus lag – wie bereits erwähnt – auf dem Balkan, auf Griechenland und der Türkei und angrenzenden Regionen. Einige Beiträge behandelten Perlen sowie Einlegearbeiten, zahleiche neue Erkenntnisse konnten bei der Glas bzw. Gefässproduktion gewonnen werden. Ergänzend durch alle Zeiten wurden Fragen zur Komposition des Glases, dessen Herkunft, Farbe analytisch beleuchtet. Die unterschiedliche Thematik und die Vielzahl der Beiträge zeigen deutlich, dass die Glasforschung ausserordentlich lebendig ist.

Der vorliegende Band umfasst 69 Beiträge, die die gesamte chronologische Spanne von den Anfängen der Glasverarbeitung bis zur Moderne umfassen. Sie beginnen beim bronzezeitlichem Glas, streifen die hellenistische Zeit und beleuchten besonders die römische Epoche. Mehrere Beiträge sind dem byzantinischen und islamischen Glas gewidmet, aber auch die mittelalterliche Epoche, sowie das 17. -20. Jahrhundert sind gut vertreten. Sowohl Glasgefässe kommen zur Sprache, wie auch Perlen und Fensterglas, spezielle Farben und Verzierungen, aber auch Glas als Grabbeigabe sowie Ateliers und natürlich Komposition und Herkunft des Rohmaterials.

Während der Generalversammlung wurde das board erneuert. Anastasios Antonaras ist neuer General Sekretär, Maria Grazia Diani und Karol Wight wurden neue board members. Huib Tijssens, unser verdienter treasurer wurde wiedergewählt. Marie Dominique Nenna schlug meine Person als ihre Nachfolgerin für die Präsidentschaft vor. Im Exekutive Kommitee sitzen neu Erwin Baumgartner und Caroline Jackson, die übrigen Vertreter wie Yoko Shindo, Marianne Stern und Lisa Pilosi wurden bestätigt, bei den Präsidenten der nationalen Kommitteen gab es keine Änderungen. Wir danken allen, insbesondere Marie-Dominique Nenna, für ihr Engagement, das immer noch andauert: steuert sie doch den weitaus grössten Teil zum newsletter bei, nachdem Daniel Keller seinen Rücktritt von dieser Aufgabe bekannt geben musste.

In tiefer Trauer mussten wir den Tod von David Whitehouse, Hubert Cabart, Birgit Klesse sowie Dunja Zobel-Klein zur Kenntnis nehmen.

Die Vorbereitungen für den 20. Kongress laufen auf Hochtouren. Er wird vom 7. bis 11. September in Fribourg und Romont (Schweiz) stattfinden (www.aihv2015.ch). Der Focus wird dabei auf dem mittelalterlichen und modernen Glas liegen. Die Mitglieder von ICOM-Glass werden sich ebenfalls in Fribourg treffen, auf dass die Zusammenarbeit zwischen den beiden Institutionen gestärkt werde.

BELLINTANI Paolo

BRONZE AGE VITREOUS MATERIALS IN ITALY

Introduction

This paper presents a synthesis of results of the "Vitreous Materials in the Italian protohistory" project, focusing in particular on the archaeological finds dated from the 21st to the 9th century BC.[1] The project began in 2005 and involves the Archaeological Heritage Office of the Autonomous Province of Trento; the Geology Department of Padua University and the *Istituto Italiano di Preistoria e Protostoria*.[2]

Despite the importance of vitreous beads in the European Bronze Age, where they are generally considered *exotica,* Italian research in this field has been limited and not systematic – up until the last decade. The only exception were the archaeometrical analyses carried out originally by Alberto Biavati, Marco Verità and later by Julian Henderson on the glass materials of Frattesina in NE Italy; at present, the most important glassworking site in the Bronze Age of Europe.

Based on the archaeometrical characterization of the vitreous materials carried out to date,[3] this work relates to the chronology, the typological characterization and the probable origin of faience, glassy faience and glass beads of the Italian Bronze Age. Special attention will be given to the state of the art concerning the origin and the development of glassworking in Frattesina.

Typology and chronology

Early Bronze Age (c. 2200-1700/1600 BC)

Recent archaeometrical research confirms the hypothesis that mixed alkali faience technology reached central Europe during the third millennium BC via the regions north of the Black Sea. In northern Italy ca 60, biconical

1 I'm obliged to Mark Pearce and Anna Maria Bietti Sestieri for the translation of the text and suggestions.

2 The project is almost complete, apart from the archaeometrical analysis of Sicilian artefacts. Bellintani 2011; Angelini 2011.

3 Tite, Shortland, Angelini, 2008; Angelini, Polla, Molin, 2010; Angelini 2011.

and segmented faience beads (Fig. 1.1-3) have been found in 6 pile dwelling sites in the Lake Garda region and in 2 Ligurian burials dated to the first phase of the Early Bronze Age (21st-19th century BC). They are similar in typology[4] and composition[5] to several beads from Bohemia and Slovakia.

Middle Bronze Age 1-2 (ca.1700/1600-1400 BC)

245 vitreous beads found in 31 sites in the Italian Peninsula are dated to this period. The glassy faience conical buttons with a rectilinear perforation at the base, dated to the Middle Bronze Age 1-2 (Fig. 1.4-5), could be an evolution (or reappearance) of mixed alkali technology in northern Italy. In the same period, a variety of button with a "V" shaped perforation at the base (Fig. 1.6) was present in central Italy. There are no finds of faience or glassy faience in northern or central Italy. Indirect evidence could be acknowledged in the specific typology and composition, in particular for the LMHK glassy faience conical buttons.[6]

At the beginning of the Middle Bronze Age, vitreous material beads (faience, glassy faience and glass), generally of ordinary forms (discoid, globular, flattened globular), started to appear in southern Italy and on the central Tyrrenian coasts, sometimes associated with Aegean pottery (Lipari and Vivara - Punta d'Alaca). The oldest HMG glass bead found to date in Italy was discovered in the "Villaggio delle Macine", a pile dwelling site in the Lake of Albano, near Rome, dated to the beginning of the MBA1.[7] Besides ordinary parallels of Mycenaean faience and glass beads, as in the case of the Sicilian examples, some beads show proximity to typical elements from the Mediterranean Levant and Egypt: the glass flattened globular beads with single spot eyes and the globular beads with arched lines (Fig. 1.18) from Grotta Manaccora (Apulia), dated to the middle of the 15th century BC, are similar to those from the Uluburun wreck, which Ingram compared to some beads found in Lachish (Israel).[8]

Middle Bronze Age 3- Recent Bronze Age (c.1400–1200 BC)

2706 faience, glassy-faience and glass beads dated to this period have been found at 36 sites in the Italian Peninsula. During the last phase of the MBA and in the so called "Recent Bronze Age," several large groups of beads (hundreds in several cases) appeared in southern Italy, some of which have complex and diagnostic forms and decoration. They are comparable in typology and composition with similar artefacts from the Mycenaean area: in particular, the flattened rhomboidal glassy faience beads with linear engravings from Cisternino, Trinitapoli (in Apulia) and Plemmirio (in Sicily; Fig. 1.29) and wheat grain beads from Trinitapoli (Apulia), Thapsos and Plemmirio (Sicily; Fig. 1.28).[9]

Beads similar to those from the Mediterranean Levant and Egypt have been found in Sardinia. The faience buttons dated to the Recent Bronze Age from the burial of Perda 'e Accutzai and Nuraghe Antigori (near Cagliari; Fig. 1.26-27) are typologically comparable with characteristic buttons of Ugaritic production, reported in Crete by Panagiotaki and in the Ulu Burun shipwreck by Ingram. Regarding archaeometrical aspects, the Bronze Age vitreous materials of Sardinia present some analogies with the Egyptian examples.[10]

The local mixed alkali faience and glassy faience tradition seem to disappear in the last phase of the Middle Bronze Age in northern and central Italy. Otherwise, the typology and the composition of faience and glassy faience beads found in several Po Plain cemeteries and settlements (Fig. 1.21-22) indicate contacts with the Aegean world. This is the case for the lentoid

4 Bellintani, Angelini, Artioli, Polla 2006a, 1496-1498, 1523.

5 Angelini, Artioli, de Marinis, Polla 2006.

6 Bellintani, Angelini, Artioli, Polla, 2006a, 1498-1501; Bellintani, Angelini, Artioli, Polla, 2006b.

7 Bellintani, Angelini, Artioli, Polla 2006a, 1501-1504.

8 Ingram 2005, 64; Bellintani 2011, 265.

9 Orsi 1891; Orsi 1895; Orsi 1899; Voza 1973; Bellintani, Angelini, Artioli, Polla 2006a, 1505-1506; Bellintani 2011, 264; Bellintani and Usai forthcoming.

10 Bouquillon and Matoïan 2007, pl. 2.1; Ingram 2005, 46, note 124; Bellintani 2011, 265-266, Angelini, Nicola, Artioli 2015.

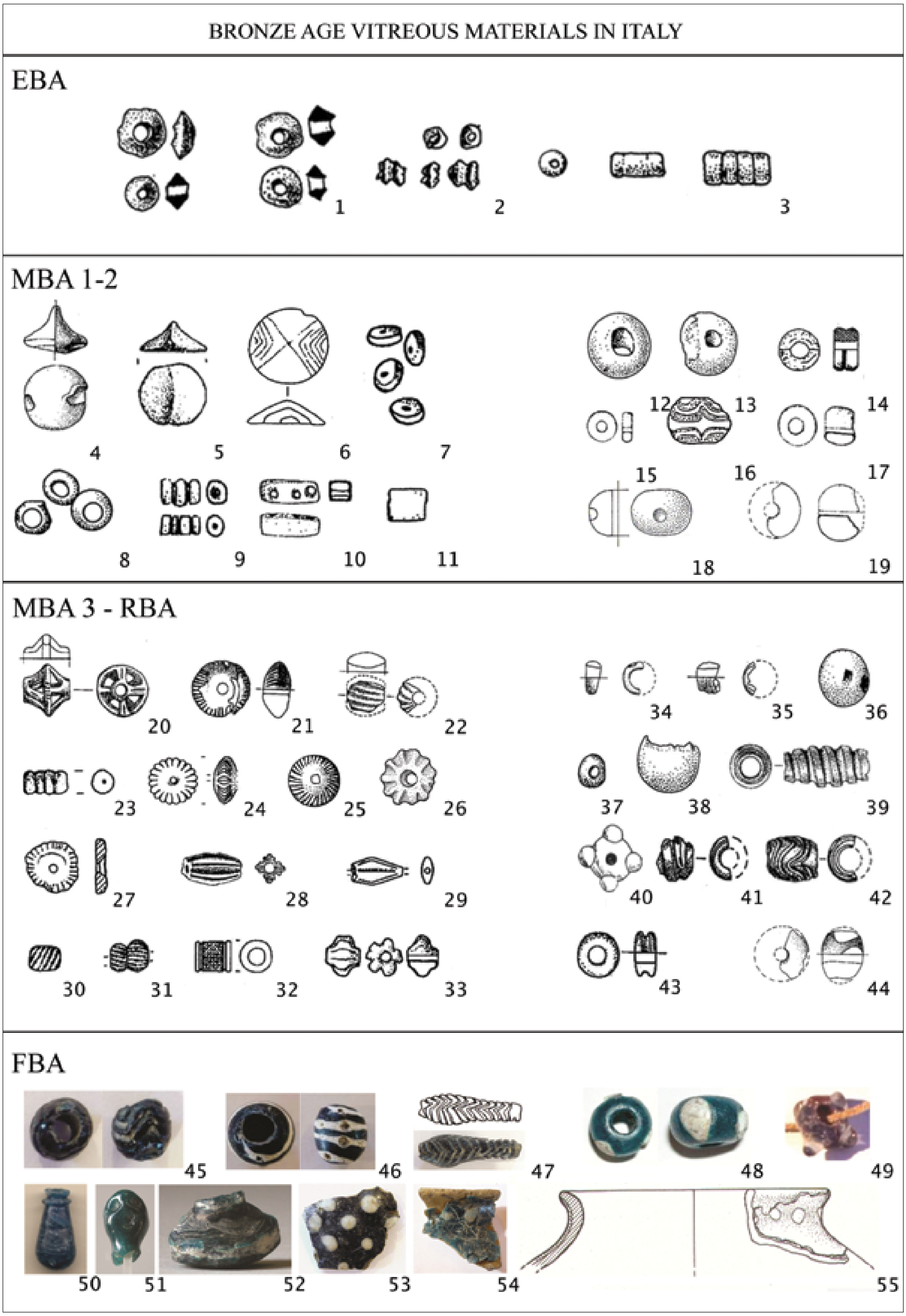

Fig.1: Bronze Age vitreous materials in Italy. The main typologies.

radially grooved beads and the wheel beads with two hubs found in the Franzine cemetery and in the Terramara settlement of Poviglio (Fig. 1.20).[11]

A group of beads dated to the second phase of the recent Bronze Age (barrel beads with spiral or wavy thread decorations[12] and eye beads;[13] Fig.1.39-44) are characterized by a specific composition called High Magnesium Brown Glass (HMBG).[14] At present, brown glass is widespread from the Adige Valley to the central Adriatic region with the focal point in the Terramare territory, in the central Po Plain, but they are not present in southern Italy and in the eastern Mediterranean.

Final Bronze Age (c 1200–1000/975 BC)

A radical change occurred during this phase: probably due to the collapse of the Mycenaean world, all the Aegean-type beads almost completely disappeared in the Italian Peninsula.

All the beads analysed in Italy and most of the Northern European examples dated to this period indicate the presence of a new recipe for glass production: "Low Magnesium High Potassium" or "mixed alkali" glass.[15]

The main typological classes of beads are: little annular blue beads, blue barrel beads with white spiral threads and blue and white eye beads (Fig. 1.45-49).[16] Widespread from England to Greece, the largest concentrations of these beads are found in the southern Veneto region and in Switzerland. They are practically unknown in Sardinia and Sicily, with the exception of Lipari.

11 Ramhstorf 2005; Panagiotaki 2008; Nightingale 2008; Tite, Shortland, Angelini 2008, 140-141; Tite, Shortland , Maniatis, Panagiotaki, Kaczmarczyk 2008, 121-125; Bellintani 2011, 266-7.

12 Bellintani, Angelini, Artioli, Polla 2006a, 1507; 1525.

13 Ghislanzoni 1933, 11: 19-20; fig. 9c ; 14; Angelini, Nicola, Artioli, de Marinis, Rapi, Uboldi 2011.

14 Angelini 2011.

15 Biavati 1983; Biavati and Verità 1989; Towle, Henderson, Bellintani, Gambacurta 2002; Angelini, Artioli, Bellintani, Diella, Gemmi, Polla, Rossi 2004; Nikita and Henderson 2006; Angelini 2011.

16 Bellintani and Stefan 2009; Angelini, Polla, Molin 2010; Bellintani 2011.

To date, mixed alkali glassworking traces are known only in the southern Veneto. The main working (and probably production) centre is the site of Frattesina, in the northern Adriatic region. In this settlement, particularly in the 11th century BC, there is evidence of several craft and trading activities connected with continental Europe and the Eastern Mediterranean: Baltic amber; elephant ivory; ostrich eggs; Aegean pottery and metal working.

The glassworking archaeological record consists of:

- fragments of at least two forms of pottery crucibles (hemispherical and low truncated cone)
- raw glass scraps and probably ingot fragments; these ingots have the same form and dimension as the low truncated cone crucibles and some regular impressions, which may be the marks of the working instruments
- about 2800 finished products with the largest typological and chromatic assortment known so far. The main colours are pale and dark blue, water green, red and white.

The "glass routes" of the Bronze Age in the central Mediterranean

It is currently difficult to define how Aegean, Egyptian or Levantine vitreous beads and/or the relative raw materials and technologies spread in the central Mediterranean. The Ulu Burun shipwreck cargo typically reflects the complexity of this issue. As reported by Ingram, glass ingots, some tens of beads of various types maybe belonging to the crew, and tens of thousands of tiny faience and glass beads - intended for the making of jewellery - were present in the wreck.

This means that the vitreous material beads found in Italy, and typologically and/or compositionally appearing similar to the eastern Mediterranean examples, could be the markers - theoretically - of several forms of cultural and/or craft interaction. Finished products may have reached the final destination via so-called "down the line" trade - in other words - from regions that traded with the primary production areas. Moreover, as the thousands of beads of Ulu

Burun suggest, jewellery made in the secondary working centres (i.e. Mycenaean jewellery) could have been made with beads produced in one or more glassmaking centres (Egyptian or Levantine) and subsequently traded toward the central Mediterranean.

Besides the finished beads, semi-finished products and / or raw materials (glass ingots, Egyptian blue, pigments etc.) may have arrived from the production and/or working centres.

There is no archaeological evidence to date of faience, glassmaking or glassworking in the Middle and in the Recent Bronze Age. However, we cannot exclude local production or (more probably) the re-working of vitreous materials on the basis of specific glass recipes present in northern Italy (HMBG glass). Moreover, in the same regions and in particular in the southern Veneto plain, "Mycenaean type" pottery - mostly considered a local production on the basis of archaeometrical analysis - has been found. Recently an amber working site has also been discovered at Campestrin di Grignano Polesine, 9 km east of Frattesina. Here thousands of amber chips and some semi-finished Tiryns-type beads have been found.

In other words, during the Recent Bronze Age (13th century BC) we can assume the appearance in northern Italy of two important innovations in local pyrotechnology. Mycenean-type pottery and glassworking would be the archaeological traces of direct contact with traders and artisans from the Eastern Mediterranean, who travelled to the north Adriatic coasts in search of exotic raw materials and/or products, such as locally-worked Baltic amber, and other commodities like Alpine copper.

From the typological point of view there are analogies between the HMBG beads of the northern Italian Recent Bronze Age and beads documented in Egyptian and Levantine production of the second half of the 2nd millennium BC: barrel beads with spiral decorations and eye beads, which were the most important classes of beads worked at Frattesina, in the Final Bronze Age.

Therefore, we can assume that the beginning of glassworking at Frattesina could have been stimulated by the probable presence in the north Adriatic region of eastern traders and/or artisans and by earlier experience of glassworking since the 13th century BC. The appearance of the LMHK recipe in the Final Bronze Age could be an adaption of the glass technology applied to the local resource.

At Frattesina, the evidence of trade with northern Europe and the eastern Mediterranean ceased in the course of the 10th century BC and, at the same time glassworking decreased.

After the decline of Frattesina (around the 9th century BC), the presence of LMHK glass in Europe was only rarely reported. All the glass materials analysed to date from the 8th century BC in northern and central Italy reveal the presence of new compositions (soda glasses with natron; potash glasses and other kinds of compositions).

In this scenario, the LMHK or mixed alkali glass could be considered a specific artisan tradition of north Adriatic Italy, and particularly of Frattesina.

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AN 18TH DYNASTY GLASS CHALICE FROM GUROB, EGYPT

Introduction

This paper examines a piece of glass which may belong to the reign of the Egyptian pharaoh Thutmose III (1479-1425 BC) during the 18th Dynasty (1550-1295 BC) of the New Kingdom (1550-1069 BC).

The paper builds on the examination of what may be a related glass chalice or goblet in the collection of the Harrow School Museum (HE121).[1]

The glasses

The Harrow vessel was bought by Sir John Gardner Wilkinson (1797-1875), probably during his residence in Egypt between 1821 and 1833.[2] Wilkinson was a pioneer of Egyptology and evidently knew the dealers of Thebes well, as a result most of the items he bought were genuine.

However, the key word here is "bought." The Harrow Chalice has no firm provenance but was purchased on the antiquities market. This is particularly unfortunate for those studying the early history of glass as the piece is believed by the authors to belong to the reign of Thutmose III (1479-1425 BC) the King under whom glass production may have been established in Egypt.

The supposed date is based on comparison with similar glass chalices but the comparison is not without difficulty, a matter which has previously been discussed by Nicholson (2006). The problem is that most of the glass which is regarded as belonging to the reign of Menkheperre Thutmose III (1479-1425 BC) – and thus at what is believed to be the start point for glass vessels in Egypt – cannot be provenanced with certainty. For example, even the well known juglet bearing the King's name – Menkheperre - which is in the collection of the British Museum (BM 47620) is without certain provenance. Both Budge[3] and Cooney[4] regard the piece as having originally come form the royal tomb and as being contemporary with

1 Nicholson and Jackson 2012.
2 Nicholson 2006.
3 Budge 1925, 391.
4 Cooney 1976, 70-71.

Thutmose III but this iconic piece lack certain provenance.

Still more relevant to the present discussion is the glass chalice now in the Munich collection (ÄS630). Like the British Museum juglet this vessel bears the name of Thutmose III and Nolte (1968) regards it as being contemporary with him rather than with the priest king Menkheperre of the 21st Dynasty (1069-747 BC). The quality of the glass suggests that it is indeed a piece belonging to the 18th rather than the 21st Dynasty.

In order to try to provide a more certain picture the nature of early glass in Egypt the authors analysed the Harrow Chalice[5] and were able to show that its composition was consistent with other early glasses known form Egypt, notably examples from Malkata and Amarna, rather than being an import from the Near East into Egypt. Whilst the information on likely area of manufacture is welcome it does not provide a date for the piece and in order to help with this matter one is forced to turn to the other examples of similar glasses.

The rounded chalice or cup form is not common in Egypt. The nearest parallel to the Harrow vessel is that from Munich which, although it lacks provenance, is generally believed to be of the reign of Thutmose III and seems to belong to a group of important vessels made for this ruler and which include the British Museum juglet.

This still leaves the matter of the dating of the glass chalices as one of "probability." However, there is one further example of a glass chalice of this form which deserves study and – in the absence of analyses of the British Museum and Munich pieces - it is this which might be regarded as holding the key to understanding these glasses.

The piece in question is a chalice vessel made in deep turquoise/copper blue glass which has been extensively weathered on the surface. The height of the vessel is approximately 7.6 cm and it has a rim diameter approximately 6.2cm. The stem foot has some signs of facetting from tooling with pincers and the underside of the

5 Nicholson and Jackson 2012.

Plate 1: The Gurob Chalice (E2451), now in the collection of the Ashmolean Museum. The height of the vessel is 7.6 cm and it has a rim diameter of approximately 6.2 cm. Reproduced courtesy of the Ashmolean Musuem, Oxford. (Photo: P.T. Nicholson).

base has the characteristic depression in it. There is no decoration. The piece is now in the collection of the Ashmolean Museum, Oxford (E2451; Pl. 1).

What is significant about the Ashmolean piece is that it was excavated rather than purchased. It comes from the site of Gurob in the Fayum and was excavated by W.L.S. Loat (1871-1932) from tomb 058.[6] Loat was primarily an ichthyologist rather than an archaeologist[7] and so was more interested in the discovery of a cemetery of sacred fish at Gurob than he was in glass from tomb 058 about which he offers no comment. Instead the proposed dating of the glass vessel is left to a rather unclear statement by Fossing[8]

6 Loat 1905.

7 See Bierbrier 2012, 336.

8 Fossing 1940, 9 note 6.

who in discussing the Munich chalice states that he knows of "only one" similar specimen, that in the Ashmolean. As he makes the comment in his discussion of the glass of Thutmose III it is reasonable to assume that he would place the Gurob chalice amongst that material. Nolte[9] has similarly placed the piece in the reign of Thutmose III.

In summary of the rounded glass chalices known, two have no proven provenance (Harrow HE121 and Munich ÄS630), though the Munich example bears the name of Thutmose III, while a third which has provenance (Ashmolean E2451) but is without a royal name and is dated largely by association with the Munich piece.

The glasses discussed thus far along with others thought to belong to the reign of Thutmose III are summarised as Table 1.

The authors[10] have demonstrated that the Harrow chalice is a genuine piece of Egyptian glass whose composition is consistent with other early Egyptian glasses and whose shape is like that of the Munich chalice, itself *probably* an artefact of Thutmose III's reign. It was thus believed to be relevant to examine the chemistry of the Gurob chalice in order to determine whether it had similarities to that from Harrow.

Analytical results cannot, of course, give a 'date' to the chalice but an analysis giving results similar to those of the Harrow Chalice and other known early Egyptian glasses might be indicative of a potential Egyptian provenance and similarity to this early group of glasses. Whilst there are some published major element analyses of Egyptian and Mesopotamian glasses, most of these relate to Egypt and particularly to Amarna primarily because of the very few examples of glasses from Mesopotamia known. Lilyquist and Brill (1993), Jackson and Nicholson (2007) and also Shortland, Tite and co-workers[11] have all published analyses. These are used as a comparative tool here.

For both Egypt and Mesopotamia fewer trace element analysed have been published, partly because it is only recently that the use of laser ablation has permitted trace elements to be measured with more success in very small samples. The main body of research in this area was published in a paper by Shortland and co-workers.[12] Much of their material relates to the Amarna period, one which is later in date than the focus of this paper, but it is the best comparative tool available at the present time. Whilst the early papers using major elements were tentative in their conclusions about provenance, trace element analysis has been more successful.

Shortland et al. (2007) analysed glass from four consumption sites, two in Egypt (Amarna and Malkata) and two in Mesopotamia (Nuzi and Tell Brak). The glass they analysed consisted of beads, vessels and ingot fragments from Mesopotamia all coloured blue by copper (some also opacified with antimony). From Egypt they analysed rods of glass and colourless glass from Amarna as well as colourless and blue glass from Malkata. The colourless glass from the two Egyptian sites appears to be naturally colourless through the use of raw materials relatively low in iron; only one contains antimony at concentrations where it would decolourise the glass. The blue glasses from Malkata were coloured blue with either copper, cobalt of a mixture of the two. Thus, whilst the data is not directly comparable with the sample of opaque turquoise glass from the Ashmolean chalice, it is the best comparison currently available.

Analysis of the Gurob chalice

A small opaque blue fragment of the chalice was removed by conservators at the Ashmolean museum for analysis. This was mounted in epoxy resin and polished to provide an un-weathered surface. The glass was subject to electron probe micro analysis (EPMA) for major and minor analyses and laser ablation inductively coupled mass spectrometry (LA-ICP-MS) to determine trace elements. Full details of the instrumentation and running parameters for the EPMA can be found in Meek *et al*. (2012) and for LA-ICP-MS in Nicholson and Jackson in press. The error on

9 Nolte 1968, 49.

10 Nicholson and Jackson 2012.

11 Eg. Tite and Shortland 2003; Shortland and Eremin 2006.

12 Shortland *et al.* 2007.

Number	Shape/Type	Body colour	Technology
Munich ÄS630	Chalice	Light Blue	Core-formed
Ashmolean E2451	Chalice	Light Blue	Core-formed
Harrow HE121	Chalice	Light Blue	Core-formed
MMA23.9*	Lotus Chalice	Light Blue	Cast and cold worked
BM 24391	Kohl pot with lid	Light Blue	Drilled and cold worked
UC 19657	Kohl pot (no lid)	Light Blue	Drilled and cold worked
MMA26.7.1179	Kohl pot (no lid)	Light Blue	Drilled and cold worked
Cairo 24959	Kohl pot (lid only)	Dark Blue	Cold worked
Cairo 24961	Handled vessel	Light Blue	Core-formed
Cairo 24960 AND Brooklyn 53.176.4	Rounded vessel	Light Blue	Core-formed
BM 47620	Jug	Light Blue	Core-formed with powdered glass decoration
MMA26.7.1175*	Krateriskos	Marbleised	"Glassy faience" – probably core formed

* Indicates Wadi Qirud provenance

Table 1: Vessels assigned to the reign of Thutmose III.

the measurements is reported in Table 2 along with the analysis of the Ashmolean chalice.

Major element analysis show that the Ashmolean chalice is a plant ash glass, similar in many ways, to the later Egyptian glasses from Amarna, but there are subtle differences (Table 2). These differences were also observed by Shortland *et al*. (2007) in the glasses they analysed of a similar date to the Ashmolean chalice. The chalice is coloured with copper and antimony which creates the opaque turquoise blue observed. Shortland *et al.* (2007) found that copper blue coloured glasses from Amarna often contain appreciable amounts of tin, but this component seems to be lacking in the early glasses and when it does occur it is only in trace concentrations. The Ashmolean chalice follows this pattern; it does not contain tin in a measurable concentration (Table 2). Whilst this factor suggests the Ashmolean chalice follows the same technological traits as other early Egyptian glass, it does not establish an Egyptian provenance.

A potential discriminator between glasses from different locations is the alkali which is derived from plant ashes. Potentially this might indicate the use of different plants, grown on differing geologies, used in glass production at different manufacturing locations. Figure 1 shows magnesium against potassium for glasses of Thutmose III and Amenhotep II (1427-1400 BC) alongside other data of this date.[13] This figure illustrates that for blue glasses from a variety of contexts the data is widely spread and does not give any further clue to provenance. What can be suggested is that the Gurob vessel falls within the distribution observed for other glasses of the period found in Egypt.

One specific colourant which has been used to suggest the use of an Egyptian raw material and hence glass production in Egypt is cobalt from Egyptian alum which has a distinctive chemical fingerprint.[14] However, the Ashmolean fragment is coloured only with copper, not cobalt, making an exploration of any compositional patterns relating to Egyptian or other cobalt sources impossible. Thus, the colouring compounds themselves cannot be used to suggests its likely provenance. Consequently these major element analyses do not tell us whether the glass is of Egyptian or Mesopotamian origin.

However, trace element analysis has been shown by Shortland *et al.* (2007) to prove a better indicator of possible origin. They have shown that the ratios of lanthanum and chromium discriminated between glasses found in Egypt and those found in Mesopotamia. Furthermore

13 Lilyquist and Brill 1993; Shortland and Eremin 2006.

14 Kaczmarczyk 1986.

Oxides (%)	Corning B published values (Brill 1972)	Corning B measured values (Brill 1972)	Ashmolean chalice
SiO2	61.5	60.75	60.10
Al2O3	4.21	4.43	0.38
CaO	8.69	8.67	7.84
Na2O	17.2	17.36	18.12
K2O	1.06	1.04	2.31
MgO	1.12	1.11	4.55
P2O5	0.9	0.76	0.18
TiO2	0.13	0.06	n.d.
CuO	2.68	2.74	2.97
ZnO	0.2	0.21	0.02
SnO2	0.03	n.d	n.d.
FeO	0.33	0.30	0.24
NiO	0.1	0.10	0.01
BaO	0.1	n.d.	n.d.
CoO	0.04	0.04	n.d.
PbO	0.5	0.39	0.02
Sb2O5	0.45	0.47	1.56
MnO	0.25	0.24	0.03
SO3	0.55	0.58	0.38
SrO	0.02	n.d.	n.d.
Selected Trace elements (ppm)	NIST612 published values (Pearce *et al.*, 1997)	NIST612 measured values (Pearce *et al.*, 1997)	Ashmolean chalice
La	36	40	2
Cr	40	42	2
Ti	48	53	291
Zr	38	41	23

Table 2: Corning B published and measured concentrations and major element analysis of Ashmolean chalice by EPMA (wt%) and trace element analysis (ppm) (n.d. indicates 'not detected' by the microprobe).

both titanium and zirconium tend to be found in higher concentrations in glasses from Egypt than those from Mesopotamia. These ratios have been used by other authors[15] to indicate the origin of glass of this period, around the Mediterranean, and to suggest possible trading links.

Using the Harrow chalice as one point of reference, the plot of lanthanum against chromium places the Harrow chalice mid-way between the Near Eastern and Egyptian glasses which does not give it a secure region of origin, whilst the Ashmolean chalice, although not falling amongst either the Egyptian or the Near Eastern samples, falls at the low end of both ranges though is very slightly closer to the Egyptian (Fig. 2).

However, plotting titanium against zirconium concentrations places the *Harrow* chalice firmly amongst the Egyptian data (Fig. 3). The Ashmolean chalice on the other hand has much lower concentrations of titanium and zirconium than the Harrow vessel, but plots somewhat nearer the Egyptian glasses than to those from Mesopotamia. This suggests that the Ashmolean chalice is more likely to be of Egyptian than Mesopotamian origin.

15 Eg. Walton *et al.* 2009; Jackson and Nicholson 2010.

Conclusion

Overall, the results from the Ashmolean chalice are not clear cut. One might have hoped that it would be both unambiguously Egyptian and have a composition similar to that of the Harrow chalice, but this is no so. However, it does fit within the distribution other early Egyptian glasses both in terms of its major, minor and trace element composition.

What we believe can be said with some degree of certainty is that the composition of the glass is more likely to be Egyptian than Near Eastern and since this particular form of vessel is rare then, if one accepts the dating of the Munich chalice to the reign of Thutmose III, it can be suggested that all those chalices so far examined belong to this era. When seen in that light it is, perhaps, unsurprising that there is variation in the composition since it might be expected that the earliest glasses might vary more in their composition than those at the height of Egyptian glass manufacture.

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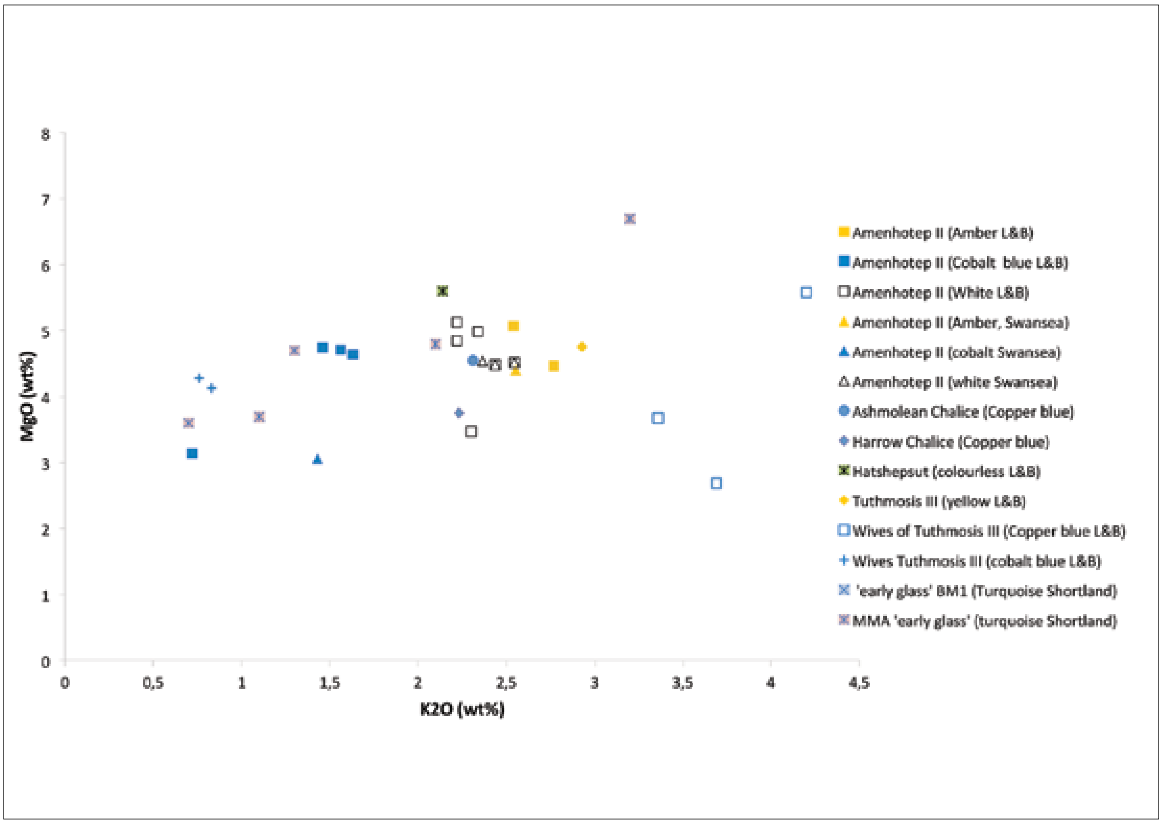

Fig. 1: Potassium and magnesium concentrations for early glasses from the reigns of Thutmose III to Amenhotep II (1479-1400 B.C.) (Shortland refers to Shortland and Eremin 2006, L&B refers to Lilyquist and Brill 1993).

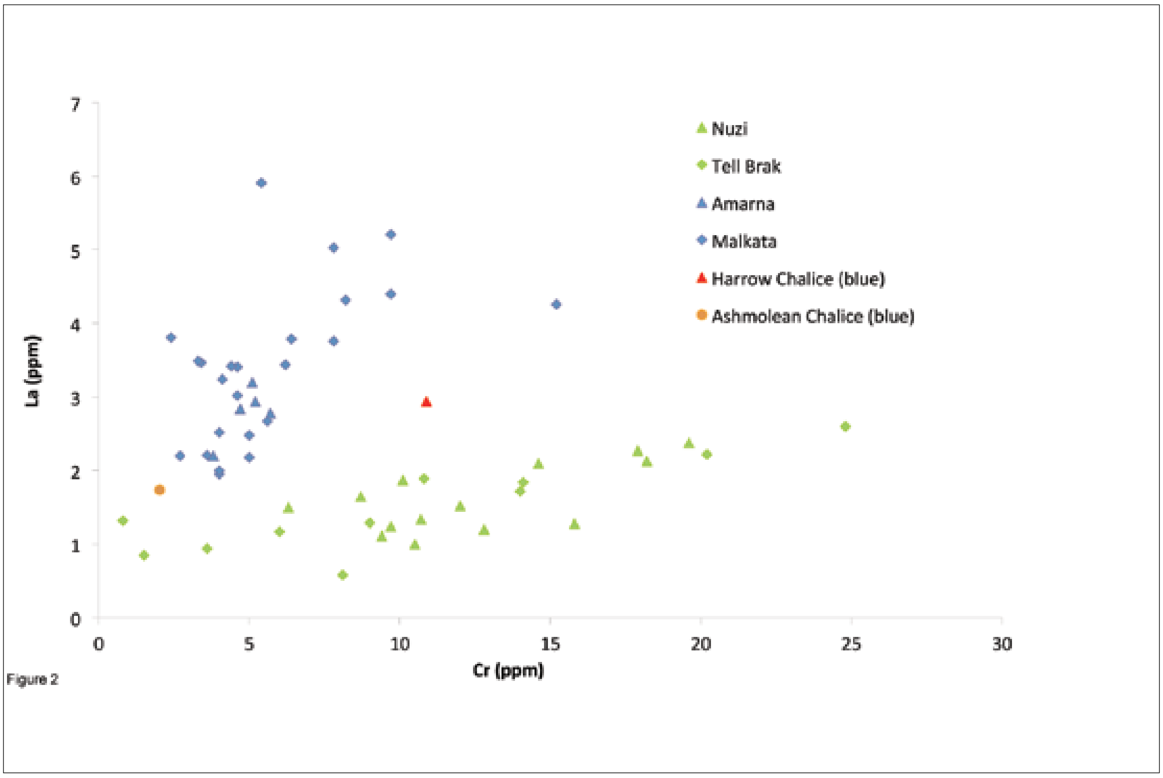

Fig. 2: Lanthanum and chromium concentrations of early glasses (data Amarna, Malkata, Tell Brak and Nuzi from Shortland et al. (2007), Harrow chalice data from Nicholson and Jackson 2012).

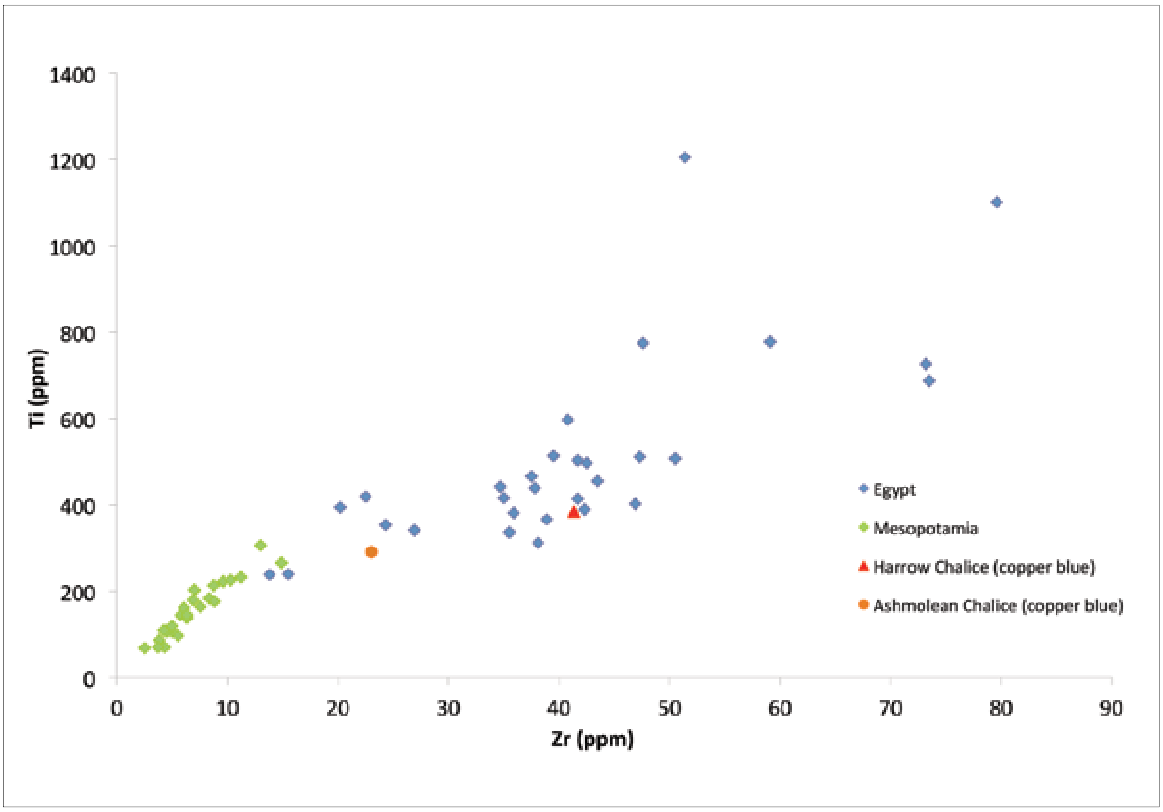

Fig. 3: Titanium and zirconium concentrations of early glasses (see legend to Figure 2).

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LE MOBILIER RELIGIEUX EN BOIS INCRUSTÉ DE VERRE DES TEMPLES ÉGYPTIENS: NOUVELLES DONNÉES (VII^{E} AV. J.-C. – I^{ER} SIÈCLE APR. J.-C.)

À la mémoire de Michel Wuttman

Pièces de mobilier datées par le nom des pharaons ou par leur contexte de fouilles, et *membra disjecta* de verre découverts dans des contextes d'atelier ou bien remisés soigneusement à la suite de la destruction de leur support, aident à retracer l'histoire de l'artisanat de l'incrustation à partir du VII^{e} siècle av. J.-C.[1] Les *naos* en bois, boîtes ouvertes à l'avant[2] ou bien fermées et s'ouvrant par une porte à deux battants,[3] figurent le sanctuaire, dans lequel on plaçait une statue de la divinité. Ils pouvaient être décorés de scènes d'offrande incrustées de verre sur leurs différentes faces. On connaît d'autres techniques d'incrustation : plaquettes de verre monochromes fixées grâce à des mortiers colorés dans des compartiments réservés sur des meubles, des sarcophages, des sculptures, des éléments d'architecture à claire-voie en bois, en marbre et en bronze,[4] ou bien plaquettes de verre polychromes à motif végétal ou géométrique fabriquées à partir de divers éléments moulés et/ou découpés, joints à l'aide de résine et de bandes de bronze, puis montés à l'aide de résine pour former de grands pectoraux.[5] À partir de l'étude des pièces du Louvre[6] et de découvertes anciennes et récentes, il m'a semblé utile de faire un bilan chronologique et technologique sur les *naos* et autres pièces de mobilier recevant des décorations figurées, qui témoignent de l'incroyable habileté des verriers égyptiens.

Le panneau arrière du naos d'Amasis (570-525 av. J.-C.) forme la tête de série chronologique.[7] Amasis agenouillé sur un tabouret offre la déesse Maât au dieu Sopdou, assis sur un trône. Les figures sont sculptées en relief et recouvertes de stuc doré. Les plaquettes en verre bleu foncé, bleu clair et rouge, de dimensions variant selon leur emplacement, apparaissent dans les frises de bordure, dans le

1 Voir Bianchi 1983a et b.

2 Voir le papyrus UC27934 ; Cervi 2011, fig. 2-3.

3 Insley Green 1987.

4 Arveiller-Dulong and Nenna 2011, 350-363.

5 Auth 2012 : éléments de la jarre de Dendara et pectoral conservé au Brooklyn Museum daté de l'époque de Ptolémée V.

6 Arveiller-Dulong and Nenna 2011, 367-383.

7 Arveiller-Dulong and Nenna 2011, no. 585 avec bibl. antérieure.

soleil ailé (bicolores, bleu foncé et rouge), dans la frise d'étoiles et dans les façades de palais. Dans la scène figurée, elles prennent place dans les hiéroglyphes désignant le dieu et dans le cartouche du pharaon, dans le trône et dans le tabouret bas. Dans la corniche d'un autre naos portant le cartouche d'Amasis, découvert à Saqqara,[8] les hiéroglyphes sont en verre rouge et bleu. En ce milieu du VIe siècle, on note donc l'utilisation de plaquettes monochromes et bichromes, avec une gamme limitée à trois couleurs, bleu clair, bleu foncé et rouge, imitant respectivement la turquoise, le lapis-lazuli et le jaspe.

Dans le panneau arrière du naos de Darius Ier (520-486 av. J.-C.),[9] le roi debout fait l'offrande de la déesse Maât à Anubis, assis sur un trône, derrière lequel se tient Isis debout. Les figures sont partiellement sculptées en creux, le reste du corps devait être représenté par des reliefs en stuc doré. Dans la figure de Darius, des éléments d'incrustation en verre monochrome moulé figuraient une partie de la couronne, la tête, le torse et les bras en position d'offrande, le devanteau du pagne à trois plis, et les jambes, ainsi que la petite déesse Maât. Pour le dieu Anubis, ils sont placés dans la couronne du dieu, dans le némès, les bras, les jambes et le sceptre; d'autres petits éléments décoraient le trône. La déesse Isis portait une couronne de cornes de vache en verre, ses bras et ses mains étaient incrustés de verre bleu clair, couleur réservée aux femmes, de même que ses pieds et son sceptre.

J'ai repris récemment l'étude du mobilier livré par les fouilles de l'IFAO, dirigées par Michel Wuttmann, sur le site d'Ain Manawir au Sud de l'oasis de Kharga,[10] dans le cadre de la publication définitive du temple de ce site. Les éléments d'incrustation ont été découverts pour certains dans l'angle Nord-Ouest de la salle hypostyle du temple devant la chapelle F-F', mais pour la plus grande majorité dans une petite jarre, qui avait été remisée dans l'une des pièces de service du temple (O). Cette jarre voisinait, avec une série d'ostraka et des pièces luxueuses pour un site aussi éloigné telles un lécythe attique, une gourde du Nouvel An, un support d'encensoir, qui ont fait considérer qu'il s'agissait là d'un *Set-en-hout-neter*, une pièce du temple possédée par le prêtre. Cet ensemble d'objets est contemporain ou postérieur à la fondation du temple dans les années 500-490. Il est antérieur aux années 410-400, si l'on considère que la jarre était rangée avec les ostraka d'un certain Harsiésis qui sont datés entre 410 et 400,[11] ou au plus tard aux années 380 qui signent la fin du fonctionnement du temple.

Les éléments d'incrustation sont façonnés en verre rouge (altéré en vert), en verre bleu foncé et un matériau intermédiaire bleu clair dont les matières constituantes ne sont pas parfaitement fusionnées (faïence vitreuse). Ces matériaux ont été moulés ou étirés en fils, qui ont ensuite été combinés de manière simple par accolement ou plus complexe en baguette pour créer un motif ovale.

Les éléments appartenant au décor architectural sont des plaquettes rectangulaires de plusieurs modules qui ornaient les frises de bordure des scènes et des éléments appartenant au décor de la corniche en gorge de différents formats. Ces derniers ne se comprennent qu'en se référant au mode de fabrication et à des exemples de corniches à tiges segmentées.[12] Issu de l'atelier de Tebtynis, un moule d'angle de corniche en plâtre (Fig. 1) présente cinq rangées superposées d'éléments de tiges segmentées. Chacun des éléments montre une extrémité supérieure convexe et une extrémité inférieure concave pour donner un effet d'emboîtement vertical des segments de tige. Les éléments d'une même rangée présentent une hauteur semblable, mais chaque rangée a sa hauteur propre. En outre, dans chacune des rangées, la largeur des éléments diminue progressivement vers le bas. Enfin, les éléments plats appartiennent

8 Insley Green 1987, 10, no. 8, fig. 12.

9 Bianchi 1983a, 31, fig. 3; Tait 1991, 54, fig. 62 en couleur. Voir aussi sans doute de la même époque, Arveiller-Dulong and Nenna 2011, no. 586.

10 Voir déjà Nenna 2000, 20-21, fig. 1-2; Nenna 2006, fig. 9a-b.

11 Chauveau 2010.

12 Voir la grande corniche de la collection Clot-Bey, Arveiller-Dulong and Nenna 2011, no. 579.

aux rangées inférieures tandis que, pour les éléments courbes, la courbure augmente vers le haut selon la place de la rangée. Les éléments de tige segmentée, tels ceux d'Ain Manawir, étaient donc probablement moulés par groupe. Vu la répartition des couleurs et des tailles du mobilier contenu dans la jarre d'Ain Manawir, on suppose la présence d'au moins deux corniches : une corniche à décor de trois couleurs, rouge, bleu foncé et bleu clair appartenant à un naos de petite taille et une corniche à décor monochrome bleu clair appartenant à un naos de grande taille.

D'autres éléments appartiennent à la représentation du soleil ailé : deux disques rouges de grande taille devaient figurer le soleil ; un certain nombre d'éléments avec une extrémité effilée les rangées de plumes du soleil ailé. Ils devaient être moulés, au vu d'un moule découvert aussi à Tebtynis (Fig. 2).

Viennent enfin, les éléments se rapportant aux personnages représentés dans les scènes : il s'agit d'éléments moulés avec une face bombée et l'autre plate et les côtés biseautés. On peut restituer le mode de fabrication à partir des outils des différents ateliers connus : création d'un archétype avec les différentes parties de corps et de vêtements en relief,[13] confection des moules en céramique ou en plâtre,[14] mise en place du verre sous la forme de poudre pour les pièces monochromes ou d'éléments semi-finis, recouverts par une plaque de verre pour les pièces en verre mosaïqué, cuisson, et réchappage des pièces pour créer des pourtours biseautés, facilitant la mise en place des pièces.

Un patient travail de mesure et de réflexion sur les positions, les attributs et les couleurs – les couleurs employées permettent de déterminer le sexe du personnage, le bleu clair est réservé aux personnages féminins, le bleu foncé aux divinités masculines, le vert clair à Osiris, tandis que le rouge peut désigner aussi bien des divinités masculines que le pharaon – permet de restituer au moins quatre scènes à partir des 53 éléments conservés dans la jarre : une scène à quatre personnages (B), soit le pharaon en train de faire l'offrande de Maât à Ammon assis sur un trône, derrière lequel se tiendrait Mout, assise sur un trône et coiffée de la double couronne et Khonsou debout à tête de faucon avec némès (Fig. 3). Cette triade ammonienne classique pourrait renvoyer au culte d'Ammon

Fig. 1: Tebtynis : moule en plâtre pour les éléments d'une corniche à tiges segmentées. Turin, Museo Egizio S18566, H. 7 cm.

Fig. 2: Tebtynis : moule en plâtre pour les éléments du soleil ailé de l'architrave de l'architrave. Turin, Museo Egizio, S19220, H. 6,1 cm.

13 Schwartz 1969, 95-96, pl. XIXb (Dionysias); Grose 1989, 353, fig. 160 (coll. L. Ishiguro, Tokyo); *JGS* 34, 1992, 126: Corning Museum, inv. 91.7.8 (sans provenance).

14 Par exemple Petrie et Griffith 1888, 42-44, pl. XVIII; Arveiller-Dulong et Nenna 2011, 366 et 378, nos. 606-607.

Fig. 3: Ain Manawir : proposition de reconstitution d'une des scènes d'offrande. IFAO, M. Ibrahim.

Fig. 4: Ain Manawir : têtes découvertes dans la jarre (1-4) et dans la salle hypostyle (5-6). IFAO, M. Ibrahim.

Fig. 5: Tebtynis : éléments découverts dans le contexte de l'atelier. IFAO, J.-Fr. Gout.

d'Hibis qui est attesté dans les ostraka d'Ain Manawir. Deux scènes (C et D) comprennent des déesses ailées, dont le costume est en verre mosaïqué, on peut en proposer une restitution avec un roi faisant une offrande à un Osiris rouge tenant un sceptre, (l'Osiris-Iou de Douch est un Osiris non momiforme), suivi et protégé par une Isis ailée. Enfin, l'existence d'un autre scène est attestée par la présence d'une tête de taille plus importante (A : Fig. 4.1). Les têtes de l'ensemble C/D se différencient nettement par l'absence de relief (Fig. 4.3-4) de celles de l'ensemble B (Fig. 4.2). En terme stylistique, la tête (Fig. 4.5) provenant de la salle hypostyle, où a aussi été découvert une tête de faucon (Fig. 4.6), est encore différente. Grâce à la découverte d'Ain Manawir, on dispose désormais, sans doute pour le plein ve siècle, d'exemples bien datés, avec la plus ancienne attestation du verre mosaïqué.

L'introduction de nouvelles couleurs, telles que le jaune, l'orange, le vert clair, le blanc, s'effectue au milieu du ive siècle comme l'atteste le panneau arrière du naos de Nectanebo II (règne de 359-341 av. J.-C.),[15] qui présente des plaquettes en verre de ces couleurs dans l'ornementation des cobras et de la divinité et dans les frises de bordure; les grandes façades de palais étant décorées de plaquettes en verre mosaïqué. En outre, on passe dans la seconde moitié du ive siècle, de figures composites avec la combinaison de compartiments réservés aux éléments en verre et de parties dorées en relief, à des figures unifiées, avec un seul compartiment pour l'ensemble de la représentation constituée uniquement d'éléments en verre. En sont témoins les sarcophages en bois de Pétosiris et de son frère,[16] qui vécurent dans la seconde moitié du ive siècle av. J.-C., le fragment Kofler Truniger,[17] qui portent des colonnes de hiéroglyphes reproduisant un passage du Livre des Morts, mais aussi un angle de coffre, conservé au Louvre, récemment publié,[18] dont le texte sur les deux faces indique qu'il s'agit d'un don royal effectué dans un site voisin de Memphis, Hes. La majorité des hiéroglyphes sont en verre monochrome, mais les hiéroglyphes des oiseaux, des corbeilles, des enseignes divines sont constitués d'éléments mosaïqués combinés en un seul compartiment pour toute la figure et reposant, comme dans le cas des divinités féminines d'Ain Manawir, sur une plaque de verre monochrome.

Seuls deux panneaux de bois qu'on peut dater de la haute époque hellénistique conservent les incrustations de verre encore en place, l'un (h. 23 cm, larg. 19 cm) découvert à Saqqara dans un contexte perturbé présente le pharaon faisant une offrande à Harpocrate debout et à Isis assise sur un trône,[19] l'autre mis au jour à Tebtynis dans les années 1930 (H. 17,2; larg. 23 cm) montre le pharaon et la reine faisant une offrande à Harpocrate et à Isis-Hathor.[20] Là encore, les parties en verre mosaïqué sont constitués d'éléments reposant sur une plaque de verre monochrome.

Dans une série d'éléments d'incrustation qu'on datera un peu plus tard sans doute dans le iiie siècle, on note une miniaturisation des décors mosaïqués, avec des découpes très soignées des éléments moulés.[21] Ainsi, dans

15 Riefstahl 1968, 109, no. 69; Fazzini *et al.* 1989, no. 79.

16 Aldred *et al.* 2009, 96 fig. 51 et 234, fig. 157.

17 Müller 1964, no. A186. Le fragment de cartonnage Gliddon placé par Bianchi 1983a, 34, fig. 6 (pour des photos en couleur voir http://www.mnh.si.edu/ no. inv. A1415-0) dans ce groupe semble plutôt montrer des hiéroglyphes peints.

18 Arveiller-Dulong and Nenna 2011, 372-372, no. 589.

19 Insley Green 1987, 10-11, fig. 13: les couleurs employées, ainsi que les compartiments uniques pour chaque figure indiquent que l'on se situe au moins dans la seconde moitié du ive siècle et non aux vie-ve siècles comme proposé.

20 Rondot 2004, fig. 71. On ajoutera Arveiller-Dulong and Nenna 2011, no. 587 qui a perdu tous ces éléments de verre.

21 Nenna 2006, fig. 11 (sceptre); Müller 1964, no. A197a (sceptre) et c (bretelles); Arveiller-Dulong and Nenna 2011, 375, no. 595 (sceptre) et 601 (bracelet de poignet); Coll. Per-neb I, 1993, nos. 36 (bracelet de bras) et 43 (élément de costume); Coll. Per-neb II, 1993, no. 180.3 (bracelet de bras et bretelle); voir aussi un groupe d'éléments d'incrustation (parties de corps et hiéroglyphes) provenant de naos différents conservé au Metropolitan Museum of Art, *Ars Vitraria* 2001, 16.

les déchets de l'atelier de Tebtynis (Fig. 5),[22] on observe l'insertion d'éléments mosaïqués complexes dans les parties monochromes du corps tels une alternance de tirets verticaux et rosettes (Fig. 5.1) ou de fleurs de lotus (Fig. 5.2) pour la figuration de bracelets de bras, ou de bandes bichromes pour celle d'un sceptre-*ouadj* (Fig. 5.3). En revanche, la découpe de la partie supérieure du corps laisse la place pour le collier *ousekh* à rangs de rosettes, de pétales cernés et de fleurs de lotus et la perruque ou la coiffe qui sont manufacturés à part. Un même miniaturisation des motifs est attestée dans les déchets de l'atelier de Tell Gemayemi dans le delta[23] et dans celui de Soknopaiou Nesos.[24]

Deux styles de tête semblent prévaloir à la haute époque hellénistique comme le montre l'archétype de la collection Ishiguro. Les têtes aux traits fins, dont la taille verticale de l'arrière du cou implique le port d'une perruque ou d'un némès, sont attestées en verre rouge (Fig. 5.4),[25] bleu clair (Fig. 5.5),[26] bleu foncé[27] et vert foncé.[28] Les têtes au cou fort à extrémité arrondie, qui recevaient divers types de couronnes recouvrant le crâne, sont à de rares exceptions près,[29] uniquement en verre rouge. L'ajout d'un élément supplémentaire pour figurer l'œil, et parfois le sourcil (Fig. 5.3-5), attesté sur les pièces de l'atelier de Tebtynis, n'est pas systématique et pourrait relever de la pratique d'ateliers différents plutôt en terme de date que de localisation, dans la mesure où il y a de fortes chances que les verriers qui manufacturaient de tels objets aient été itinérants. Parmi les têtes à fort cou, on pourrait distinguer sans doute des variantes, en fonction de la courbure arrière du cou plus ou moins accentuée, liée à la forme de la coiffe ou de la couronne[30] et du caractère joufflu ou non du personnage. La variante joufflue est la plus commune[31] et peut varier en dimensions (les plus petits exemplaires mesurent 2,4 cm, les plus grands 6,5 cm, avec une concentration autour de 3,3 cm), mais on rencontre aussi des visages plus fins.[32] Peu d'objets proviennent de fouilles scientifiques: la très belle et grande tête de Méroé (h. 6,8) a été trouvée dans la tombe W323 datée des années 40-50 apr. J.-C., il s'agit sans doute d'une pièce bien plus ancienne que la tombe, et récupérée. Une tête joufflue (sans ajout de détail pour les yeux ou le sourcil) a été trouvée récemment à Bakchias. La fouille du temple a livré un très abondant mobilier en bois incrusté. Plus de 60 kg de fragments de bois et 530 éléments d'incrustation en verre ont été mis au jour dans les couches de destruction du temple datées de la fin du IV^e siècle-début V^e siècle apr. J.-C.; ils ont été récemment publiés en détail, mais sans essai de reconstitution.[33]

La tête de Backhias et ses parallèles se comparent aussi à un ensemble d'éléments découverts en 2009 à Tell el-Herr dans le nord-ouest du Sinaï.[34] Le mobilier mis au rebut avait été déposé dans une fosse sans doute dans un contenant en bois; la date du dépôt est difficile à cerner, mais se situe dans la première moitié de l'époque ptolémaïque. Il contenait notamment

22 Rondot 2004, fig. 67 et 69.

23 Petrie et Griffith 1888, 42-44, pl. XVIII.

24 Cervi 2012.

25 Rondot 2004, fig. 67j; Dépôt de fouilles de Karanis inv. 7905.4. toutes deux provenant de Tebtynis.

26 Goldstein 1979, no 702; Coll. Per-neb I, 1992, nos. 26, 34, 39; Coll. Per-neb II, 1993, no. 181; Stern and Schlick-Nolte 1994, no. 107-108; Rondot 2004, fig. 67a et i, fig. 68a (Tebtynis); Arveiller-Dulong and Nenna 2011, no. 591 (Tanis), pour ce dernier site, voir aussi le moule de torse, *ibid.*, no. 606.

27 Terrace 1963, 269-270, pl. 56,1; Coll. Per-neb II, 1993, no. 171 (dr.), 178. Musée gréco-romain, inv. 24851 (inédit).

28 Coll. Per-neb II, 1993, no. 180.

29 Stern and Schlick-Nolte 1994, no. 106 (bleu foncé h. 2,2); Spaer 2001, no. 561 (vert foncé h. 2,5).

30 Comparer par ex. Coll. Per-neb II, 1993, no. 173 et no. 175.

31 Dunham 1963, 258, fig. 168.6 (Méroé, Boston Museum of Fine Arts 24.548); Riefstahl 1968, 109, no. 76; Scott 1986, 148, no. 82; Fazzini *et al.* 1989, no. 87; Coll. Per-neb I, 1992, nos. 30-31; Coll. Per-neb II, 1993, nos. 171, 173-175; Stern and Schlick-Nolte 1994, no. 105; Bermann 1999, 494, no. 391 (jaspe rouge provenant d'Edfou); Arveiller-Dulong and Nenna 2011, nos, 592-593.

32 Coll. Per-neb I, 1992, no. 42; Coll. Per-neb II, nos. 177, 179.

33 Gasperini, Paolucci and Tocci 2008, pour la tête no. 76.

34 Valbelle and Marchi 2012.

67 tambours en faïence de colonettes d'un naos. Les 167 éléments d'incrustation étaient principalement en verre rouge, mais on note aussi des pièces en verre mosaïqué, non décrites dans la publication. Parmi les personnages, on remarque un Harpocrate debout et un Osiris momiforme. Les différents éléments se rapportant au Pharaon montre que ce dernier était en position agenouillée en train de faire une offrande. À cela s'ajoute différents éléments faisant partie du décor et des hiéroglyphes. Les éléments décrits proviennent d'au moins cinq scènes différentes réparties selon les auteurs sur l'arrière, les deux côtés et les deux battants de porte frontaux d'un même naos. La pratique de remiser des éléments en verre détachés de leur support dans un contenant en céramique dans le cas d'Ain Manawir ou en bois dans celui de Tell el-Herr en raison de leur caractère sacré est encore attesté à la fin de l'Antiquité avec les deux jarres contenant des éléments appartenant pour l'une à un naos, pour l'autre à un grand pectoral et les tambours de colonne de verre découverts dans les catacombes d'animaux sacrés du temple de Dendara.[35]

La datation précise des lots de Tebtynis, Soknopaiou Nesos, Bakchias, de Tanis, de Tell Gemaiyemi et de Tell el-Herr, est difficile : ils proviennent de fouilles anciennes mal documentées, de couches de destruction et d'abandon de l'époque romaine tardive, ou de contextes perturbés récemment. On se situe sûrement dans le IIIe siècle av. J.-C. comme le montre la seule pièce datée intrinsèquement, un fragment de meuble portant une titulature relative à Ptolémée V qui montre un faucon avec un collier *ousekh*[36], mais rien pour l'instant ne nous permet de savoir combien de temps ces techniques de miniaturisation ont continué à être pratiquées, avant le bond technologique à la fin de l'époque hellénistique que constituent les représentations figurées complexes tirés de la religion égyptienne ou du répertoire théâtral.[37] La combinaison d'éléments préfabriqués y atteint une complexité encore plus grande, mais le travail se simplifie une fois la barre constituée car il est possible par découpage de la barre de répéter le même motif à l'infini. En dehors de ces pièces et du possible pectoral de Dendara daté du tournant de l'ère par S. Auth, peu de pièces de mobilier de temple présentant des scènes religieuses composés d'éléments moulés peuvent être datés avec certitude de la basse époque hellénistique ou du Haut Empire et ce sont essentiellement des sarcophages ou des cartonnages qui offrent ce type de figures. Elles montrent un recours limité à la miniaturisation et au verre mosaïqué,[38] à l'exception de deux grands colliers *ousekh*,[39] sans doute destinés vu leur taille, à orner des sarcophages qui montrent des motifs notamment de palmettes et de fleurs à pétales cordiformes et que l'on date à partir de trouvailles dans des contextes bien datés des Ier-IIe siècles apr. J.-C.[40]

35 Auth 2012.

36 Tait 1991, 54, fig. 63.

37 Mahnke 2008; Arveiller-Dulong and Nenna 2011, 384-391.

38 Arveiller-Dulong and Nenna 2011, 367; voir Coll. Per-neb III, 1993, no. 183-184.

39 Auth 2005.

40 Arveiller-Dulong and Nenna 2011, 387.

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THE GAME OF GLASS BEADS IN THE ATTIRE OF THE CULTURES OF CAPUT ADRIAE AND ITS HINTERLAND

Subtle elements of attire, sometimes almost invisible to the eye of the beholder but loaded with meaning, were the main objects of the "*Glass bead game*". Following the traces towards its beginning, we reach the period of the Late Bronze Age on the territory of the eastern extension of *Caput Adriae* and its hinterland; the period when ownership of metals reached its social and cultural climax, causing a frenzy of the social and religious elite obsessed with the supply and circulation of different metals. Important consequences of this state included the creation of so-called global connectedness, of reconciliation of *exacta* and of the *independent*.

Connected to the concept of the Late Bronze Age metallurgy were the interpretation of the finds of so called "exotic" attributes, the circulation of which was linked to the acquisition and production of bronze artefacts. Among them were specially "desired" glass beads which, beside the amber cunterparts, quickly became the indicators of luxury and prestige in the movement of goods towards the "ideal" end. The oldest glass beads from the sites on the northern Adriatic and the closely linked south-eastern Alpine hinterland were "caught" in the ambience of these "new" social and economic models. Since their technological and chemical analyses are still missing, they will be presented contextually and typologically and so linked directly with the trends of activities of the vast cultural *koiné* ranging from the Alps to the Aegean.

On the aforementioned territory, almost every large necropolis excavated together with other finds contained at least a smaller number of glass beads which could be generally classified into two groups –monochrome and polychrome. From a typological point of view, they can be placed into three categories with additional variants (Fig. 5).[1]

Most frequently used were small flat ring shaped beads of the so called Type I (Fig. 1; Fig. 4). They were generally of oval or circular forms and monochrome – mostly of a naturally light blue or green colour. Typologically, they could be further divided on every site according to variations of their size and form.

1 The typological division has been proposed by the Italian researchers Bellintani and Stefan (2009).

Small ring-shaped dark blue beads were well known from older publications. First of all, these were finds from the necropolis Brežec in Škocjan on Slovenian Karst, where the grave (number 155[2]) of a rich female should be noted. Furthermore, they are known from the territory of the Dolenjska group and from graves in Ljubljana[3] and Novo Mesto[4] as well as to the north-east at the southern edge of the Pannonian territory, from the luxuriously equipped grave 7 linked to the necropolis in Ormož.[5] On Adriatic territory they were known from the necropolis of St. Barbara / Elleri in the gulf of Trieste,[6] and from the necropolis of Limska gradina on the western coast of Istria.[7] In addition, there have been important finds of monochrome beads from Dalmatia – Privlaka near Nin, Vranjic near Solin and Babino polje on the island of Mljet.[8] Recent research in Northern Dalmatia led to the discovery of 3 beads in the grave I/4 in Kosa near Ljubač (Fig. 5).[9] Regarding their typological characteristics, these beads have excellent comparisons on the Italic peninsula, especially on sites of the Po Plain[10] and extending to the broader Central and Western Alpine territory.[11]

In relation to the territory discussed, it is necessary to highlight the relatively newer finds since they provied solid evidence for chronology. First of all, these are the beads from the necropolis Gorice near Turnišče in Prekmurje/Eastern Slovenia. Altogether 30 blue ring-shaped beads of the type I were discovered in cremation graves.[12] Grave no. 1, containing two beads of this type, is especially interesting due to its radiometric dating. Structural carbonate from the cremated bone fragments, belonging to an adult male, was also dated (Fig. 1). Due to the pottery form and the results of the radiocarbon dating, the grave was dated to the older phase of the Urnfield culture of the Late Bronze Age (KIA31892 3066±34),[13] consequently making the glass beads, equated with the HaA1 phase of central European periodization in the13th century BC, the oldest finds of this kind on Slovene territory today.[14]

It has also been possible to date to the beginning of the Late Bronze Age the truly unique find of glass beads from the southern hinterland of Lika from the cave of Bezdanjača (Fig. 2). There, a representative number of 34 dark blue glass beads of type I was discovered, together with two sea snails.[15] Although lacking a direct context in the cave, due to their typological and stylistic characteristics and the presence of other finds in the cave, they could be dated to the BrD/HaA1 phase.[16]

Among the sites located on the Adriatic coast, the necropolis on the Limska gradina

2 Vitri 1977, 91, no. 39.

3 Starè 1954, 64, pl. XLVI, 7; Puš 1971, 30, pl. 16, 13; Puš 1982, 36, 38, pl. 25, 8; pl. 27, 8.

4 Knez 1984, pl. 4, 1; Križ 1995, 38, no. 37; 57, no. 113.

5 Tomanič-Jevremov 1989, 282, pl. 16, 5.

6 Montagnari Kokelj 1997, 150, pl. 24, pl. 17, 5.

7 Mihovilić 1972, pl. 12, 16-17; pl. 26, 24.

8 Batović 1983, 315, 345, 363, Fig. 24, 6, pl. XLVIII, 8-12, pl. LI, 6-7 (with older literature). They were considered the only sites with such finds at the Eastern Adriatic coast (Forenbaher 1995, 277, fig. 14-17; Barbarić 2010, 318).

9 Vujević 2011, 10-11, pl. III, 3.

10 Salzani 1992, fig. 17, 19. 21; 18, 6-7; 22, 5. 9, 10; 24, 3. 8; 31, 4; 40, 4; 41, 10; 45, 15; etc.; Towle et al. 2001, fig. 6, 36-39; Bellintani and Stefan 2009, 72, etc. - with earlier literature.

11 Only the most representative and chemically analyzed finds are taken into consideration. For example Salorno, Hauterive Champreveires, Allendorf (Rychner-Faraggi 1993, 64, fig. X, XII, 78; Bellintani and Stefan 2009, 81-82, fig. 3-5; compare Towle et al. 2001 - with earlier literature).

12 Plestenjak 2010, 44, no. 85-86; 100-104; 116-117.

13 Plestenjak 2010, 40-41, 43-44, 62, figs. 29; 33, A1; 87; 96; no. 85-86; as well as personal information.

14 From two other sites, Šiman pri Gotovljah (Tomažič, Olić 2009, 15, 49, no. 384-385) and Piran (Karinja 2013), also originates a small number of blue glass beads from the Late Bronze Age period. They cannot be precisely determined due to the unclear circumstances of discovery and due to the lack of any chemical analysis performed on them.

15 Kukoč 2009, 21, fig. 44 - with earlier literature.

16 Samples Z-174 (3351±80 bp) and Z-186/II (3299±60 bp) (Sliepčević and Srdoč 1980, 81-82).

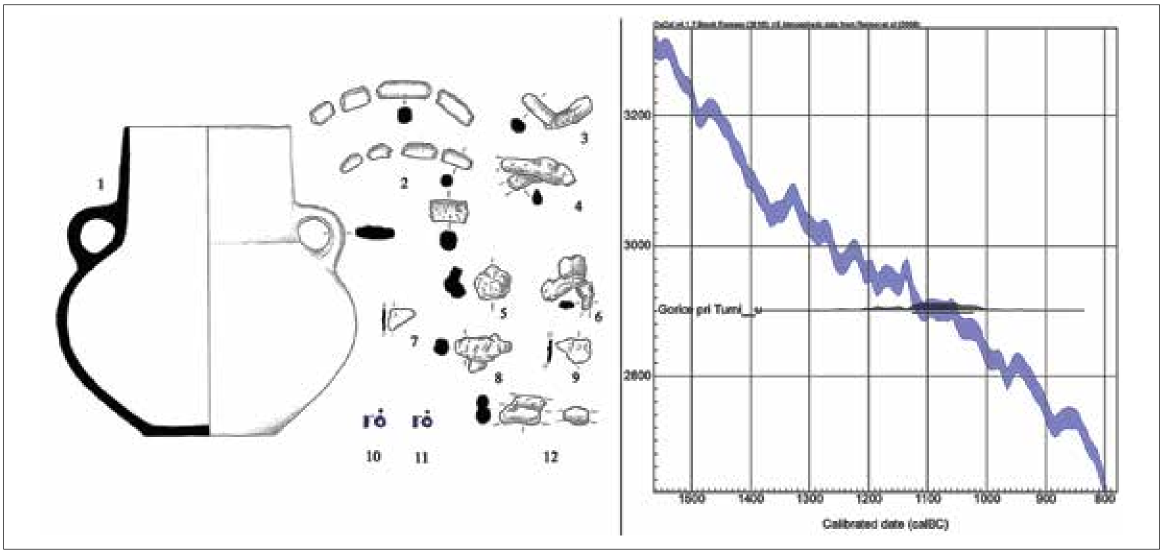

Fig. 1: Gorice pri Turnišču, grave 1, and the results of the radiocarbon dating plotted against the calibration curve (after Plestenjak 2010).

plays a special role where altogether 10 beads of the type I were discovered in graves. However, this site is special because of the presence of polychrome beads. So-called barrel-shaped beads were discovered in two interesting and rare graves (Fig. 3).[17] They represent an interesting group designated as Type II. Due to their size and decoration, they can be separated into two variants. Three examples from graves 57 and 60[18] were included in the Type IIa with barrel-shaped beads of bluish and green color with white spiral thread. Firthermore, it is important to note the discovery of a greenish bead with a white trail from a distant grave 289 in Dobova in Slovenian Posavje (Fig. 5).[19] That latter burial was that of an adult female and is one of the most prestigious and wealthy graves of the necropolis, comparable to grave 57 in the necropolis in Limska gradina. Alongside this grave a bead of the Type IIb is present. These were elongated spindle shaped beads of a dark blue colour with the chevrons decoration made of white trails.[20]

17 Mihovilić 1972, 29-30, 33, pl. 26; pl. 30.

18 Mihovilić 1972, 30, 33, pl. 26, 23; pl. 30, 4-5.

19 Starè 1975, 34, pl. 41, 3; Gabrovec 1983, 56, pl. VII, 16.

20 Mihovilić 1972, 29, pl. 26, 4-5.

Identical beads were discovered on the territory of Frattesina.[21] They were also presents in other well-dated sites, mostly pile dwellings in Italy and in the Alps.[22] Although they appear from BrD onwards, they are most numerous in the so called "wealthy horizon" of the HaA2/B1 period while they remained in use only in the HaB1/B2 phase.[23] Consequently they were discussed in the Istrian Ia and the Dobova II regional phases.[24]

Another larger concentration of glass beads occurred in the necropolis in Tolmin, in the territory of Slovenian Posočje, where 62 examples were discovered in 29 graves.[25] The

21 Salzani 1992, fig. 13, 7; 24, 3; 29, 9; compare Towle et al. 2001, 11-14, fig. 6, 41-44; Bellintani and Stefan 2009, 75-77; Bellintani 2011, 268-271, fig. 4, 19-20.

22 E.g. Hauterive, Cortaillod, Lausanne, etc. Rychner-Farragi 1993, 64-65, fig. XI, XII, XVI, 78; Bellintani, Stefan 2009, 80-83, fig. 3-6; Bellintani 2011, fig. 4, 1,7,12-14, 17; Bellintani and Usai 2012, 1128, fig. 1, 11.

23 Bellintani et al. 2004, 1507, 1513, fig. 2.

24 Mihovilić 1972, 44-45; Teržan 1995, 338-339, fn. 45-47.

25 Pogačnik 2002, 65-67, figs. 59-62. Beside in the female, they appear also in male graves as judged according to the attire of the deceased from the graves 113, 163 and 222 (Svoljšak and Pogačnik 2001, 51, pl. 21, 16-17; 68, pl. 29, 7; 90, pl. 40, 4).

Fig. 2: Glass beads from Bezdanjača (after Kukoč 2009).

most interesting was the burial of a female (number 459), one of the wealthiest burials on the necropolis (Fig. 4). Besides the fibulae of different typological characteristics, 16 small beads of dark blue colour of Type I were discovered. The grave was, according to the context, synchronized with the central-European HaB1 phase.[26] It is interesting that in the same grave a further 5 round dark blue beads decorated with 3protruding white eyes were discovered.[27] Good comparisons can again be drawn with the examples from the Frattesina settlement and necropolis.[28]

In the second half of the 11th and whole of the 10th century BC (Ha B1-B2), circular polychrome beads appeared on the aforementioned territory, but only on appointed sites. They were determined as Type III according to decoration of profiled and bulged ornament – the co-called eye. Their number and technology of decoration suggest the recognition of different variants (Fig. 5). Two large groups are those with three (Type IIIa) or four eyes (Type IIIb). Besides the aforementioned grave in Tolmin, it is worth recalling the finds of grave 13 from the necropolis SAZU in Ljubljana, where a dark blue bead with four eyes was discovered,[29] a find almost identical to the one made of dark glass from grave 67 at the necropolis in Limska gradina.[30] The discovery of a turquoise blue bead with distinctly profiled eyes from Podosojna Cave on the eastern side of Istria[31] can also be added to this group (Type IIIb), where it was discovered in a Late Bronze Age fireplace in a cave (Fig. 5).

Since they differ from all other known examples of Type IIIb, which generally belong to the later form (Type IIIb2), the closest comparisons could be made again with the Frattesina complex[32] and other Alpine sites.[33] This observation is also confirmed by their dating since the bead from grave 67 from the necropolis in Limska gradina was dated according to its context to the Ib phase of Istrian culture, chronologically synchronized with the HaB2 phase. The same grave should also be compared to grave 13 from the necropolis in Ljubljana, linking at least its initial phase of the relative phase Ljubljana Ib with the second half of the 10th century BC.[34]

Younger forms of the Type IIIb, the so-called Type IIIb2 beads, were discovered in Pula,[35] Brežec in Škocjan,[36] Tolmin,[37] Ljubljana[38] and Novo Mesto (Fig. 5).[39] The latter became the

26 Teržan 2002, 95.

27 Svoljšak and Pogačnik 2001, 189, pl. 88, 15-16.

28 Salzani 1992, 130, fig. 17, 20; 29, 9; 41, 8; etc.; Bellintani and Stefan 2009, 77.

29 Starè 1954, 30, pl. XIV, 3.

30 Mihovilić 1972, 35, pl. 32, 10.

31 Starac 1994, 22, Prilog XIII, 5.

32 Towle *et al.* 2001, 12-13; Bellintani and Stefan 2009, 78-79.

33 Rychner-Faraggi 1993, 64-65, fig. XII, 78; Bellintani and Stefan 2009, 81-82, fig. 4-5; Bellintani 2011, fig. 4, 2, 4, 5, 8-9, 15.

34 Pare 1998, pl. 4.

35 Percan 2008, 34-35, fig. 35, pl. 31, 253-265. Several of the presented beads could be attributed to the Late Bronze Age production; especially a rare type of a large bead with several concentric circles, comparable to the one discovered in the grave 427 in Narde (Salzani 1992, fig. 37, 9), as well as several beads with a drop-like ornament.

36 Vitri 1977, 84, 88, pl. XI, pl. 130.9; pl. XII, pl. 150.10-11; etc.

37 Svoljšak and Pogačnik 2001, pl. 37, 13-14, pl. 40, 4, pl. 66. 13, pl. 67, 9, pl. 68, 15, pl. 83, 7.

38 Starè 1954, 64, pl. XLVI, 7; Puš 1971, 30, pl. 16, 13.

39 Knez 1984, pl. 4, 1; Križ 1995, 33, no. 17; 38, no. 37; 41, no. 51; 43, no. 59; 57, no. 113; Križ, Stipančić, Škedelj Petrič 2009, 246, no. 6.

production centre of more developed beads, which in the Iron Age became completely smooth and popular, especially in the territory of Dolenjska and in the Japodian cultural group.[40]

In conclusion, all three basic types of glass bead can be found on the territory of the eastern side of *Caput Adriae* and its hinterland during the Late Bronze Age. They were mostly worn independently as amulets and sometimes as necklaces in combination with beads from other materials, mostly bone and amber. They occurred in combinations of Type I beads with Type II and Type III, while a joint occurrence of Types II and III is still missing. The only site where all three types were discovered is the necropolis of the hill-fort Limska gradina in Istria (Fig. 5).

Chronologically, they can be traced from BrD/HaA1 and all the way to HaB2/HaB3 period when they appear changed in Early Iron Age contexts. Ring shaped beads seem to have been consistently used in all phases of cultural development as they were discovered on numerous sites and on different sets of attire. Research has suggested that they were not all products pf direct imports, but could also be perceived as regional products.

It seems that an interesting and not widely accessible "*Game"* was played with glass beads that had special morphological forms, which were until now, discovered only in Istria and its hinterland without crossing the line represented by the river Sava (Fig. 5 map). Their concentration in quantitative, qualitative and divergent so as to mark the periods HaA2/B1 and B1, which represented the first phases of regional cultures from the 12th to the 10th century BC.[41] In this period, barrel-shaped beads (Type II) appear while later on in HaB1, according to the European trends, the earliest forms of eye beads also make their appearance (Types IIIa1, IIIb1). They remained in use in the subsequent phase HaB2 while the younger forms (Types IIIa2, IIIb2), dated to the 9th century BC, can be interpreted as the results of local productions. The comparison of these examples has reinforced the existing arguments concerning early production connected to the sites on the Po plain.[42] Consequently, when considered as direct imports, the beads of the II, IIIa1 and IIIb1 types can be linked to the so called "*Frattesina type*"[43] beads with the artisan complex of the *Frattesina phenomenon*,[44] incorporating them to the well-known circulation of goods in the territory of *Caput Adriae* and its Alpine hinterland, ranging from its west and all the way to its eastern side.[45] Cultural contacts with these regions were long known since they were reflected in the general trends of the wealthier sets of attire. This interpretation could also be linked to the expansion of technologies and trade with the alpine bronzes and understood within the complex context of other finds from Central and Southern Italy[46] or the Aegean,[47] which were also connected – in a cultural and technological sense – to direct contact with the glass of the North Italian or Alpine production.

Since the glass beads – beside the beads made from bone and amber – decorated the attire of socially prominent individuals, individuals of connected cultures and cultural groups, they act as indicators of trade and exchange, thus substantiating the extent, potency and complexity of this wide cultural *koiné.*[48]

40 For example Bakarić, Križ, Šoufek 2006. - with earlier and extensive literature.

41 Bellintani *et al.* 2004; Bellintani and Stefan 2009, 84-86; Bellintani 2011, 271-273.

42 This is valid also for other sites in the Po and Adige plain; Angelini *et al.* 2009.

43 Bellintani 2011, 275-277.

44 Angelini *et al.* 2009; from the not exclusively Frattesina sites.

45 Blečić Kavur 2012.

46 Towle *et al.* 2001, 13-14; Bellintani *et al.* 2004; Bellintani and Stefan 2009; 83, fig. 6; Bellintani 2011, 273-274; Bellintani and Usai 2012, 1127-1128.

47 Henderson *et al.* 2010; Nightingale 2008; compare Bellintani *et al.* 2004, 1509-1510, 1515; Bellintani and Stefan 2009; 84, fig. 7; Bellintani 2011, 275.

48 We have to thank the following colleagues for their support and help: Irena Lazar, Marija Lubšina Tušek, Ana Plestenjak, Jana Puhar, Petra Stipančić, Metka Štrajhar (Slovenia) and Lidija Bakarić, Martina Čelhar, Tihomir Percan, Ranko Starac (Croatia). The article was submitted and accepted for publication in 2012.

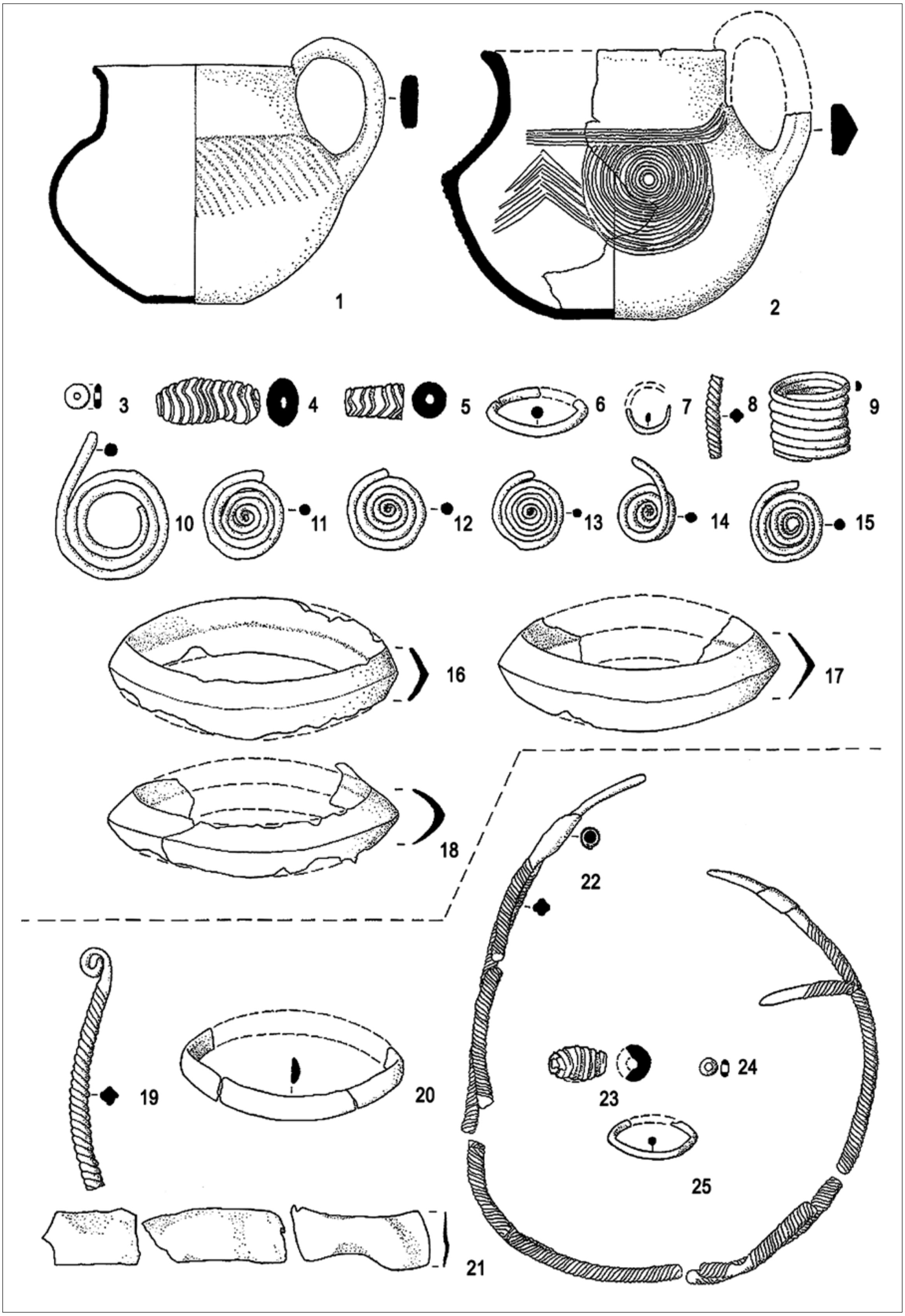

Fig. 3: Grave 57 of the Lim necropolis (after Mihovilić 1972).

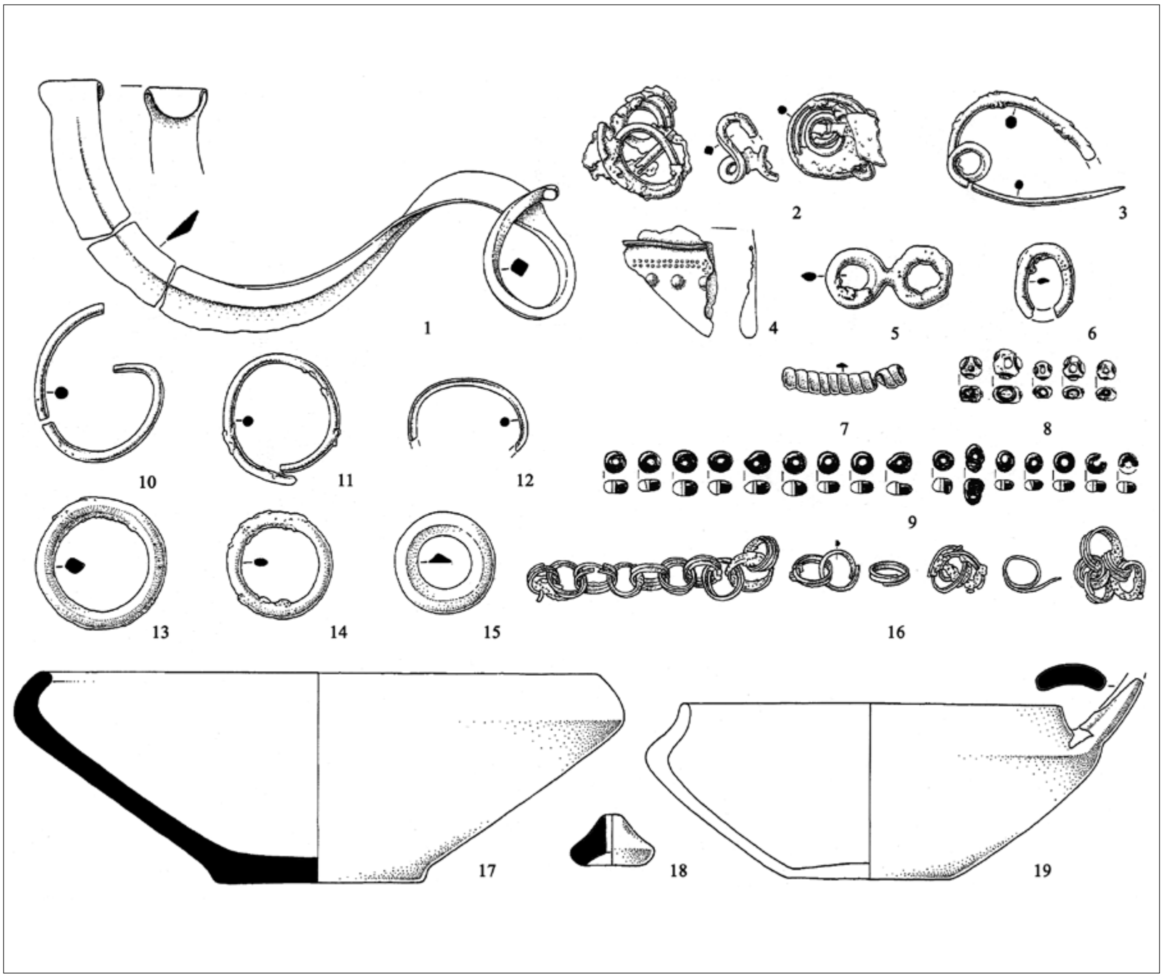

Fig. 4: Tolmin, grave 459 (after Svoljšak, Pogačnik 2001).

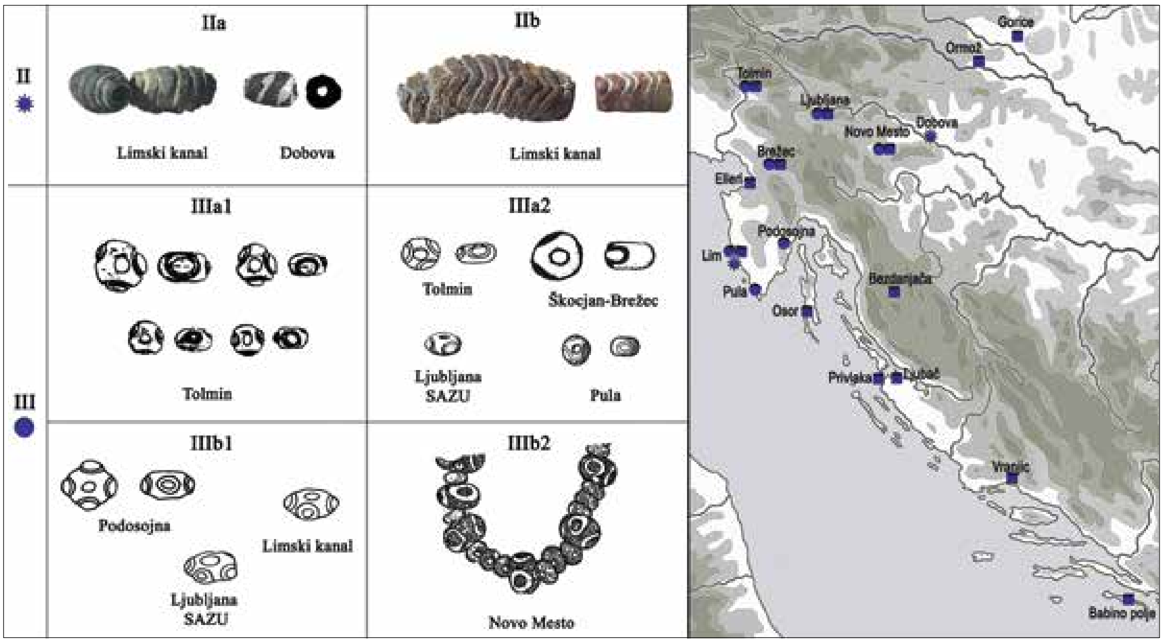

Fig. 5: Typological representation and distribution of glass beads types: I - ■; II - ●; III - ✸.

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KRIŽ Borut, GUŠTIN Mitja

PREHISTORIC GLASS FROM NOVO MESTO / SLOVENIA

The town of Novo Mesto is located in the centre of the Dolenjska (Lower Carniola) region, in the south-eastern part of Slovenia. The medieval town, which was founded in the 14th century, is located on a bend of the Krka River. In the immediate vicinity lies a prehistoric hillfort, which was occupied from at least the Late Bronze Age until the beginning of the Late Iron Age. The associated Late Bronze Age cemeteries were located on the adjacent hills of Mestne njive and Kapiteljska njiva and nearby Bršljin. More than eight hundred cremation graves have been found on all three Bronze Age archaeological sites. Seven necropolises, dated from the Early Iron Age, with almost 1000 excavated graves are located within the Novo Mesto area: the Kandija barrow cemetery, the Kapiteljska njiva barrow cemetery, the Smolova hosta barrow, the Portoval barrow, the barrow on the landholding of P. Malenšek, the barrow near the Kandija hotel, and the graves on Mestne njive (Fig. 1).

There are also four archaeological sites from the Late Iron Age: the three cemeteries of Kapiteljska njiva, Kandija and Beletov vrt that feature almost eight hundred cremation graves from this period, as well as a settlement near the sv. Nikolaj parish church.

The Novo Mesto area was also settled in the Roman period, during Late Antiquity, and in the Early Medieval period. Prehistoric glass stands out among the archaeological finds and has been presented in numerous exhibitions and publications.[1]

The Urnfield culture

The earliest examples of glass objects in Novo Mesto are featured in Late Bronze Age cremation graves. The graves were simply dug into the ground and in rare cases a stone slab was placed below the urn. In most cases a pottery bowl was placed over the urn, which was usually covered with a stone slab. Urns were filled with charcoal, ash, burnt bones and small grave goods made of bronze, pottery, glass and even iron.

1 Križ and Turk 2003a; Križ and Turk 2003b; Križ 2004; Bakarić *et al.* 2006.

Graves with glass were relatively rare at that time and the glass itself exclusively appears in the form of simple beads.[2] The number of glass beads in individual graves is limited; in most cases only a few glass beads were found in grave inventories. The high frequency of damaged beads indicates that they were cremated on the funeral pyre along with the deceased.

The glass beads are of various sizes with a large hole for suspension. They are mostly made with different shades of blue glass. Most of the small beads are not transparent in contrast to larger examples, which also tend to be made of paler blue glass. Blue glass beads, with 'eyes' made of white or yellow glass, first appeared in the Bronze Age. The applied elements often fell out and therefore, only the grooves of concentric circles remained, hence the 'eyes'. Most graves are dated to the late period of the Urnfield Culture i.e. to the 9th or more often to the 8th century BC.

The flourishing Hallstatt of Dolenjska

The first millennium BC, particularly the Early Iron Age period, was a time of prosperity, progress and the blossoming of society in Dolenjska as well as in Novo Mesto. The number of cemeteries and graves in Novo Mesto increased sharply during this period. Nearly one thousand skeleton graves discovered in more than fifty-two barrows have been dated to the Hallstatt period. The powerful and extensive settlement - the hillfort - was surrounded by facilities for producing iron, which prove that Novo Mesto was one of the largest and the most important prehistoric centres in Europe.[3] The multitude and quality of grave goods and their value in the eyes of contemporaries also reflect the economic power of local inhabitants.

Changes in society brought changes in burial rituals. A transition occurred when urns used for cremations in the Late Bronze Age gave way to the use of tumuli with inhumation graves. Most of the barrows were created at the beginning of the Early Iron Age. The diameter of the barrows was 10-35 metres and each contained from ten to eighty radially placed graves. This indicates that these were clan mounds that remained in use over the centuries in which members of a single clan or family were buried. The leaders of clans or families were all buried in the circle among other graves. They were considered 'first among equals,' as was the case among the rest of the Dolenjska group of south-eastern Alpine Hallstatt Culture. Only the founder of the lineage was sometimes buried in the centre of the barrow. The rich grave goods show that Novo Mesto was connected with the Mediterranean world (Greece and Etruria), but also with tribes in the Pannonian area and the Alpine region.[4] Apart from agriculture and crafts, metallurgical production was also highly developed, and the finds show that production of glass jewellery took place in this area (Fig. 2).[5]

The settlement at Novo Mesto, on the bend of the River Krka, was an important seat of the Hallstatt Princes, and a number of the graves found here stand out due to the exceptional goods that mark the princely status of the deceased.

The male princely graves of Novo Mesto contain the following: bronze or iron equestrian equipment; personal warrior equipment such as armour, shields, helmets and weaponry - including axes and lances; metal vessels; figurally decorated bronze belts and situlae; and extraordinary imported metal and ceramic objects. The rich female graves contain ornaments made of bronze, glass and amber, as well as metal vessels and imported ceramic items. Spindle-whorls and pyramidal loom weights for spinning and weaving are also characteristic of female grave goods.[6]

Glass jewellery

Glass jewellery can be found in female graves dated to the Early Iron Age i.e. from the beginning of the 8th century BC up until the 3rd century BC. Its multitude and variety

2 Križ and Turk 2003a; Križ and Turk 2003b; Križ 2004.

3 Mahr 1934; Gabrovec 1966; Dular 2003.

4 Teržan 1995.

5 Križ 2004.

6 Guštin, Križ 2007.

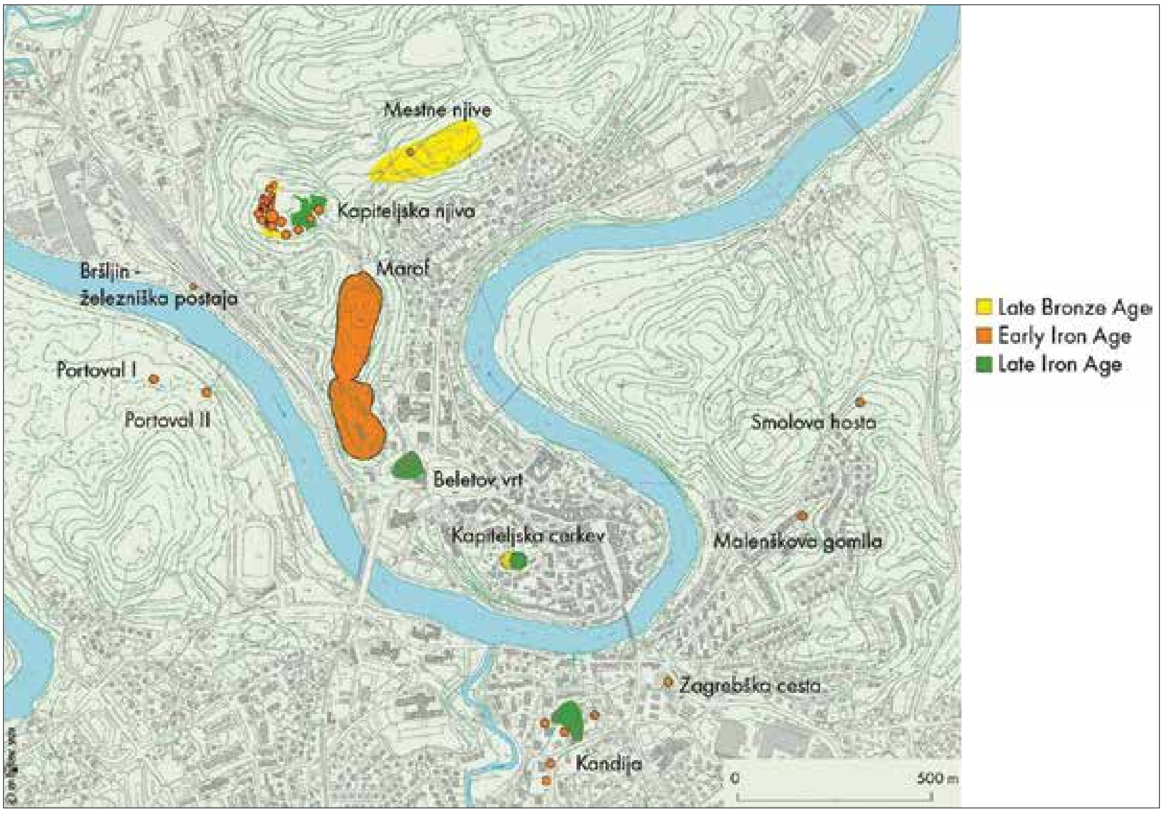

Fig. 1: The prehistoric archaeological sites in Novo Mesto / Slovenia.

surpass specimens from other parts of Europe during this time, which reflects its significance for the identity of the Iron Age population of Novo Mesto. The most frequent types of jewellery are necklaces composed of numerous multicoloured glass and amber beads, which appear in an entire series of graves that belong to inhabitants from both wealthy and poorer backgrounds (Fig. 3). The most common position of the glass or amber beads was the functional and logical position located around the deceased's neck and chest, although when excavated, the beads were mostly scattered around and therefore, often prevent the reconstruction of the original arrangement. Necklaces were also placed by the head of the deceased or sometimes by their legs. Single beads were most often found at the bottom of the coffin, but sometimes lay above it, which might indicate that they had been placed on the coffin cover. The glass and amber beads were threaded onto cords of organic material that has not been preserved, but in certain cases, the beads were threaded onto a bronze wire, which has been preserved inside the holes of individual beads. All the beads have a hole in the middle, usually for a cord to be threaded through. In some cases, an iron or bronze loop was inserted into the glass bead and a cord then threaded through the loop. Glass and amber zoomorphic beads have threading loops made of multicoloured glass or amber.

The glass beads were made in various shapes: spherical, cylindrical, discoid, annular, spherical with four flat sides, square, or amphora-shaped. Some had applied decoration, including lugs, protrusions or circles, while others were made from several pieces or were cylindrical with a thickened central section and protrusions. The glass beads were decorated with a wavy line and single or double 'eyes' in various colours and shades. Deep blue was the dominant colour in all possible forms while milk-white, yellow, turquoise and black were also common, although brown was quite rare.

The combinations of form, colour and decoration vary. Beads with a wavy line are mostly blue with a white, yellow, green or pale blue wavy line. White beads usually have a blue, green, turquoise or yellow wavy line while pale green transparent beads have a yellow or white wavy line. Blue, yellow, white and green round beads are usually combined with blue/white 'eyes' in all shades of blue, followed by green, turquoise and yellow single or double 'eyes.' Glass protrusions are sometimes found on cylindrical beads. The number of protrusions on each side of the bead ranges from three to six, and even more in a few exceptional cases, all in a single colour. Occasionally beads have protruding relief multicoloured 'eyes'.

Special types of bead include transparent amphora-shaped beads, which appear in the later stages of the Early Iron Age. The most distinctive glass beads are shaped like ram heads (Fig. 4).[7] These zoomorphic beads appear in four basic forms that are distinguished by their size, eyes, horns and their combination of colours.

All the ram head glass beads have attachment loops separately fused onto the back of the head. Only one has a loop made of bronze, which replaced the original glass loop. The lower side is either hollow or has a circular impression from the manufacturing process. Glass ram heads were found in eight graves at Novo Mesto. Eleven sites with ram heads are known from the same period in Slovenia. All the ram heads made of glass appear in the later stages of the Early Iron Age in inhumation graves from the 5th - 4th century BC, while a single sample was found in cremation grave 56 in Kandija from the La Tène period (4th century BC).

The glass material from the Hallstatt period in Novo Mesto also includes two bronze fibulae with a glass bow. The fibula with a blue glass bow found in grave III/5 at Kapiteljska njiva was very damaged,[8] while the fibula from grave XXXIII/19 at the same site was in a much better condition (Fig. 5). Bronze fibulae, bronze bracelets and ankle rings, pottery vessels, a bronze lid, bronze phalera and many glass beads have also been found in this very rich grave dated to the 6th century BC.

Fibulae with a glass bow are characteristic of the items belonging to the Dolenjska Hallstatt group from the 6th century BC, and specifically hedgehog-bow fibulae, noted for their outstanding shape.[9] They are distributed mostly throughout the Dolenjska region with only few exports known at Hallstatt, Este and Most na Soči. The unique shape and material of the bow and diversity of the glass colours clearly indicates local production.

Taking into consideration the large quantity of glass jewellery found in Early Iron Age graves in Novo Mesto and other parts of Dolenjska, as well as the varied decoration and colour combinations that appear on the glass objects unknown anywhere else in Europe, the hypothesis of whether local glass production existed in Dolenjska is yet to be proven.

Late Iron Age, end of Prehistory

The strategic position of Novo Mesto meant that it was one of the most important centres within the region during the Late Iron Age (3rd century BC) when the Celtic tribe of Taurisci occupied the area of Dolenjska.[10] Following the Celtic occupation, the Early Iron Age tradition of inhumation burials under large earthen barrows was replaced with flat cemeteries and cremation burials. This kind of burial lasted until the mid 4th century AD.

The Celts brought numerous novelties into the region through the production of metal, ceramics and glass. The ritual of burning the deceased and their personal possessions on a pyre damaged the majority of glass finds, but there are still some well preserved glass objects that seem to have been placed in the graves only after cremation took place.[11] Celtic glass production focused mostly on glass arm rings of different colours. Some are typical for the La Tène civilisation, but certain examples could have been produced locally (Fig. 6). Beads were less numerous than in

7 Egg 2010.

8 Križ 1997, 55.

9 Haevernick 1959; Stare 1978.

10 Guštin 2011.

11 Križ 2005.

Fig. 2: Novo Mesto-Kapiteljska njiva, Early Iron Age glass beads from different graves (photo B. Križ).

Fig. 3: Early Iron Age glass beads, Novo mesto-Kapiteljska njiva, tumulus 36, grave 10 (photo B. Križ).

Fig. 4: Early Iron Age glass beads in a shape of a ram's head, Novo Mesto-Kapiteljska njiva, tumulus 7, grave 28 (photo B. Križ).

Fig. 5: Novo Mesto-Kapiteljska njiva, tumulus 33, grave 19, Early Iron Age bronze fibulae with glass bows (photo B. Križ).

Fig. 6: Late Iron Age glass objects from Novo Mesto-Kapiteljska njiva - different graves (photo B. Križ).

earlier periods and were mostly made of dark blue glass. An outstanding find is a finger ring made of yellow glass from grave 110 at Kapiteljska njiva in Novo Mesto.[12] In the last period of the Celtic tradition during the 1st century BC, glass forms are limited to large beads with a diameter of 3-4 cm that seem to have had a more apotropaic than ornamental function.

In light of the huge quantity of glass beads with various types of decoration and colour combinations as well as special glass forms - such as ram head beads and hedgehog-bow glass fibulae, it is logical to suppose that Novo Mesto was one of the centres of glass production within Dolenjska culture during the Early Iron Age. Research in the future should therefore, focus on the search for material evidence that would support this hypothesis. There ought to be two main areas of focus: the analyses of glass items[13] and excavations of settlements and industrial areas with a view to identifying the location of glass workshops.

Lectured by Adrienne C. Frie

12 Križ 2001, cat. no. 81.

13 See initial studies of Greiff, Hartmann 2013.

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CORE-FORMED GLASS CONTAINERS FOUND ON RHODES (END OF THE 6TH – 5TH CENTURY BC). CHEMICAL ANALYSIS

Core-formed glass containers are widely known as the first Greek glass containers, produced from the mid-6th century BC until the end of the 1st century BC and distributed around the Mediterranean world and the shores of the Black Sea. Since D. B. Harden's publication regarding the British Museum collection,[1] they have generally been classified into three broad chronological groups, mainly on the basis of morphology, i.e. Mediterranean group I (late 6th to early 4th century), Mediterranean group II (mid-4th to late 3rd century) and Mediterranean group III (mid-2nd to end of 1st century). D. Grose[2] in his Toledo Museum publication followed this line of reasoning, creating workshop assemblages ("classes") for each of the three periods. M. McClellan,[3] in his unpublished Ph.D. thesis, further refined the classification, systematically including objects both held in museums and discovered during excavations. The common hypothesis, first proposed by Th. E. Haevernick[4] and G. D. Weinberg[5] and developed more recently on the basis of archaeological finds of misshapen products by P. Triantafyllidis,[6] is that they were continuously produced on the island of Rhodes, but the question of other centres of production for each group arises frequently in literature.[7]

Core-formed containers have been submitted to analysis less often than other categories of glass vessels, and the analyses conducted have been on items discovered far from Rhodes, in Northern Italy,[8] Sicily[9] and Georgia,[10] with unpublished works addressing items from Anatolia.[11] The idea of the present study was to sample items from the Mediterranean Group I discovered in Rhodes in order to establish a reference group.

1 Harden 1981.
2 Grose 1989.
3 McClellan 1984.
4 Haevernick 1960.
5 Weinberg 1968.
6 See *inter alia* Triantafyllidis 2009.
7 Ignatiadou forthcoming.
8 Arletti *et al.* 2008, 2010, 2011. See also Panighello *et al.* 2012.
9 Arletti *et al.* 2012.
10 Shortland and Schroeder 2009.
11 Reade, Jones, Privat, 2015.

Fig. 1: Core-formed containers from Rhodes kept in the AGER Section, Louvre Museum : a) LV6; b) LV5; c) LV3; d) LV2; e) LV1; f) LV4. © V. Arveiller-Dulong.

The Greek, Etruscan, and Roman Antiquities Section of the Louvre Museum includes six such items and sampling was permitted thanks to the support of the Section Director, Jean-Luc Martinez, and the Curator, Anne Coulié. In the interim P. Triantafyllidis, I. Karatasios, and E. Andreopolou-Mangou published a broader study based on SEM/EDX analysis of items from all three Mediterranean groups.[12]

Description of the samples

Five of the containers belong to the Arapides Collection, of secure Rhodian provenance and acquired by the Museum in 1902 (Fig. 1a-c, e-f).[13] The sixth item was donated by A. Salzmann in 1863 and comes from his excavations at the Camiros necropolis (Fig. 1d).[14] Two items (one amphoriskos and one oeinochoe) belong to the very first generation of such containers (mid 6th to early 5th century BC), the other four (alabastra) can be dated more loosely to the 5th century.

Until recently the first generation of core-formed glass was not very well known due to its scarcity in museums and the lack of well-dated contexts. P. Triantafyllidis[15] recently emphasised the importance of the funerary context of tomb 68 in the Platsa area at Daphne, Ialysos. Two amphoriskoi and two oeinochoi, together with a translucent monochrome alabastron, were discovered in this female burial. The numerous other non-glass finds, including accurately dated ceramics, indicate a date in the late 6th century BC. In his comparisons of amphoriskoi, P. Triandafyllidis rightly lists the amphoriskos of the Arapides Collection LV6,[16] along with three other items from Rhodes.[17] All these amphoriskoi (which can be classified in the broad group Harden amphoriskos 1; Grose amphoriskos I:1) have in common an inward sloping rim, a high narrow neck, a piriform body with pronounced maximum diameter at the conjunction of the sloping shoulders and the body, which rests on a small base-knob, and tall handles that extend from the shoulder to the underside of the rim. Made in dark cobalt blue glass, they are similarly decorated, with a yellow trail on the rim, and a thin yellow trail beginning on the upper neck and spiralling down to the transition between the shoulder and body, and then tooled in a close-set zigzag pattern on the middle of the body. In this area, a thick light

12 Triantafyllidis, Karatasios, Andreopolou-Mangou 2012.

13 Arveiller-Dulong and Nenna 2000, nos. 5, 13, 25, 85, 135. A sixth piece of the same provenance is kept in the Department of Eastern Antiquities of the Louvre, but was not sampled (*ibid.*, no. 82).

14 Arveiller-Dulong and Nenna 2000, no. 12. Since the publication in 2000, the correct origin of the piece was retraced.

15 Triantafyllidis 2009.

16 Arveiller-Dulong and Nenna 2000, no. 85 (H. 10). Inv. no. AM1080.

17 McClellan 1984, 203, no 201 and 204, no 4; Harden 1981, 80, no. 170.

blue trail is pulled into the zigzag pattern. On the lower part of the body there are two trails, one yellow and one light blue, with a single yellow trail on the base-knob. They body trails exhibit vertical indentations, caused by the tooling of the zigzags.

The oinochoe of the Arapides collection LV5[18] can be classified in the broad group Harden oinochoe 1; Grose oinochoe I:1, but its decoration is distinct from that of the small group that consists of items from tomb 67 of Ialysos.[19] A rather thick white trail spirals on the shoulder and is then tooled into a wide-set zigzag pattern on the middle of the body, before spiralling again on the lower part on the body, while a very thick yellow trail is tooled into a one revolution zigzag on the middle of the body. The oinochoe has vertical indentations on the middle of the body, caused by the tooling of the zigzags, as well as indentations on the foot. This decoration finds its best parallels in a group of amphoriskoi discovered in the votive deposits of the Artemision of Thasos, where no less than 19 exemplars have been registered.[20] These deposits mainly include objects characterized by vertical indentations caused by tooling and dating to the second half of the 6th century to the early 5th century.[21]

The four alabastra belong to better known groups which can be dated to the 5th century. The white alabastron with a finely marvered purple trail LV3[22] follows what Harden termed “normal pattern”, consisting of a purple trail spiralling from the upper body to the lower part of the handles, then tooled in close-set zigzags on the middle of the body, with a supplementary trail spiralling in two or three revolutions just under the zigzags, leaving the lower part of the body free of decoration.[23] This item can easily be associated with objects discovered in Rhodian necropolises and dated by their context between 490 and 425 BC.[24]

The alabastra in blue glass with finely marvered yellow and turquoise trails, one of which belongs to the Arapides Collection LV1[25] and the other to the necropolis of Camiros LV2, where it was discovered by Salzmann,[26] bear the same kind of decoration but in yellow and turquoise glass.[27] They can also be easily associated with objects discovered on Rhodes and dated by their context between 500 and 425 BC.[28]

The brown glass alabastron[29] with close-set finely marvered yellow and turquoise glass zigzags covering all the body LV4[30] is part of a very homogenous group, widely used in Rhodian funerary contexts and dated between 480 and 400 BC.[31] In Northern Greece, it is found in funerary contexts dated between 450-425[32] and is very widely distributed on the Black sea shores in the second half of the 5th century.[33] Brown glass is used quite frequently for this form.[34]

18 Arveiller-Dulong and Nenna 2000, no. 135 (H. 10). Inv. no. AM1082/S2405.

19 Triantaphyllidis 2009, 28, Fig. 3a-c ; Harden 1981, nos 242-244; Arveiller-Dulong and Nenna 2000, nos. 133-134.

20 Nenna 2012, 64: Groupe 6, Fig. 5a.

21 Nenna 2012, 65-66.

22 Arveiller-Dulong and Nenna 2000, no. 5 (H. 9,7). Inv. no. AM1092/ S2368. Harden Alabastron 1.2; Grose Alabastron I:2.

23 See Mc Clellan 1984, class II.A.4.

24 Harden 1981, no 85-86, 90, 94 ; Jacopi 1931, 97, nos 6-7 Fig. 85, 105, no. 4, Fig. 89.

25 Arveiller-Dulong and Nenna 2000, no. 13 (H. 10,5). Inv. no AM1086/S2364. Harden Alabastron 1.2; Grose Alabastron I:2.

26 Arveiller-Dulong and Nenna 2000, no. 12 (H. 9,5). Inv. no. A 376, NIII 1652. Harden Alabastron 1.2; Grose Alabastron I:2.

27 See Mc Clellan 1984, class II.A.11.

28 Harden 1981, nos. 97-99, 101, 103.

29 Arveiller-Dulong and Nenna 2000, no. 25 (H. 10). Inv. no S2365. Harden Alabastron 1.3; Grose Alabastron I:3A.

30 See Mc Clellan 1984, class II.A.13; Grose 1989, class I:F.

31 Harden 1981, nos. 129, 130, 133 ; Jacopi 1929, 249, nos. 17-18, Fig. 244; Jacopi 1931, 90, Fig. 76, 135, no. 3, Fig. 131

32 See for example Glass Cosmos 2010, no. 48 (Veroia), no. 432 (Akanthos). Only three exemplars in the Thasos Artemision votive deposits, see Nenna 2012, 65, groupe 7.

33 Voscinina 1967.

34 See for example Arveiller-Dulong and Nenna 2000, nos. 23, 25-28.

From this data, two main questions arise: are there any differences in composition between the three generations/kinds of objects? How do they compare to other objects analyzed to date?

Experimental methods

Due to the good state of preservation of most of the samples, the removal of only small chips of a few hundred μm^3 was possible. For each find, when possible, sampling was performed on all the decorations and colours present on the surface of the vessel. Chemical analyses and scanning electron microscopy observation were subsequently carried out on the same glass chip samples.

WDS-Electron Microprobe Analysis (EMPA)

The chemical analyses were carried out with an ARL-SEMQ electron microprobe equipped with four scanning wavelength spectrometers, on the same chips used for the X-ray diffraction experiments. The samples were embedded in an epoxy resin and polished with diamond paste. The elements analysed were: Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, Cr, Mn, Fe, Co, Cu, Sn, Sb, Pb. The following natural standards were employed: albite (Na); olivine (Mg); microcline (K, Al); clinopyroxene (Si, Ca); sodalite (Cl), apatite (P); ilmenite (Fe, Ti); spessartine (Mn); chromite (Cr) and cerussite (Pb). Metallic cobalt and metallic antimony were used for Co and Sb calibration, while synthetic cassiterite, a $Cu_{94}Sn_6$ alloy, and synthetic $Pb_4Ag_6Sb_6S_{16}$ were used for the calibration of Sn, Cu, and S, respectively. The analyses were performed operating at 15 kV, 20 nA, using counting times of 5, 10, 5 sec. on background-peak-background, respectively. To prevent the known migration phenomenon of alkalis under the electron beam, a 30 µm defocused electron beam was used. Several points were analysed on each sample to test the homogeneity, and the mean value of all the measurements was calculated. The results were processed for matrix effects using the PHI(rZ) absorption correction of the Probe programme.[35] The measured accuracy for the analysed elements was better than 3%, while precision was between 1-2% and 2-3% for major and minor constituents, respectively. The results are reported in Table 1.

Scanning Electron Microscopy

Backscattered electron images (BSE) and energy-dispersive (EDS) spectra were collected on polished samples, using a ESEM Quanta 200 environmental electron scanning microscope equipped with an energy dispersive spectrometer OXFORD - SATW at the Centro Interdipartimentale Grandi Strumenti of the University of Modena and Reggio Emilia. The analyses were performed on the same polished and carbon coated samples used for the EMPA analyses, with an acceleration voltage of 25 kV and a working distance of 12 mm. The BSE images were mainly collected on opaque glass samples to highlight the presence of crystalline opacifying agents in the glass matrix, and EDS analyses were run to obtain qualitative chemical analysis of the inclusions.

Results

From the reported data, it appears that almost all the samples are quite homogeneous. In Fig. 2, the levels of K_2O and MgO show that all the samples analysed, regardless of typology and colour, were produced starting from an inorganic sodic source of alkalis, which was probably natron, as confirmed by the high levels of Na_2O. The plot of Fig. 3, reporting the Al_2O_3 and CaO contents of the analysed glass, further emphasizes the chemical homogeneity of the sample sets. All the samples show levels of Al_2O_3 and CaO ranging from 1.83-2.53 wt.% and 7.18-8.43 wt.%, respectively; the only exclusion is represented by LV-4y in which the percentages are diluted as a consequence of a high lead content. The major differences are related to the colour of the samples. Iron is present in all samples in very variable percentages: the highest iron oxide levels are from the turquoise portion of LV4 and from the two blue portions of the alabastra LV1 and LV2. The other two blue samples, on the contrary, have rather low levels of FeO, comparable with those found in the

35 Donovan and Rivers 1990.

	LV1-b	LV2-b	LV3-w	LV3-p	LV4-t	LV4-y	LV5-b	LV6-b
Color	blue	blue	white	purple	turquoise	yellow	blue	blue
Typology	alabastron	alabastron	alabastron	alabastron	alabastron	alabastron	oinochoe	amphoriskos
SiO_2	69.29	66.53	68.69	67.72	65.13	62.67	68.54	67.86
Al_2O_3	2.04	2.53	2.13	2.07	2.26	1.92	1.97	1.83
TiO_2	0.06	0.09	0.07	0.07	0.09	0.05	0.07	0.05
MnO	n.d	0.08	n.d	2.29	0.07	n.d	n.d	n.d
MgO	0.42	0.58	0.42	0.42	0.42	0.31	0.37	0.42
FeO	1.56	1.81	0.39	0.45	2.86	0.66	0.57	0.54
CaO	8.43	8.12	7.77	7.63	7.18	5.38	7.80	7.84
Na_2O	13.49	15.79	15.85	14.91	13.87	12.22	17.01	16.88
K_2O	1.02	0.59	0.62	0.69	0.56	0.39	0.34	0.38
Sb_2O_3	0.27	0.15	2.49	0.10	0.40	0.59	0.49	0.07
Cu_2O	0.09	0.61	0.04	0.09	5.17	0.18	0.07	0.37
PbO	0.73	0.20	0.02	0.04	4.53	14.47	0.10	0.06
SnO_2	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
CoO	0.05	0.03	n.d	n.d.	0.06	n.d.	0.10	0.12
SO_3	0.17	0.28	0.31	0.30	0.27	0.19	0.13	0.22
Cl	0.45	0.72	0.96	0.93	0.91	1.04	1.49	0.91
Cr_2O_3	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
P_2O_5	0.09	0.14	0.04	0.04	0.12	0.09	0.05	0.11
Totals	98.20	98.10	99.85	97.76	101.93	100.58	99.13	97.60

Table 1: Chemical analyses (oxides weight %) obtained by EMPA for the analysed vessels. (abbrev. n.d. non detected).

white, yellow, and purple samples. Manganese oxide is present at trace level in most of the analysed samples (the values reported in the tables are very close to the detection limit of the instrument), and only the purple trail has higher levels (2.29%) of MnO. The highest level of Cu_2O is found in the turquoise trail of sample LV4, while cobalt oxide is present at levels around 0.10-0.12 % in the blue body of the oeinochoe and of the amphoriskos; a few hundreds ppm of Co (sufficient to impart a deep colour) are also present in the blue body of the LV1 and LV2 alabastra and in the turquoise trail of sample LV4. Lead and antimony are present in widely variable percentages: high levels of PbO are found in the yellow and turquoise trails of sample LV4, representing 14.47% and 4.55%, respectively. In all the other samples, lead oxide never exceeds 1%; in the purple, white, and blue glass of LV5b and LV6b, it does not exceed 0.1%. Antimony is present in high concentration in the white glass (Sb_2O_3 = 2.49 wt %) while in all the other samples, antimony oxide is lower than 0.6 %. Tin and chromium were not detected in any of the samples.

Scanning electron microscopy analyses were performed on the opaque trails of the vessels (the white trail of sample LV3 and the turquoise and yellow portions of sample LV4) to understand the origin/cause of the opacity. The BSE images collected on these samples (reported in Figs. 4 and 5) show the presence of abundant particles with high atomic numbers, which are higher than the matrix of the white and yellow portions of the samples while conversely, in the turquoise decorations (darker port of Fig. 5a) only a few particles were identified. The BSE images indicate that while in white samples numerous particles of a few microns are well dispersed in the matrix, in the yellow sample the opacifiers form aggregates and their dispersion is less homogeneous. The EDS spectra (Figs. 4b, 5b) indicated that all these particles are Sb-base opacifiers (Ca-antimoniates for white and Pb-antimoniates for yellow). High levels of lead were also found dispersed in the glass matrix of

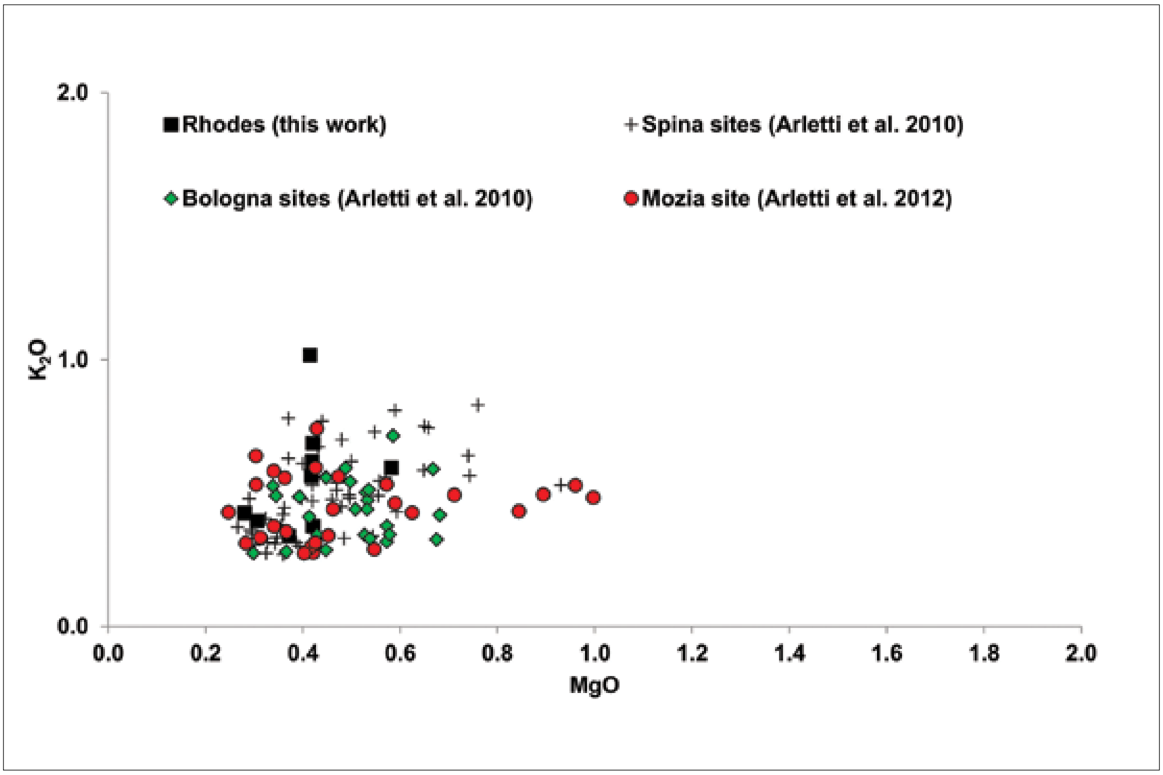

Fig. 2: K2O vs. MgO for all the samples analysed here compared with literature data from Arletti et al. 2010 and Arletti et al. 2012.

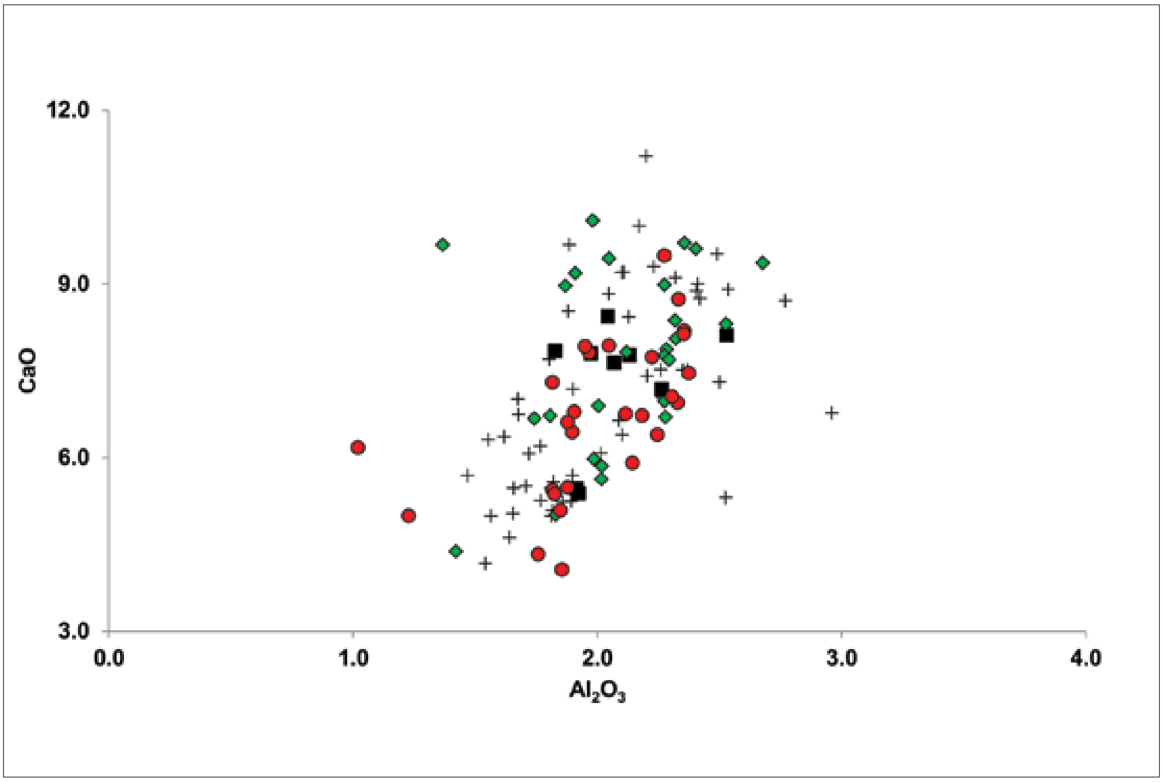

Fig. 3: CaO vs. Al2O3 for all the samples analysed here compared with literature data from Arletti et al. 2010 and Arletti et al. 2012 (symbols are the same as fig. 2).

yellow and turquoise decorations (Fig. 5c), in agreement with the chemical data.

Discussion

The alkali composition of the analysed glass samples allows them to be classified as silica-soda-lime glass, produced with natron (Fig. 2). In general, on the basis of the Al_2O_3 and CaO contents, all the samples were produced starting from siliceous calcareous sand as the vitrifying component.

All the analysed samples are deeply coloured and opaque. The SEM-EDS analyses proved that the presence of crystalline phases dispersed in the glass matrix was responsible for the opacity of the white and yellow glass. The presence of dispersed particles of $Ca_2Sb_2O_7$ and $CaSb_2O_6$, in white glass – neo-formation phases produced by adding Sb to a Ca-rich glass batch or raw glass – and of $Pb_2Sb_2O_7$ in yellow glass is very common in vessels of this period in Georgia,[36] as well as in Italy.[37] In the turquoise trail the number of opacifier particles is probably too low for detection, as is confirmed by the low level of Sb found in the chemical analyses. In all the vessels, the blue glass represents the bulk glass body to which the decorations were added. The opaque appearance of this blue glass is due to its very dark blue colour and its thickness.

The chemical data of this study are compared in Figs. 2-3 and 6 with other data from Mediterranean I group vessels recovered in Etruscan contexts in Northern Italy (Bologna and Spina sites)[38] whose provenance, deduced on an archaeological basis, was assumed to be the island of Rhodes; and in a Punic context in Mozia,[39] where the presence of Greek culture (and probably a Greek community) is documented from the 6th century BC.

It is evident that the composition of the four sample sets is extremely similar as regards both sand and flux components. This clearly indicates that they could derive from the same production. Overall, all the data relative to Mediterranean I glass are relatively homogeneous[40] while the major differences in the results of the chemical analyses are related to the contemporary beads rather than to the vessels. These data are also consistent with those reported by Shortland and Schroeder[41] for contemporary Mediterranean unguentaria from Pichvnari in Georgia. This leads to the hypothesis that almost all the glass finds were produced starting from the same type of sand. All these glass finds could be derived from coastal sand in the Levant or a similar source of sand. Comparable results were obtained from analyses of Iron Age French beads.[42]

Fig. 6 reports the levels of CuO and CoO for all the blue samples analysed in this work and by Arletti *et al*. (2010, 2012). The levels of transition elements employed for the coloration of the vessels – which in general are subject to major variations – are very similar in the four groups and the samples considered show a homogenous distribution. However, there is not a clear correlation between the two elements and the unavailability of trace element compositions excludes hypotheses regarding the Co ores employed.

The small number of white, yellow, and turquoise samples analysed makes it impossible to compare the different sample sets, but it could be postulated that the phase employed to impart opacity to the glass is the same. In addition, it is noted that the presence of lead in the turquoise decorations (in general not observed in glass of this period) is a peculiar trait that is also present in some turquoise samples from the Bologna and Spina sites.

36 Shortland and Schroeder 2009.
37 Arletti *et al.* 2008; Arletti *et al.* 2010; Arletti *et al.* 2011; Arletti *et al.* 2012.
38 Arletti *et al.* 2010.
39 Arletti *et al.* 2012.
40 See e.g. Arletti *et al.* 2010; Arletti *et al.* 2012.
41 Shortland and Schroeder 2009.
42 Gratuze 2009; Gratuze and Picon 2006; Gratuze and Billaud 2003.

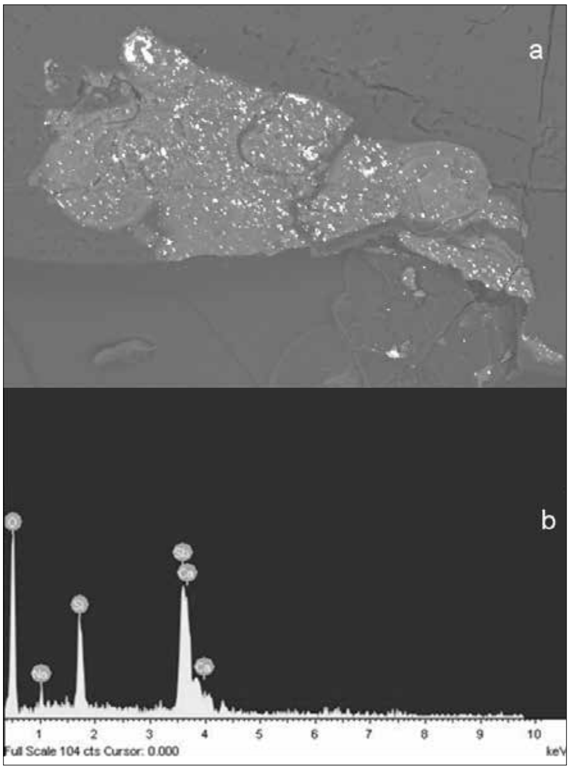

Fig. 4: a) BSE image collected on sample LV-3 showing the opacifier particles; b) EDS spectrum collected on opacifiers.

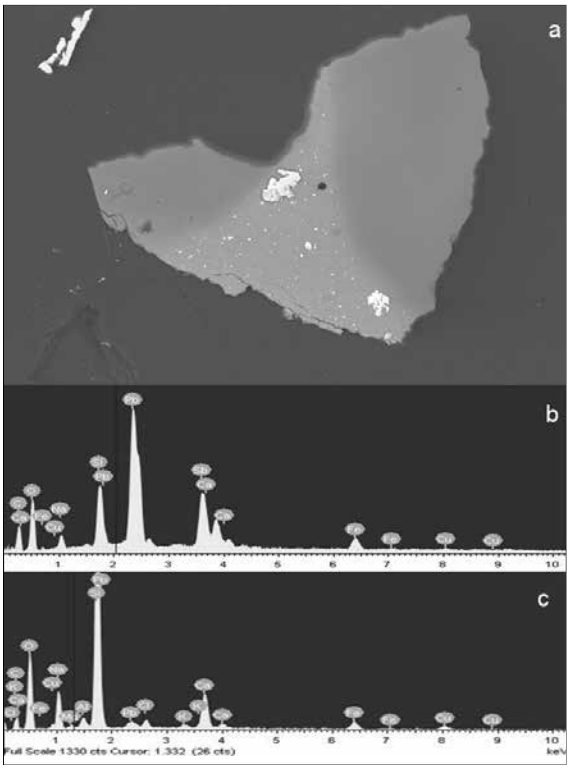

Fig. 5: a) BSE image collected on sample LV-4 at the interface between yellow (light grey) and turquoise (dark grey) decorations; b) EDS spectrum collected on a particle in the yellow portion; c) EDS spectrum collected on the turquoise matrix.

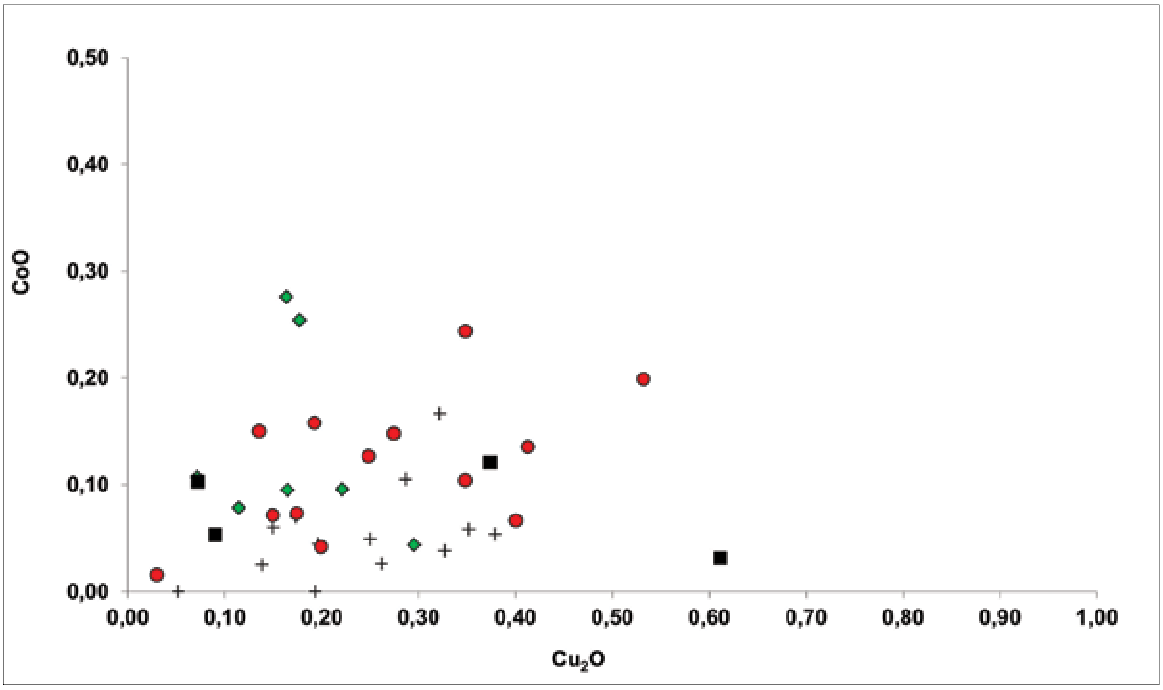

Fig. 6: CoO vs. Cu2O for all the blue samples analysed here compared with literature data from Arletti et al. 2010 and Arletti et al. 2012 (symbols are the same as fig. 2).

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MEDITERRANEAN GROUPS I AND II CORE-FORMED VESSELS FROM THE FIRST MILLENNIUM GORDION. COMPOSITIONAL ANALYSES

Introduction and aims

Core-formed glass from Gordion, in central Turkey, dates from the 6th to the early 2nd century BC or from the Classical and Achaemenid periods to the Hellenistic era.[1] This glass is represented by over 150 vessel fragments of great significance in terms of their value for the archaeological investigation of trade, technology and provenance. Mediterranean core-formed glass is divided into three chronological groups, which were subdivided into classes.[2] All three groups of core-formed glass have been excavated at Gordion, which is important, because it extends the known distribution of Group I (late 6th to early 4th century BC) and Group II (late 4th to late 3rd century BC) into Anatolia.

Mediterranean Groups I and II are the most numerous and best represented at Gordion. They form the basis of this preliminary study as part of an ongoing program of typological and compositional analyses of Gordion glass. Forty-seven samples of core-formed glass from Gordion have been analysed by electron probe microanalysis (EPMA) with the aims of addressing key issues about the nature and origin of core-formed glass found in Anatolia, and of the relationship between core-formed groups at Gordion. This study also examines whether the groups and their sub-groupings or classes can be distinguished by chemical composition: Group I from Group II, Class II:A from II:B and so on.

In a broader survey, we have compared Gordion core-formed compositions with those of published core-formed glasses from other regions. The study of the available data elucidates the nature of the Gordion glasses in the context of the wider region and sheds light on the distribution of core-formed glasses to Anatolia and around the Mediterranean at this time.

Gordion and glass

The site of Gordion was one of the key sites in Central Anatolia in the early to mid-

1 Jones 1995, 21.
2 Grose 1989, 95-174.

1st millennium BC when it was the seat of the Phrygians. Gordion was situated on major trade routes that connected it to the Mediterranean world to the west, the lands of the Near East and probably also to northern regions around the Black Sea.

The corpus of core-formed material from Gordion includes fragments decorated with the distinctive trailed and festooned threads of blue, white and yellow that are typical for this ware. The colour of the samples analysed in the present study are predominantly dark and light blue, and translucent and opaque turquoise blue, which were chosen, because they are the most abundant and best preserved samples.

Vigorous production of core-formed vessels began in the eastern Mediterranean from c. 550 BC following a hiatus after an earlier period of production using this technique in the Near East. The majority of the 6th to 2nd century BC Gordion fragments belong to the first two of the three main phases of Mediterranean core-formed glass vessel production.[3] There are 106 fragments from Group I, which represents the largest group; 34 from Group II; one fragment from the earliest classes of Group III; and a few Group II fragments that are unable to be subdivided into classes. A valuable *terminus ante quem* for the core-formed glass found at Gordion is provided by the Roman sack of the city in 189 BC, an event that marks the end of occupation of the site for at least two centuries.[4]

Group I, typically represented by alabastra, oinochoae, amphoriskoi and aryballoi, is the earliest and typologically most uniform of the Mediterranean core-forming industries represented at Gordion. Sub-group, or Class I:B, is the most common at Gordion and was dated by imported Attic pottery to between the 5th and early 4th century BC. Based on the distribution pattern of its products, the workshop (or workshops) for Group I was probably located on the Aegean islands or along the coast of Asia Minor. Rhodes has been nominated as a possible production site on the basis of the concentration of vessels of Group I found in early to mid-5th century tombs there.[5]

Group II represents a new core-forming industry, which arose approximately fifty years after production of Group I bottles had come to an abrupt end, probably due to the political and economic turmoil of the late 5th century BC.[6] Bottles of Group II are characterized by new forms, decorative schemes and colours, and are found throughout the Mediterranean basin, but the production centre(s) is unknown.

Very few examples of Group II had been reported from western Asia. However, the material from Gordion changed the picture when the site yielded a significant number of bottles (15) from Group II, their presence indicating that the core-formed vessel market remained active long after the production of Group I bottles ended. The body of material from Gordion also refines our understanding of the distribution pattern of Group II, making it clear that the bottles of that group penetrated a substantial distance into Asia Minor.[7]

Chemical analysis

Forty-seven samples taken from core-formed vessels dated to between the 6th and 3rd century BC (19 of I:B, 5 of II:A, 9 of II:B, 1 of II:E, 6 of II:G, 7 of II no class attributed) were chemically analysed via wavelength-dispersive spectrometrym using a JEOL JXA-8500F electron microprobe at the University of New South Wales. Analytical conditions of 20kV accelerating voltage, 20nA probe current and a 100μm probe diameter were used for analysis. The X-ray spectrometer was calibrated with well-characterised standard natural minerals. Accuracy and precision of results were checked against secondary standards: Corning Museum of Glass standard reference glasses A and B[8] and

3 Grose 1989, 95-174.

4 Jones 1995, 22.

5 Harden 1981, 52-53, 157-159; Jones 1995, 26; Rehren *et al.* 2005; Shortland and Schroeder 2009, 960; Triantafyllidis 2003; Triantafyllidis 2009; Triantafyllidis 2012.

6 Harden 1981, 53, 102-103; McClellan 1984, 322-323; Grose 1989, 115.

7 Jones 1995, 27.

8 Brill 1999b, 539-544.

Samples	Na_2O*	SiO_2*	MgO*	K_2O*	CaO*	P_2O_5*	FeO*	Al_2O_3*
Group I:B SD (n=19)	15.20 0.85	72.50 1.47	0.49 0.15	0.69 0.15	7.82 0.84	0.06 0.02	1.16 0.53	2.09 0.11
Group II:A SD (n=5)	17.57 1.19	71.35 1.76	0.47 0.10	0.50 0.12	7.39 0.63	0.06 0.02	0.49 0.09	2.16 0.08
Group II:B SD (n=9)	17.25 1.74	71.03 1.07	0.49 0.09	0.67 0.20	7.48 0.71	0.08 0.03	0.87 0.28	2.13 0.14
Group II:E (n=1)	17.74	69.50	0.62	0.60	8.29	0.08	0.90	2.27
Group II:G SD (n=6)	16.69 0.89	71.00 1.76	0.74 0.45	0.84 0.15	7.67 1.16	0.09 0.01	0.88 0.21	2.08 0.10
Group II unattributed SD (n=7)	16.89 1.86	70.87 1.74	0.51 0.13	0.78 0.31	7.76 0.92	0.09 0.05	0.93 0.15	2.17 0.06
Group I dark blue (n=16)	15.20	72.50	0.49	0.69	7.82	0.06	1.16	2.09
Group I light blue (n=3)	15.57	73.13	0.42	0.62	7.78	0.06	0.37	2.05
Group II dark blue (n=25)	17.28	70.84	0.57	0.67	7.64	0.08	0.79	2.13
Group II light blue (n=2)	18.41	71.38	0.42	0.48	6.69	0.06	0.38	2.19

Table 1: Average reduced compositions of Gordion core-formed glasses in wt% oxide normalised to 100%.

Glen Spectra soda-lime-silica RM01. Detection limits were between 40 and 120 ppm; analytical totals fell between 97% and 99%. Sample measurements were conducted in triplicate and averaged results are reported (Table 1). The accuracy and reproducibility for these analyses were better than 0.70% absolute for major and minor elements and 0.06% or better for trace elements (i.e. <1 wt%).

Results and discussion (Table 1)

Most of the glass analysed was dark blue (41), three specimens were opaque light blue or turquoise, two light blue translucent and one amber. Chemical analysis revealed both Groups I and II from Gordion to be of typical silica-soda-lime composition with levels below 1.5% of magnesia and potash (LMLK), indicating that they are natron or mineral soda fluxed glass specimens. These are the two key glass oxides used to distinguish plant ash and mineral soda base glass compositions.[9] The magnesia range is generally below 0.7 % while the potash ranges more widely from approximately 0.3 % to 1.2 %. While the compositions of the two groups are similar, Group I has on average slightly greater levels of silica (Fig. 1) than Group II glass and lower average soda content (Fig. 2). The different classes of Group II are indistinguishable from each other using base glass chemistry.

Both alumina and iron may occur as sedimentary contamination of the silica source. The range of alumina contents for both Groups I and II Gordion glass is narrow, being between approximately 1.9 and 2.4 %, and averaging 2.1 %. Gordion Groups I and II are distinguished,

9 Brill 1999a, 277.

however, by their iron oxide concentrations (Fig. 1). In Group I the range for iron oxide is greater: from 0.3 % to 2.1 %, averaging 1.2 %, but in Group II the iron oxide content ranges from 0.4 % to 1.3 %, averaging 0.8 %.

While the LMLK compositions of Groups I and II are closely similar, they are not exactly the same. Although the magnesia, potash, lime and alumina levels are indistinguishable, the silica, iron and to a much lesser extent, the soda levels, differentiate the groups. Consequently, this indicates that they are the products of different workshops, of a different mix or of different proportions of raw ingredients. Certainly these two glass groups are chronologically distinct and as such, compositional differences are to be expected, but in general scheme of pre-Roman glass production, these are small differences in a generally well-regulated recipe.[10]

Colourants used in the core-formed glass specimens analysed include lead antimonate yellow and calcium antimonate white, both intended for decorative trails, while the blue glass was coloured with cobalt, copper or sometimes a combination of both. Dark blue glass specimens are coloured with cobalt in concentrations between 0.05 % and 0.12 % for Group I, and 0.04 % to 0.24 % for Group II. Dark blue glass specimens in both groups also contain small amounts of copper oxide between 0.02 % and 0.37 %. Elemental mapping with EPMA confirms that cobalt-rich areas of dark blue glass are not opacified with antimony, but may be associated with elevated iron and be supplemented with copper. It has been suggested that the cobalt colourant of the dark blue glass was sourced from an iron-rich ore and might contribute to the observed elevated iron levels.[11] Indeed, the glass specimens with relatively higher cobalt also have higher iron oxide content while the copper light blue and amber glass of both groups have lower iron oxide content, comparable to that of contemporary monochrome glass from Gordion (Fig. 1).[12] Iron might also enter the glass in association with the sand source of silica. High iron quartz sands have been identified on Rhodes,[13] for example, which has been proposed as a glassmaking centre at this time. The lack of correlation between iron and cobalt as well as iron and silica in the Gordian core-formed glass specimens, might be explained by the addition of iron from more than one source. Light blue glass from both groups is coloured with copper from 1 % to 3.3 % (average 2.1 %), contains no cobalt and is either translucent or opacified with calcium antimonate to form turquoise opaque glass.

Comparisons with contemporary monochrome glass specimens

When the Gordion core-formed glass compositions are compared with contemporary LMLK monochrome glass from Gordion[14] and from several sites in Greece,[15] the same tight grouping is observed when a comparison is also made between magnesia, potash and lime. The higher iron concentrations of much of the core-formed glass (Fig. 1), especially the dark blue specimens, and the higher average alumina concentrations of monochrome glass distinguish both types from one another (Fig. 2). The light blue and amber glass without cobalt have similar low average iron oxide (FeO 0.4%), supporting the theory that there may be an association between iron and cobalt. Group I glass is also distinguished from monochrome glass by its higher average silica (monochrome: 70.3 %, Group I: 72.5 %) and lower average soda levels (monochrome: 18.6 %, Group I: 15.2 %). Group II glass specimens are closer in composition to monochrome

10 See Panighello 2012, 2953 regarding the difference in sands used to make Groups I and II glass and the supposition that there were different production centres for Groups I and II glass despite typological similarities.

11 Shortland and Schroeder 2009, 958; Panighello 2012, 2953 who notes the indications that different ores have been added as chromophores, although their nature appears difficult to interpret.

12 Reade *et al.* 2012.

13 Triantafyllidis 2003, 134.

14 Reade *et al*. 2012.

15 Brill 1999b, 62-65, for Vergina, Rhodes and Olympia; Ignatiadou 2000 for Pydna.

glass with regard to silica and soda (Group II: SiO2 70.8 %, Na2O 17.3 %; Figs. 1, 2). These comparative results indicate that contemporary core-formed and monochrome wares, although not exactly the same, conform to a similar composition.

Our chemical investigation of the LMLK monochrome glass specimens from Gordion16 revealed that cobalt blue glass from the Iron Age, dated to between the 9th and the 7th century BC, had elevated magnesia and alumina, amongst other elements associated with an alum-derived cobalt colourant from Egypt.[17] The fact that cobalt blue core-formed glass specimens from Gordion have relatively low concentrations of these oxides, and associated higher iron content, indicates that their source of cobalt is different.

The compositional similarities between Gordion core-formed glass and monochrome glass from Gordion and Greece, combined with the use of a non-Egyptian cobalt source, indicate that the glass found at Gordion came from another, possibly western source. It is interesting to consider whether it might have reached Gordion across land, perhaps on the trade route via Sardis, or if it was transported up the coast of Asia Minor and entered Anatolia from the Black Sea region to the north. From the 6th century BC, the Greeks established sea-trading colonies in this region.[18] The discovery of Group I core-formed glass at two Georgian sites, Pichvnari and Tsikishdiri,[19] has suggested the possibility of overland trade with the north, perhaps through the Greek trading port of Sinope, which gave access from the Black Sea to the heart of Anatolia.[20] The Gordion and Georgian core-formed glass compositions were compared in an attempt to gauge their similarity or differences as an indicator of trade connections between central Anatolia and the Black Sea region.

16 Reade *et al.* 2012.

17 Kaczmarczyk 1986; Wypyski in Lilyquist *et al.* 1993.

18 Boardman 1999.

19 Shortland and Schroeder 2009.

20 Boardman 1994, 218-220.

Inter-regional comparisons: Group I

6th to 3rd century BC core-formed glass from Gordion is different from the preceding Late Bronze Age Egyptian and Iron Age Near Eastern cobalt blue-coloured glass, but bears a chemical likeness to contemporary monochrome Gordion and Greek glass specimens.[21] It is now valuable to compare the Gordion Group I glass specimens with those from other neighbouring regions to the west and north. Analyses have been published for core-formed glass from Georgia,[22] from Rhodes[23] and from sites in Italy: Spina,[24] Bologna,[25] Mozia[26] and Adria.[27]

While all glass specimens considered here are of LMLK composition, with closely similar levels of soda and lime, they do not appear to be exactly the same. The plot of alumina and silica (Fig. 3) best illustrates the distinction between them and suggests possible differences in the source of silica, as neither of these elements is colourant-related. Group I glass specimens analysed from Gordion are dark and light blue while those analysed from other sites vary, for example, Georgian glass is coloured black, brown, light blue, white and yellow.[28]

The iron oxide levels in core-formed glass specimens from both Gordion and Georgia are high when compared with the relatively low levels of iron oxide in contemporary LMLK monochrome glass from Gordion. The glass specimens from Georgia with the highest iron content are black and contain cobalt (with one exception, P4bl), but there is also one high-iron yellow glass sample (P2y).[29] All except six of the Gordion glass specimens are cobalt blue

21 Reade *et al*. 2012.

22 Shortland and Schroeder 2009.

23 Triantafyllidis *et al.* 2012.

24 Arletti *et al.* 2010.

25 Arletti *et al.* 2010.

26 Arletti *et al.* 2012.

27 Panighello *et al.* 2012.

28 Shortland and Schroeder 2009, 955.

29 see also Arletti *et al.* 2010, 711; Arletti *et al.* 2011, 2097-2098; Arletti *et al.* 2012, 3399; Panighello 2012, 2953 regarding the association of high iron levels due to iron accompanying the lead minerals added to achieve the colour and opacity of yellow glass.

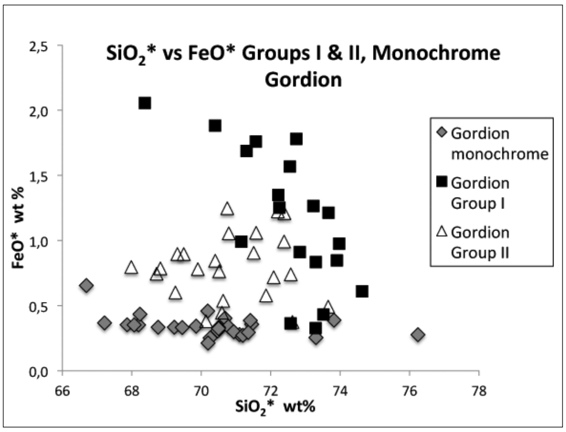

Fig. 1: Scatter plot of silica versus iron oxide for Gordion Groups I, II and monochrome glasses [indicates reduced composition].*

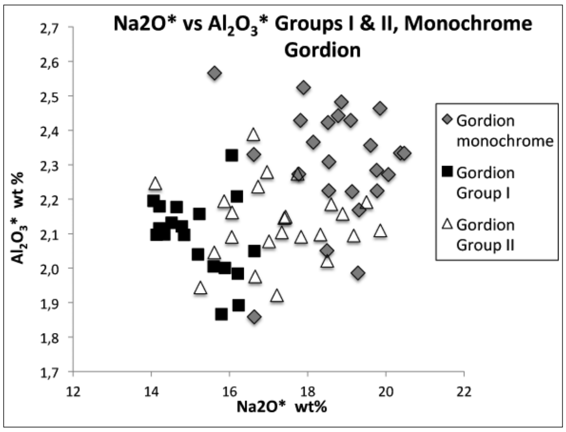

Fig. 2: Scatter plot of soda versus alumina for Gordion Groups I, II and monochrome glasses [indicates reduced composition].*

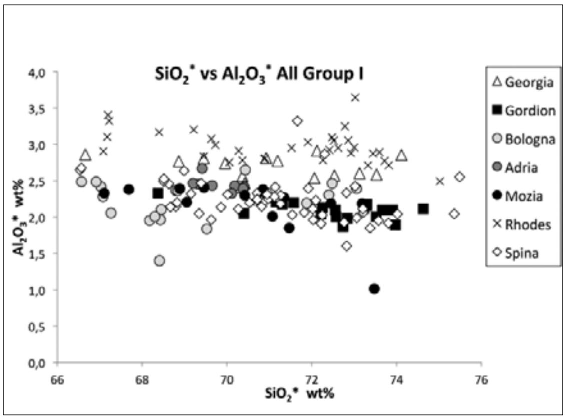

Fig. 3: Scatter plot of silica versus alumina for Group I glasses from Georgia (Tsikishdiri, Pichvnari), Rhodes, Italy (Spina, Bologna, Mozia, Adria) and Gordion. References cited in text [indicates reduced composition].*

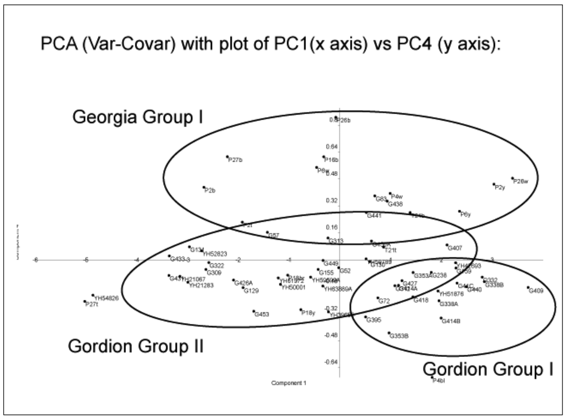

Fig. 4: Principle Components Analysis plot for Groups I and II glasses from Gordion and Group I glasses from Georgia (Tsikishdiri, Pichvnari). Reference cited in text.

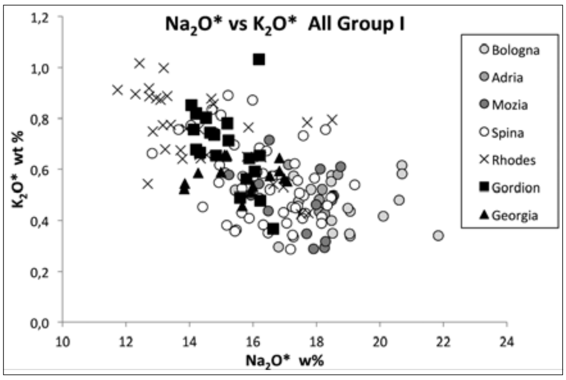

Fig. 5: Scatter plot of soda versus potash for Group I glasses from Georgia (Tsikishdiri, Pichvnari), Rhodes, Italy (Spina, Bologna, Mozia, Adria) and Gordion. References cited in text [indicates reduced composition].*

with iron levels ranging from 0.5 % to 2 %. Shortland and Schroeder[30] similarly commented that cobalt was often, but not always, associated with elevated iron and zinc content, perhaps indicating an iron-rich ore source. The light blue Gordion glass specimens are coloured with copper, but the Georgian light blue glass examples contain both cobalt and copper - an interesting variation that raises the question of whether there are different colouring traditions involving either the separate use of cobalt and copper, or the combination of the two to produce blue. It is difficult to assess whether this would be likely to occur in one workshop or whether

30 Shortland and Schroeder 2009, 958.

it suggests multiple workshops with different methods of making blue glass.

Principal Components Analysis confirmed that there are differences between Group I glass from Georgia and Gordion, and Gordion Group I and II glass (Fig. 4). A student's T-Test was applied to the Gordion and Georgian data, confirming that the differences between the average concentrations of alumina, potash and phosphorus oxide are significant. The subtle differences revealed by the data suggest that Gordion and Georgian core-formed glass had different origins - creating debate over whether the glass reached Gordion a different way from the Black Sea trade route to the north, or at least not from the Georgian source. However, we are not yet able to prove where and how many production centres existed at this time.

The analysis of Group I core-formed glass from Spina, Bologna and Adria in northern Italy, Mozia on Sicily and Rhodes have revealed closely similar levels of magnesia and potash content. The Italian and Georgian glass specimens have lower average potash levels than those of Gordion and Rhodes. The Italian glass specimens have a higher average level of soda than other glass while the Rhodian examples have the lowest average concentrations of this oxide and are closest again to the Gordion glass samples (Fig. 5).

Further comparisons with the Group I glass specimens show that the silica content of Gordion glass is on average higher than that of Italian glass while that of the Georgian, Spina and Rhodian glass specimens range more widely than their Gordion counterparts (Fig. 3). The Bologna glass samples have the lowest average silica content. All groups have a similar range of iron oxide concentration, regardless of colour. High levels of iron oxide are not always associated with the presence of cobalt in core-formed glass. The majority of light blue or turquoise glass specimens from Italian sites are coloured by copper, with a few examples coloured by copper and cobalt, as is the case with the three light blue examples from Georgia. Alumina concentrations are on average greater in the Rhodian and Georgian specimens than in those from Gordion and Italy (Fig. 3). The reason for these differences, and whether they are significant enough to suggest different locations of manufacture, is yet to be resolved. Gordion Group I glass is not consistently similar regarding all oxides to any one of the comparative groups from different sites.

Inter-regional comparisons: Group II

There are fewer Group II compositional analyses available for comparison with Gordion glass. There are none reported from Georgia, confining the comparisons of Gordion glass to those from Spina,[31] Adria[32] and Mozia[33] in Italy, and from Rhodes.[34] Overall, the Group II glass compositions are more consistent and less wide-ranging than Group I glass, when all reduced glass oxides are considered.

Conclusions

All Gordion core-formed glass specimens conform to the silica-soda-lime LMLK profile. Groups I and II glass specimens can be distinguished to some extent by reduced glass oxide concentrations when sufficient numbers are compared. As with all glass considered in this study, the similarities are close and to assign a single glass specimen to a group using base glass chemistry alone would be unwise.

A comparison of chemical compositional evidence from the data and other published contemporary glass specimens revealed that there are differences of some significance among Group I glass samples from different regions, leaving open the question of whether there are multiple production locations. The different physical classifications of Group II cannot be distinguished by reduced glass composition. These glass specimens appear to form a more consistent compositional group - regardless of excavation provenance - and therefore, suggest centralised production.

31 Arletti *et al.* 2011.
32 Panighello *et al.* 2012.
33 Arletti *et al.* 2012.
34 Triantafyllidis *et al.* 2012.

Cobalt was derived from a non-alum source and acts as a dark blue colourant, either alone or together, with supplementary copper. Light blue or turquoise glass of both groups from Gordion and Italian sites are coloured with copper, while some Italian and all three Georgian glass specimens are coloured by both copper and cobalt. Whether this is due to random survival and a small sample set or to the existence of different colouring traditions requires further investigation. By comparison with contemporary monochrome glass, core-formed glass may have elevated iron concentrations, particularly when coloured with cobalt. Iron would have been incorporated into these glass specimens as a component of the silica sand sources and could be associated with the lead used to colour yellow glass.[35]

There is still much work to be done to establish where Mediterranean core-formed glass was made and by which route it reached Gordion. It is anticipated that trace element analysis and increasing numbers of analysed glass specimens from other sites that can be used for comparison will provide greater clarity regarding the nature and distribution of core-formed glass around the Mediterranean region.

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35 See footnote 29. No yellow glass from Gordion was analysed.

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STAMPOLIDIS Nikolaos

A "HOMERIC" GLASS OBJECT FROM THE NECROPOLIS OF ELEUTHERNA, CRETE

For the past 28 years, an extremely interesting necropolis has been undergoing excavation at the Orthi Petra site on the western slope of Prine Hill at ancient Eleutherna, which is located near Rethymnon on Crete.[1] Although its boundaries have yet to be discovered (Fig. 1), one very important part has been excavated.

Three types of burial practice[2] presenting minor variations have been identified: (1) cremation, primarily for adult males belonging to a warrior aristocracy; (2) pithos burial in large vessels, chiefly for women of a certain status and wealth, and in smaller vessels for minors of both sexes; and (c) pit graves, below ground or at ground level.

The same necropolis also contains grave monuments above ground, interred or semi-interred; some are fully or partly hewn in the marly limestone of the hill while others are stone-built, of rough stone or ashlar, and with or without any architectural decoration.[3] Additionally, dozens of plain or decorated grave stelae and even Oriental/Phoenician type cippi have also been located there.[4] The number, quality and different places of origin of the grave goods found at the necropolis also require attention.[5]

Outstanding among the large-built, semi-interred burial monuments is a tomb, discovered approximately three years ago at the north-central part of the excavated necropolis. Building M (Fig. 2),[6] as it was named from the excavation section it belonged to, was built of rough irregular limestone. Its approximate external measurements are: 3.30 m long from east to west and 3.10 m wide from north to

1 See most recently: Stampolidis 2004, 117-138 and 234-295; Stampolidis 2008, 105-170.

2 More explicitly on the burial practices, see Stampolidis 2004, 119-132; Stampolidis 2008, 105-132.

3 Stampolidis 2004, 122-125 and 132-134 and Stampolidis 2008, 133-137.

4 Stampolidis 2004, 134-136 and Stampolidis 2008, 139-140.

5 Stampolidis 2004, 234-295 and Stampolidis 2008, 151-160 and sporadically.

6 Stampolidis 2008, 134-135 fig. 88 (during excavation). For a first presentation see Stampolidis 2012, 177-188.

Fig. 1: Aerial photo of the Eleutherna necropolis.

south; its entrance opening, between the pillars, is approximately 1.22 m and its surviving height ranges from 1.50 m (to the west) to 1.90 m (to the east).

Towards the tomb's western half, to the north and east respectively, are two built pillars with a height of 0.45 m. East of these pillars, we found the skeletons of 4 women, aged approximately 72, 28, 16, and 13½,[7] placed and apparently adorned with gold-bedecked garments that have since deteriorated, thus leaving the cut-out gold sheets in place. At the same time, jewels of gold, silver, bronze, amber and semi-precious stones (rock crystal, carnelian, amethyst and so forth), scarabs (of Egyptian blue, amber or faience), and tesserae of various materials also covered the bones. Other outstanding objects include a bronze bull figurine, two small saws, a small bronze measuring spoon and 5 gold pectoral ornaments, three of which are half-moon shaped: one bears depictions of a young god or hero among lions, one with the heads of two warriors and another with the bust of what appears to be a lion. The wealth of vases, bronze, clay and some faience is remarkable. There are 70 vessels, of virtually all shapes, amphorae both with and without lids, basins, jugs, lekythoi, phialae and so forth.[8]

Fig. 2: The funeral bulding M during excavation.

So far, the building itself is unique in the Orthi Petra necropolis, and the wealth of grave offerings leave no doubt as to the high social status of the 4 women.

7 Agelarakis 2012, 189-204.

8 Stampolidis 2012, 205-233.

Fig. 3a: Particular of the skeletons (right) and the clay amphoras including the amphora with the glass phiale in its neck.

Fig. 3b: The neck of the amphora with the glass phiale inside.

Fig. 4a-b: The glass phiale (bottom and profile).

Of the 4 large amphorae found practically against the eastern wall of the building, the second from the north is unfortunately broken; this however, allows us to distinguish differences in its clay compared to that of others and hence enables us to conclude it was imported into Eleutherna (Fig. 3).[9] With regards to both material and quality, its mouth was closed with an exceedingly rare and practically intact (except for some minor damage) vase, which had been placed with its base facing up, rim to rim with the amphora.

It is a glass phiale 14 cm in diameter, with a preserved height of 4.2 cm and is just 3 mm thick (Fig. 4).[10] It has a central omphalos, which provides the starting point for 46 flat ribs that cover the entire exterior surface and terminate at a flat recessed band, 1 cm high, below the rim. The exterior surface has deteriorated to an off-white colour with brown spots. In places without corrosion, the exposed surface reveals a colourless greenish glass core.

The remarkable exterior surface of the vase indicates the material had been spread evenly over a mould. Contrariwise, the internal surface, especially towards the bottom, appears irregular, as if it had been sloppily applied or, at least, with less care.

The composition of both the corroded surface and the exposed glass of the Grave M phiale was investigated. The investigation was carried out before and after the removal of the surface corrosion at specific points of the

9 Stampolidis 2012, 39-40; 179 fig. 6; 180; 226 no. 73 and fig.

10 Stampolidis 2012, 217, no. 45 and fig.

rim over a length of 2 cm. The analyses[11] were performed with XRF and two X-ray sources, Am-241 (for elements with a higher atomic number) and Fe-55 (for elements with a lower atomic number):

- Elements with a higher atomic number (higher than iron): The elements Sr (strontium), Zr (zirconium), Sb (antimony) and Ba (barium) were detected in levels similar to those of the untreated approximate level "white part", i.e., Sr (strontium, 385 ppm), Zr (zirconium, 16 ppm), Sb (antimony, 2766 ppm, i.e., 0.27%) and Ba (barium, 106 ppm).

- Elements with a lower atomic number (lower than iron): here too, essentially similar results were originally obtained from both the cleaned and the unclean part (3 points of the phiale's rim were tested, one on the cleaned part and the other two on the unclean part of the rim).

However, a difference did appear in relation to the first results with regard to silicon and potassium (the rim appears to contain much less silicon and potassium). This difference has nothing to do with whether the rim was cleaned or not. It is telling that the same area of the rim was tested "from above" as well as "from the side" and that the test "from above" indicated much less silicon and potassium (practically undetectable) than the "side" test (its results are similar to the "flat surface" test).

Although the phiale of Grave M at Eleutherna is made of a rare material, in typological terms, glass belongs to the series of metal phialae (primarily bronze) we are familiar with, thanks to various sites (sanctuaries and graves) located mostly in the Near East, and the eastern and central Mediterranean.[12] The diameter-height relationship rule is frequently mentioned in literature[13] regarding 7th century BC phialae (where the classic ratio is considered 1:3). Taking into account the wear at the end of the rim and assuming its height was more or less 4.5 cm, the proportions of this particular phiale are of a smaller ratio than 1:3 when the diameter-height relationship rule is applied, therefore suggesting a slightly earlier date of origin. The phiale was found on the neck of a late 8th century amphora and so the phiale can most probably be dated to at least the second half of the 8th century BC even though such a fragile and sumptuous vase had been placed in a large clay vessel – apparently with a longer proven life-expectancy – dating several decades later.

Be that as it may, the rarity and opulence arising from the material itself,[14] makes the Eleutherna specimen unique, not only due to its preservation, but also due to its early chronological appearance. Contemporary vases are rare and only those from Gordion in Asia Minor[15] - even broken specimens – are familiar to us. However, the Eleutherna phiale differs essentially from the Phrygian finds since it is uniquely decorated with ribs, and additionally, seems to have a different composition.[16]

The dozens of objects found at Eleutherna are made of different materials: clay, gold, silver, bronze, glass, faience, ivory and so forth, which were imported into the necropolis from a number of geographical longitudes and latitudes: from Crete, the Aegean Islands, the Peloponnese, Attica and the Dodecanese to Cyprus, Phoenicia, the Syro-Palestine shore, Egypt and so forth. There is nothing unusual about the presence of this glass phiale in Eleutherna; rather, it provides one more piece of evidence that reflects the direct or indirect

11 All analyses have been possible with the generosity of Professor N. Kallithrakas - Kontos from the Polytechnic School of Crete to whom I would like to extend, once more, my thanks.

12 See for example *Anatoliki Mesogeios,* 244 nos. 299 (from Ampelokipi, Knossos) and 300 (from Eleutherna), both imports from Asia Minor or the Near East; *Eastern Mediterranean*, 124 no. 23; *Sea Routes*, 440-442 nos. 751 ff. from various find spots (some with a small central boss as ours).

13 Cf. Stampolidis 1994, 112 ff. and especially 115, 177-118 with the relevant bibliography.

14 Cf. Triantafyllidis 2004 on kyanos and glass, their rarity and their association with gods, kings and priests.

15 Cf. e.g. tumulus P, von Saldern 1959, 23-27, fig. 1-2; Young 1981, 32 fig. 18, pl. 15A-B. Also Howes Smith 1981, 11 note 76. Jones 2005, 104-108.

16 The absence of potassium indicates that the row glass was probably made with natron, not plant-ash like the Gordion tumulus P phiale.

relations of Crete and 9th, 8th and 7th century BC Eleutherna with the Aegean, the East and the Central Mediterranean.[17]

The use of the vase for libations was associated primarily with sanctuary, but also with funerary rites, and once again demonstrates that (a) it might belong to the funerary rites conducted for the last time at Grave M before being used to serve as an amphora cover for eternity, or (b) it belonged to one of the women found buried inside. In the latter case, one might attribute a priestly function to the deceased who possessed the phiale in life. Of all possible hypotheses, this conforms best to modern bibliographical interpretations,[18] which state that phialae primarily made of metal found in female graves, are linked to a priestly rank. Of course, a combination of the two theories referred to above cannot be excluded under any circumstances.

In any case, the glass phiale of Eleutherna – presented briefly for the first time at this conference – is among those extravagant rarely complete preserved objects, which when its data is published in full and when compared with the material of other glass objects (mainly necklace beads)[19] from the same necropolis, will shed light on numerous questions and hypotheses that archaeology raises - especially on the dissemination of the Homeric epics.

17 Cf. Stampolidis 2004, 234-295 sporadically and Stampolidis 2008, 112 ff. and especially 151-160.

18 See most recently Stampolidis 2012, 44-45 and notes 96-99; Chryssostomou and Chryssostomou 2012, 373; Ignatiadou 2012, 395-396; Kottaridou 2012, 418-420.

19 Dated from the 9th to 7th century BC of different sizes and colours resembling to analogous examples from Ialysos on Rhodes or Delion on Paros etc. (see *Anatolike Mesogeios,* 225 no 266; *Sea Routes,* 522 no. 1019 and 524 no. 1025 with figures.

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EARLY GLASS IN METHONE

Ancient Methone was a city on the west coast of Pieria, to the north of ancient Pydna (present day Makrygialos).[1] The city flourished due to two main factors. Firstly, it was built close to the ancient north-to-south axis of mainland Greece and had easy access, not only to central and western Macedonia, but also to the Balkan hinterland. Secondly, the city had the safest harbor in the Thermaic Gulf. Today, the ancient settlement is approximately 500 m away from the coastline due to alluvial deposits of three rivers. In antiquity, the sea was at the east edge of the settlement, where it formed the east harbor. Immediately to the north was a second harbor, which was protected from both the north and south strong winds that often blew in the region. This double harbor became a center point for trade in the Aegean.

The area had been inhabited since the Neolithic period, but Methone was built ca. 733 BC as a colony of Eretria and, according to the sources, it was the first colony in the north Aegean. In early antiquity, this area was still called Thrace and was the homeland of Orpheus who was born in the city of Leibethra, which was nearby. Methone was named after Methon who was an ancestor of Orpheus.

The colony maintained contacts with her metropolis and was a member of the Athenian League. Additionally, she had supported a contender for the throne of Philip II. The Athenian presence in Macedonia disturbed King Philip, who decided to subdue Methone and banish the Athenian Navy from the area. During the fierce siege of Methone, the king lost his right eye. The city was defeated and was transferred to the hinterland, her territory distributed to Macedonians. The original inhabitants were forced to abandon it, taking only one piece of clothing. In 354 BC, the city was destroyed by Philip and was never inhabited again, thus giving the archaeologists the rare opportunity to excavate a closed context.

During the last few years, limited excavation research has taken place in three parts of the city: the East and the West hill and the flat area

1 On the history of Methone see Tzifopoulos 2012.

between them. Glass finds were unearthed in all three areas: the "Ypogeio", the Agora, and the Acropolis.[2]

Some of the glass pieces were surface finds, revealed to be core-formed glass fragments, blown-glass fragments, and beads. The general picture that the surface finds create becomes much clearer when objects found in stratigraphy are closely examined.

Glass in the "Ypogeio"

The earliest glass finds date to the Geometric period and were excavated in the "Ypogeio" at the top of the East hill. The "Ypogeio" was a basement approximately 3.5 by 4 meters, and 12 meters deep. It was dug in the 8th century BC by the first settlers, probably to serve as a cooling cellar. It was filled with soil in a relatively short time in the 8th or beginning of the 7th century BC. Masses of pottery sherds were found in the fill. The earlier examples are Euboean pottery from the 8th century BC and were obviously brought by the colonists. Some sherds are also inscribed in the Euboean alphabet. The fill contained debris from workshops for various materials. Evidence shows the working of bronze and gold, ivory, bone, tusk and glass.[3] Glass beads were also found in the basement fill and those can therefore, be securely dated to the 8th century BC, or shortly after (Fig. 1).

The beads are both undecorated and decorated. The undecorated are two colorless round beads, one greenish and the other bluish green, as well as one blue ring bead. Similar undecorated beads are quite common in central Macedonia, but have not been studied to date, with the exception of those from Thermi (Sedes).[4] Most interesting are the decorated kind, which are six eye beads and triangular with spiral eyes. The beads are dark and the eyes are white opaque with the exception of one very well preserved bead with one white and two yellow spiral eyes.[5] Contemporary triangular eye beads were found in Dailaki, Kastoria, but with round rather than spiral eyes.[6] The origin of a single find with spiral eyes is unfortunately untraceable.[7]

Glass in the Acropolis

The Acropolis occupies the West hill of the site. It is a trapezoidal hill, which was originally fortified. Erosion has destroyed the city walls and only some tunnels survive. This was the location of the Bronze Age cemetery of the settlement where some pit graves have been investigated. Later, the settlement was extended over this area too. Two apsidal public buildings of the 7th century BC can be also recognized by their post holes. Glass finds were recovered from excavation trenches dug in three stone buildings (Fig. 2). The buildings and the small finds indicated workshop activity through the use of pyrotechnology. A hearth with remains of molten bronze was also excavated. The buildings were destroyed by fire in the second quarter of the 6th century BC. The stratified glass finds are therefore, dated to before this time. The following beads are also all known to have been found elsewhere in the region:[8] a brown, round and slightly conical version; an off-white disc beads; two brown ring beads; an off-white round bead; and a blue conical example.

Glass in the Agora

Between the hill of the "Ypogeio" and the Acropolis hill, part of the Agora (the Forum) was revealed, as well as the trade and political center of Methone, where monumental buildings were excavated around an empty space, probably an open square.

The excavation of the Agora provided most of the glass finds from Methone: 29 tiny fragments of core-formed vessels; 6 fragments of

2 Regarding the excavations in the area and also the sites discussed here see Bessios *et al.* 2004; Bessios *et al.* 2008; Bessios 2010, 61-63, 104-111, 305-314.

3 On the "Ypogeio" see Bessios 2012.

4 Ignatiadou, Chatzinikolaou 1997.

5 On the technique see Spaer 2001, 52.

6 Glass Cosmos 2010, cat. nos. 19, 21, 27 (D. Ignatiadou); see also the examples without traceable origin 386, 388 (A. Dimoula).

7 Glass Cosmos 2010, cat. no. 387 (A. Dimoula).

8 Ignatiadou, Chatzinikolaou 1997, chart A.

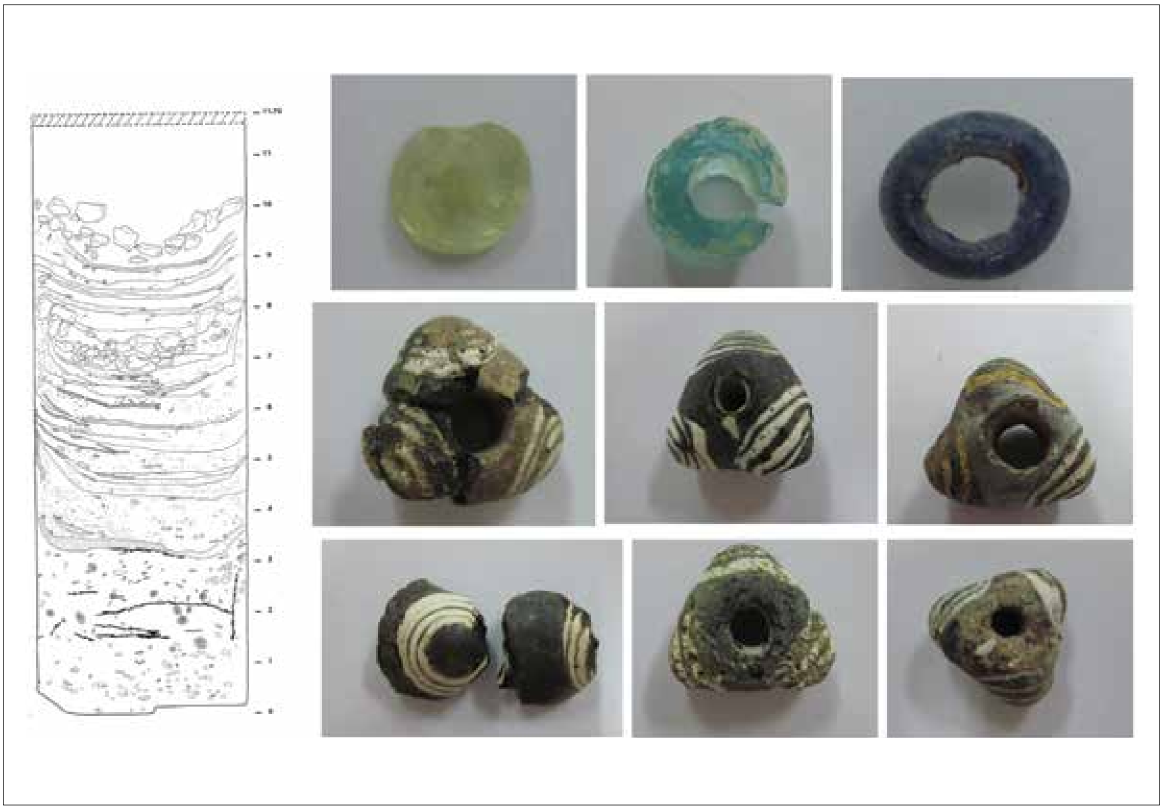

Fig. 1: Stratigraphy and glass beads found in the "Ypogeio".

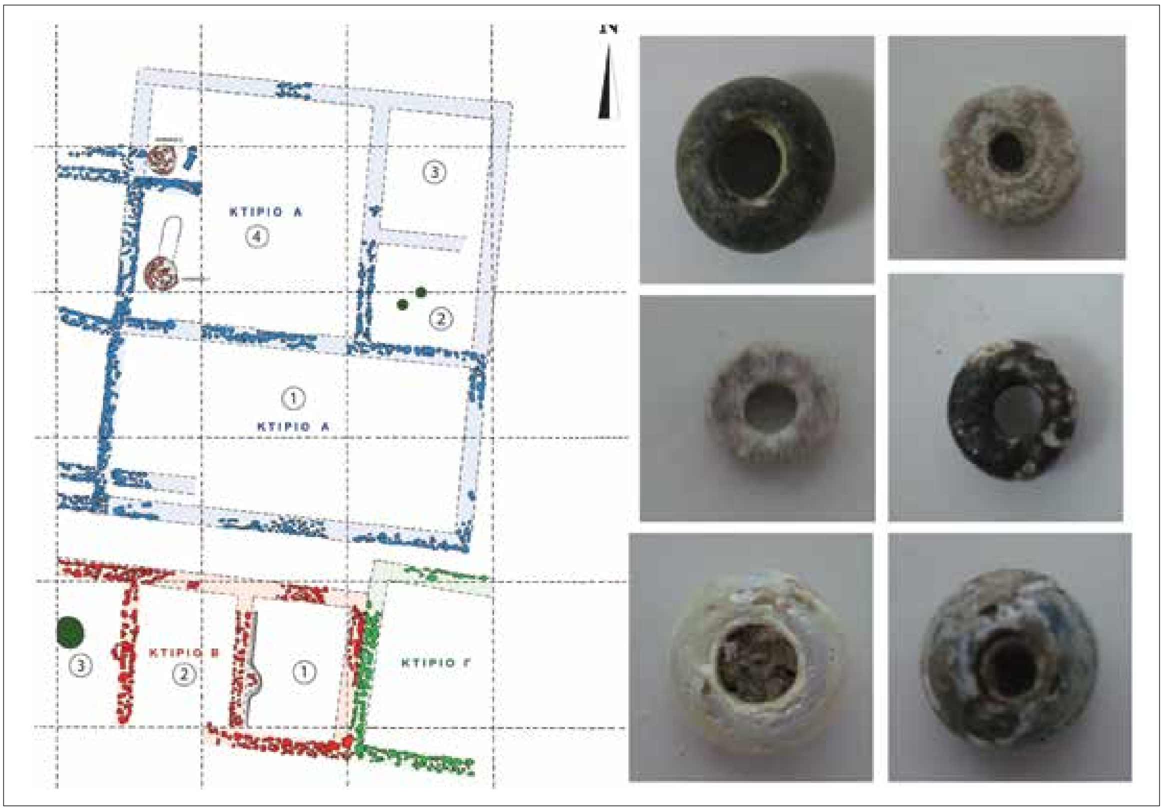

Fig. 2: The three buildings revealed in the Acropolis and the beads found there.

Fig. 3: Core-formed glass fragments found in the Agora.

rods; one gem; one colorless vessel-fragment; and 56 beads. They were all found inside or outside the buildings, all of which also provided evidence for the operation of workshops.

Of the core-formed fragments (Fig. 3), the most interesting example is part of a blue neck with yellow rim (Fig. 3 center). The irregular tooling and the hole probably indicate a reject discarded somewhere near the workshop. It was found with pottery of the 6th and the 5th century BC.

Building A

Building A is a public building of the second quarter of the 6th century BC (Fig. 4). It has three rooms which were dated by silver coins, tetradrachms of Athens and Macedonia. In the 5th century BC, a stoa was added at the front (north) side. Two earlier buildings were found below its foundation levels, buildings D and E to the West. Of those, the earliest is building D which was constructed from the 7th to the 6th century BC.

The beads are the most interesting finds of this sector. Most of them are transparent poppy-seedpod beads, widely known as melon or ribbed beads. These were being manufactured from the 9th or 8th century BC from amber or dark glass. They are not associated with Egyptian melon beads, but they evoke the gold or crystal poppy seedpods of the Bronze Age. The early poppy beads have more ribs than the later versions, usually six or seven, and the earliest are also usually decorated with transverse trails of a second color.[9] This is later reduced to a single revolution or it disappears completely. The plain poppy beads usually have five ribs and are made of transparent light blue-green glass. They

9 A dark bead with yellow thread was found in a 7th century BC grave in Thermi (Sedes); see Ignatiadou, Chatzinikolaou 1997, 63-65, fig. 15, chart B1a; also Glass Cosmos 2010, cat. no. 307 (E. Skarlatidou). An 8th century BC example was found in the sanctuary of Ammon-Zeus / cave-sanctuary of Dionysus in ancient Aphytis (Chalkidiki); see Glass Cosmos 2010, cat. no. 443 (D. Ignatiadou).

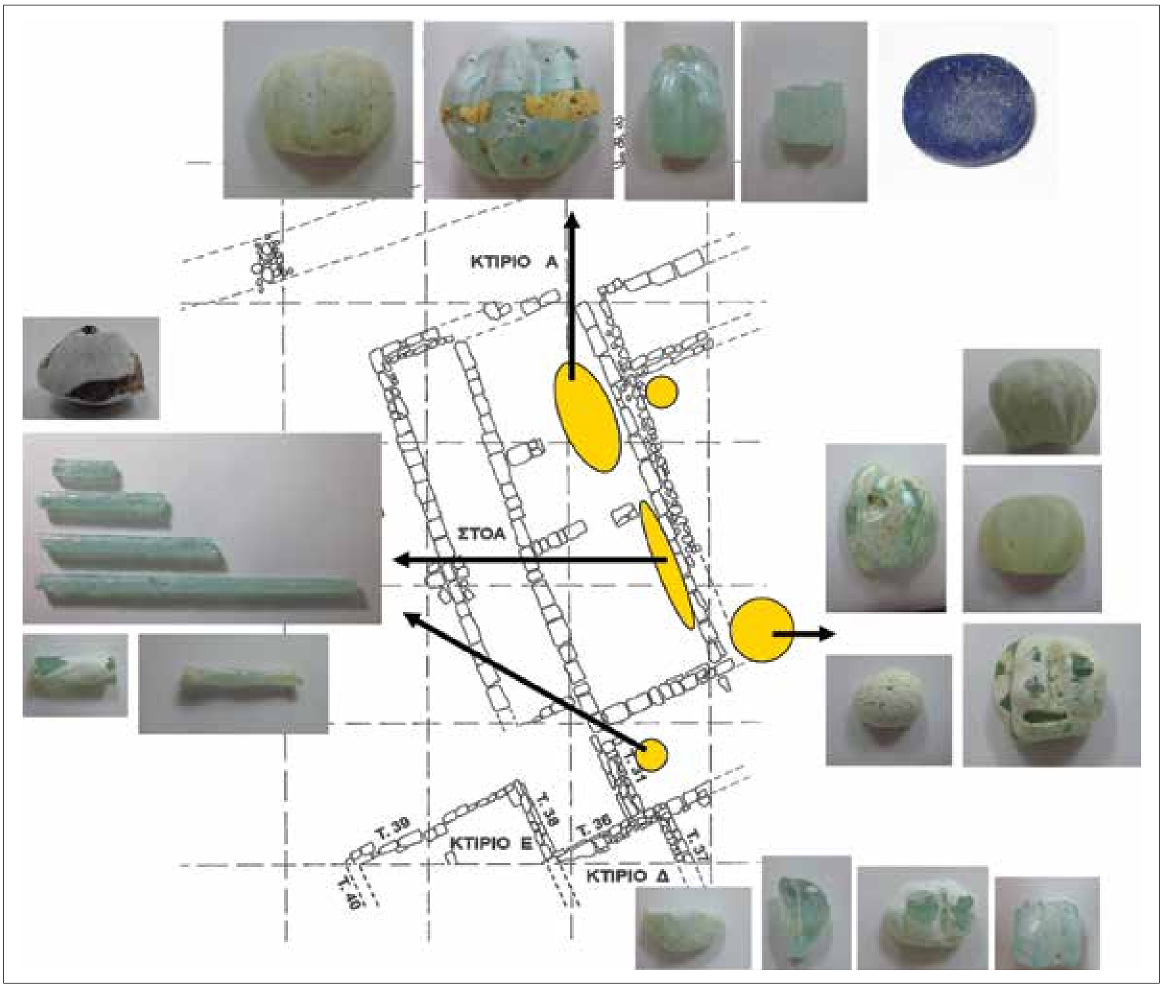

Fig. 4: Agora. Public stoa-building A and the glass objects found inside it (North is to the left).

were thought to have been manufactured in the classical period, judging by their appearance from the 5th-4th century BC Macedonian burials. Yet the result of this study, in light of the stratigraphy, is surprising as now it can be proven that these beads were manufactured from the 6th century BC and were sometimes two centuries old when they were deposited in the graves. A necklace of 33 early poppy beads (with six ribs) was found in a 5th century BC grave in Souroti, near Thessaloniki,[10] and contemporary isolated finds were also found in the late 5th to the early 4th century BC burials in Thermi (Sedes).[11] A five-rib type, prevalent in Methone, was found in a BC 350-300 burial in nearby Pydna.[12]

10 Glass Cosmos 2010, cat. no. 321, (K. Havela, D. Ignatiadou).

11 Ignatiadou, Chatzinikolaou 1997, chart B5.

12 Glass Cosmos 2010, cat. no. 87 (D. Ignatiadou).

In stoa-building A, beads were found in both the rooms and in the stoa, in strata dated to as early as the 6th century BC. A single glass gem was found in the east room. It is a blue undecorated gem and was found under the fallen roof; it is therefore dated to the first half of the 4th century BC, before its destruction in BC 354.

In the west room, in a trench dug deeper along the south interior wall, a biconical amber bead and fragments of light blue rods were found. One rod fragment was found outside the building. The rods were drawn by twisting. A tapering fragment of similar fabric but of smaller diameter is also preserved. These rods appear to be of the same kind of glass like most of the poppy beads. They are obviously unused rods intended for making the poppy beads through winding. The tapering fragment is the thin end

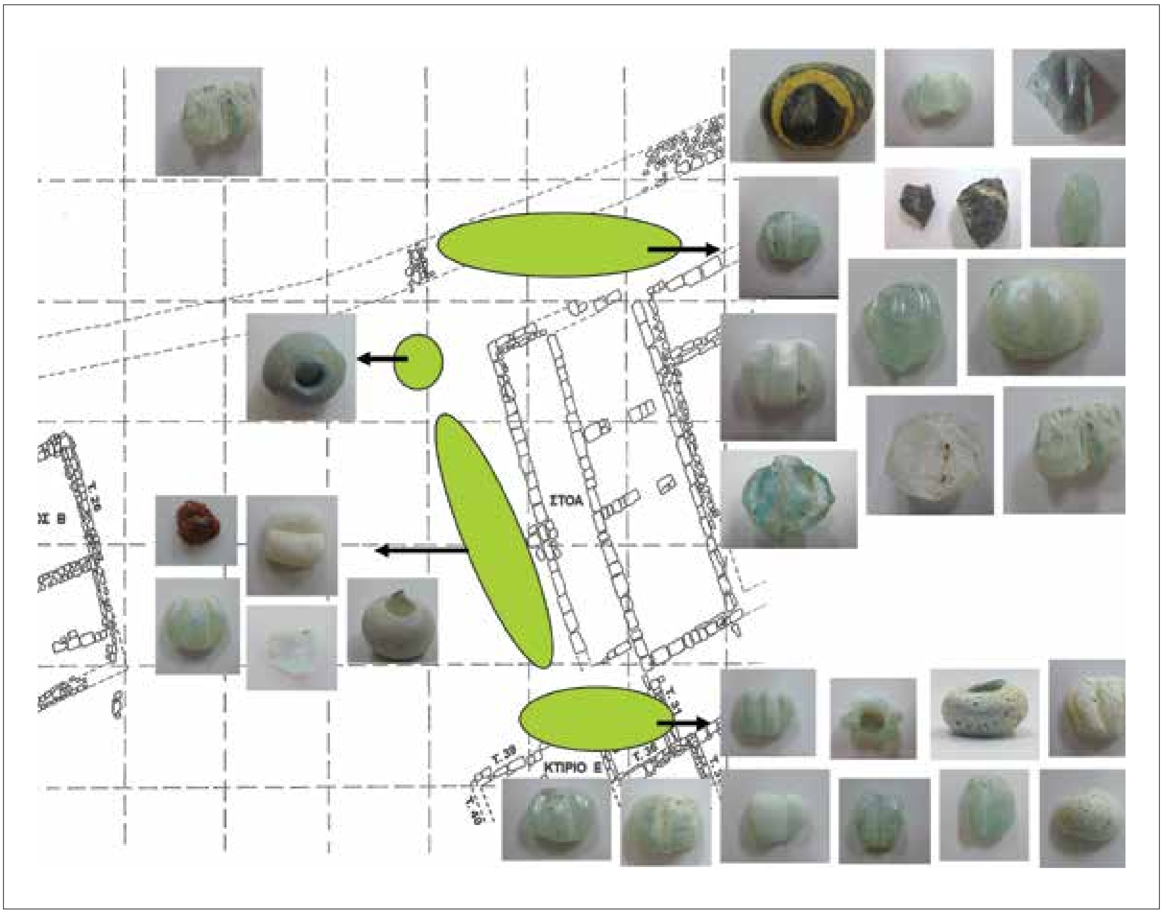

Fig. 5: Agora. Public stoa-building A and the glass objects found outside it (North is to the left).

of the hot mass of glass pulled to create a rod.[13] Black figure pottery found together with the rods dates the stratum and this bead, indicating activity in the 6th century BC.

A single large bead with a transverse yellow revolution (Fig. 4, upper row, second from left) is of a type also found on another central Macedonian site, the Mieza cemetery. Several such beads were found there in a burial of the second quarter of the 5th century BC.[14]

Several beads were found outside the building, mainly along the outer east and north wall, and also to the west where earlier buildings D and E are preserved at a lower level (Fig. 5).

Building B

Building B has two rooms from the 6th century BC and front yard of a later date. This building was identified as an ironsmith's workshop due to the nature of the finds there.

Here the poppy beads were fewer and four eye beads were also found (Fig. 6). They are of common types, except the last one in the bottom group; this blue bead with four composite white eyes and with eight yellow blobs is unknown elsewhere in Macedonia.

Bead making in Methone

While most of the eye, ring and conical beads survive intact, all of the poppy beads were found broken. The two whole examples were one unstratified and one surface find (Fig. 7). The majority was either broken in antiquity or presents some kind of flaw. Some have disfiguring protrusions, as do two undecorated and one eye bead. One has a big pit, which perhaps started as a bubble and another one a transverse dent, perhaps caused by awkward handling.

13 E.g. Spaer 2001, 16 c.

14 P 1673, grave 93. Romiopoulou, Touratsoglou 2002, 95, pl. 13 with bibliography, and also chart 1.

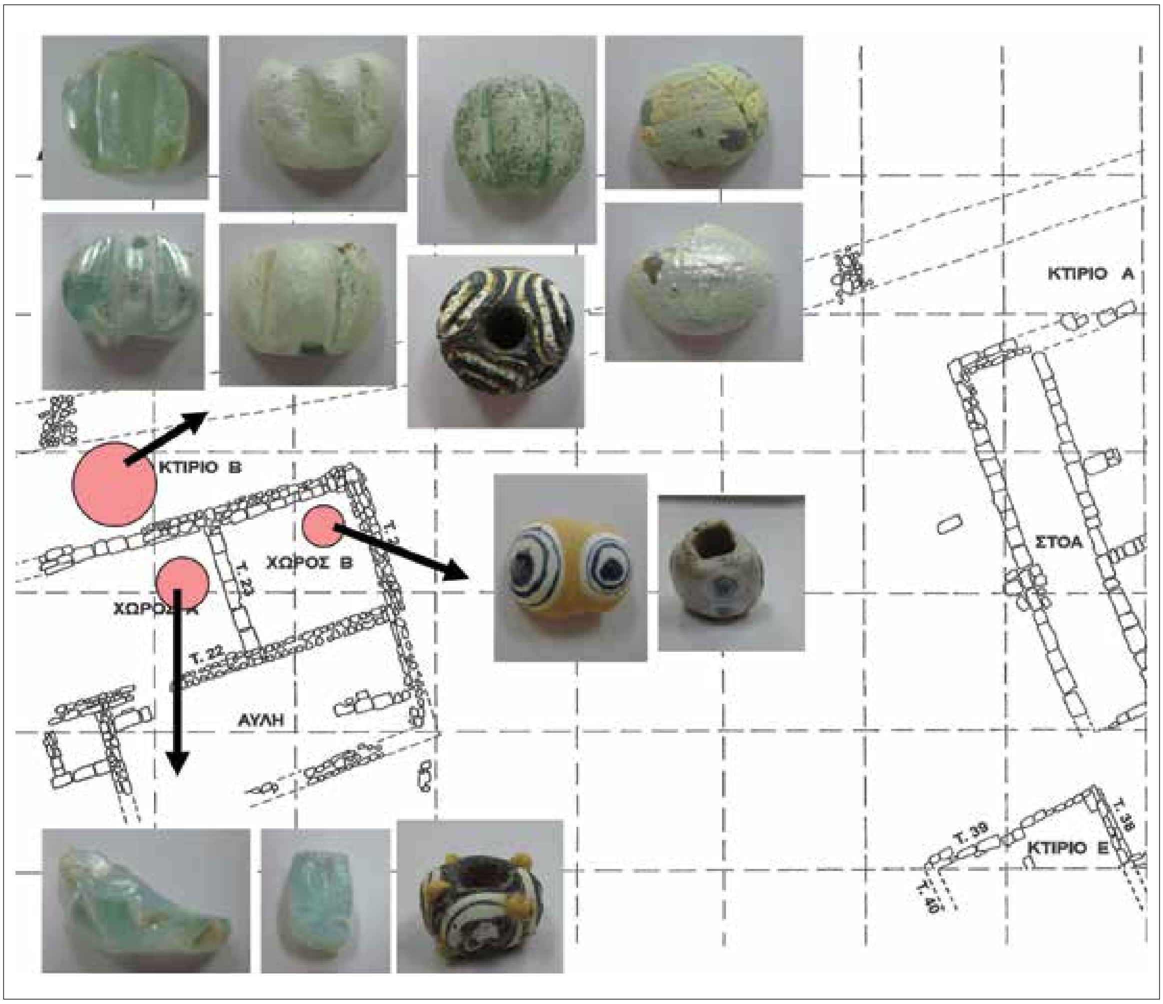

Fig. 6: Agora. Public building B – the ironsmiths' workshop (North is to the left).

Others have irregular or flawed ribbing. An interesting find is that of a bead from which an oblique slice is missing. The exposed surface has the same soft contour and corrosion like the rest of the surface; it therefore seems that the bead was exposed to heat after it was broken in antiquity and perhaps while still on the mandril.

The prevalence of a single type of bead, the poppy version, and the existence of rejects and rods can be considered relatively safe proof for bead making in Methone from as early as at least the 6th century BC.

Acknowledgements

This study of the Methone beads and other glass finds is at a preliminary stage and will be concluded for the final publication of the excavation. The author extends sincere thanks to the excavator Manthos Bessios and the archaeologists Athena Athanassiadou and Konstantinos Noulas for access to the finds and their documentation and for valuable discussions.

All the photographs in this paper are taken by the author.

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UNE COUPE HELLÉNISTIQUE AU LOUVRE. UNE DECOUVERTE

En 1894, le docteur Daniel Fouquet fit don au Louvre d'un lot important de fragments de verre à décor gravé. Le travail de restauration fut confié, en 2005, à Juliette Dupin qui à partir des 290 fragments réussit avec beaucoup de patience et un long et minutieux travail d'assemblage à reconstituer une pièce exceptionnelle. Exceptionnelle à plusieurs titres, d'abord sa taille : elle présente une hauteur de 13,5 cm, un diamètre de 22 cm et une épaisseur de 0,7 cm. Son poids est également à noter: 1,044 kg. Enfin sa technique de gravure est assez rare.

Description

La forme est celle d'un bol hémisphérique profond à bord arrondi souligné d'une rainure sur la paroi interne. Le décor est en relief: il s'agit d'un calice de quatorze feuilles larges et pointues à leur sommet et dotées d'une nervure centrale tantôt lisse, tantôt hachurée horizontalement; sur ces dernières sont ajoutées des nervures obliques de part et d'autre de la nervure centrale hachurée, offrant ainsi une alternance de feuilles nervurées avec ou sans décor ajouté plus réaliste. Le fond , défini par deux rainures concentriques de 6,5 cm et de 5,5 cm est orné d'une rosace à six feuilles à nervure centrale. C'est sur le cercle extérieur que repose l'objet (Figs. 1, 2, 3). Aussi bien le décor de la panse que le décor du fond sont uniques: toutes les comparaisons citées plus bas offrent un décor végétal sur la panse mais différent de celui de la coupe du Louvre: ce sont le plus souvent des restes de pétales qui peuvent alterner avec des cannelures (ou joncs). Le second décor est constitué simplement de feuilles: celles-ci sont dessinées et gravées généralement sans ajout de détails (si c'est le cas ils sont très sommaires). À cela s'ajoutent une série de pièces où s'ajoutent des bossettes en relief entre les feuilles. On ne retrouve en aucun cas la finesse et la minutie du dessin des feuilles du vase du Louvre.

La technique de fabrication

Le processus de fabrication de ce type de vase a été reconstitué par K. Cummings et décrit


Fig. 1: La coupe à décor végétal. Musée du Louvre. Copyright Musée du Louvre, Patrick Lebaube.

par M.E. Stern.[1] Le verrier prenait un bloc de forme grossièrement carrée et le chauffait à une température de 700 degrés pour former un disque de verre d'une épaisseur de 0,7 à 0,8 cm. Puis le disque encore chaud était placé sur un moule convexe en céramique et déposé dans le four. Par son propre poids le disque s'affaisse le long des parois du moule et le recouvre intégralement. Le bord du bol est plus épais que le fond par un phénomène de gravité. Après le démoulage du bol, le verrier retravaille la lèvre si nécessaire puis il laisse le bol refroidir lentement. La paroi interne était ensuite polie comme le prouvent les fines lignes concentriques qui la recouvrent et le décor intérieur de rainure sous la lèvre était obtenu à la meule. Puis le graveur décorait la paroi extérieure du bol.

Une autre hypothèse de fabrication[2] est celle du pressé/moulé sur un tour et dans un moule portant le motif décoratif que l'on veut obtenir. Cette dernière hypothèse serait confirmée par les fines traces concentriques visibles sur l'intérieur de la paroi du vase. Ensuite la décoration était sans doute rehaussée par de courts traits gravés.

L'ensemble du décor du bol conservé au Louvre est en relief et se démarque ainsi des décors exécutés le plus souvent en creux sur ce type de vaisselle. Seuls deux fragments de Délos, un fragment de Cnossos[3] et également un de Jéricho[4] sont réalisés selon cette technique beaucoup plus rare.

1 Stern 1994, 66-71.
2 Lierke 2009, 42.

Comparaisons dans d'autres matériaux

Cette vaisselle en verre s'inspire de pièces de vaisselle métallique ou céramique. Ainsi une belle coupe en argent d'époque hellénistique conservée au musée de Berlin[5] (Fig. 4) et découverte en Iran offre un décor de quatre feuilles pointues à nervure centrale alternant avec quatre ensembles de cannelures (joncs). Les coupes en faïence égyptienne d'époque hellénistique offrent également parfois un décor de calice de feuilles à nervure centrale et feuilles striées couvrant les parois du vase et partant d'une rosace à huit feuilles.[6] Une autre coupe en faïence, de plus petit format, en provenance de la nécropole de Myrina fouillée par E. Pottier et S. Reinach est conservée au musée du Louvre et présente un décor en relief analogue de rosette sur le fond et de calice de feuilles d'acanthe alternant avec de longues feuilles de nymphaea nelumbo sur les parois.[7]

3 Nenna 1999, 94 et 95, nº 256-257 et note 126.
4 Jackson-Tal 2013, 102, pl. 3, 1:3.
5 Silver for the gods 1977, 76, nº 41; Stern 1994, 102, fig. 187.
6 Yalos 2009, 35, fig. 6.; Nenna et Seil el Din 2001, 195-200, Type 2.3B, n° 140-150.
7 Jentel, CVA Louvre 15 1968, III N, pl.12.2: nº inv. Myrina 593. Pottier et Reinach, 1887, nº 593.

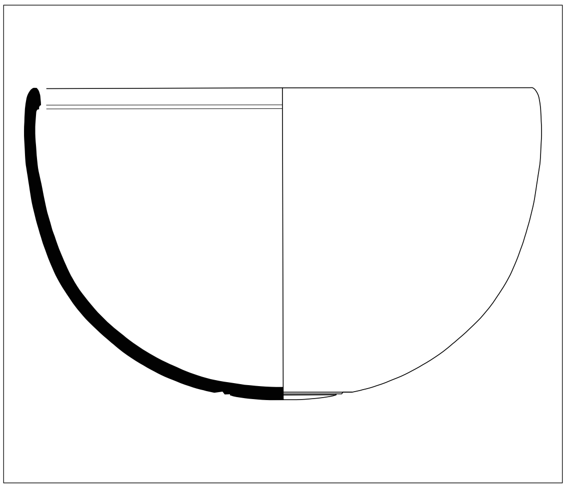

Fig. 2: Le profil de la coupe. Musée du Louvre (dessin Christine Walter).

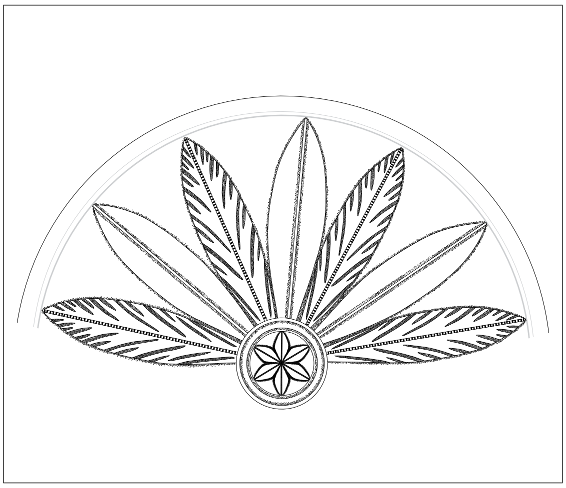

Fig. 3: Dessin du motif végétal de la paroi et du fond (dessin Christine Walter).

Diffusion

Délos est le premier site à avoir livré tant de bols à décor végétal: vingt pièces ont été publiées par M.-D. Nenna en 1999. Cette dernière montre qu'ils ont une diffusion large avec des pièces découvertes en Grèce à Délos et Amorgos, en Turquie à Gordion et Kayseri, en Israël, en Jordanie à Pella et en Italie à Rome, ainsi que dans les épaves d'Anticythère et de Camarat 2.[8] On note que la découverte de bols décorés de motifs végétaux en Israël n'est pas très fréquente en Israël selon l'étude de R. Jackson-Tal parue en 2004.[9] Deux fragments de Maresha proviennent de contextes datés des III-II^{e} siècle av. J.-C., celui découvert à Ashod avec feuille pointue schématique est daté du II^{e}-I^{er} siècle av. J.-C., celui découvert à Nessana est daté du Ier siècle av.-Ier siècle apr. On peut y ajouter des fragments inédits à Jaffa et Akko ou récemment publiés à Tel Anafa[10] et à Jéricho.[11] Toujours au Proche-Orient, en Syrie orientale, le bol de Jebel Khalid est daté du II^{e}-début I^{er} siècle,[12] en Jordanie, un fragment de Pella du I^{er} siècle av. J.-C.[13] Notons aussi des fragments d'un bol hémisphérique découvert sur l'île de Kos:[14] le fragment no. 8.2 offre un décor de cannelures alternant avec des pétales, dont le diamètre est plus petit que celui du Louvre, 14 cm, mais néanmoins de bonne taille. La très belle coupe ambre de l'épave d'Anticythère (autour de 70 av. J.-C.), si elle présente un décor de feuilles ovoïdes pointues alternant avec des bossettes, se rapproche de notre pièce par sa taille, Diam. 23,6 cm.[15] Enfin, assez loin des régions évoquées plus haut, rappelons les deux bols à calice et bossettes découverts dans l'épave Camarat 2 (50-45 av. J.-C.),[16] et un fragment de bol à décor végétal comportant la partie supérieure d'une feuille pointue à nervure centrale a été découvert à Bibracte en Bourgogne.[17]

Origine et destination

La densité des trouvailles dans le monde égéen et en Syrie-Palestine ne peut que confirmer l'existence de centres producteurs dans ces régions bien qu'aucun atelier n'ait été clairement identifié. Ces vases sont façonnés et décorés sur la côte syro-palestinienne, sans doute dans les mêmes ateliers que ceux à décor cannelé (55 fragments à Délos 1999) ou à décor de rainures (320 individus à Délos). A ce jour aucune trace

8 Voir Nenna 1999, 95 pour les références bibliographiques.
9 Jackson-Tal 2004.
10 Grose 2012.
11 Jackson-Tal 2013, 102, pl. 3, 1:3.
12 O'Hea 2002, 250-256, fig. 5.5.
13 O'Hea 1992, 255, fig. 3.
14 Triantafyllidis 2006, 158.
15 Avronidaki 2012, 137, n° 99.
16 Tout feu, tout sable 2001, 104, n° 129.2 et 129.3.
17 Foy, Colombier *et al.* 2008, 10, pl. 1, n^{o} 3.

Fig. 4: Coupe en argent de Berlin, Staatliche Museen, Antikenabteilung inv 31 425 (d'après Silver for the Gods, 1977, 76, no. 41).

de structures de production n'a été découverte le long de la côte syro-palestinienne. Pour l'époque hellénistique seuls deux lieux sont attestés: le site du dépotoir du quartier juif de Jérusalem daté du milieu du Ier siècle av. J.-C. et celui, un peu plus récent, du chantier du petit sérail du centre-ville de Beyrouth.[18] Malheureusement en dépit des abondantes quantités de verres découverts en Syrie-Palestine, la question de la localisation des ateliers reste entière. Les sites israéliens semblent livrer plus de matériel que ceux de Jordanie, Liban et Syrie. Mais l'intensité du travail archéologique dans ces trois pays n'est sans doute pas la même. Les bols moulés hellénistiques se retrouvent partout en Israël avec une prédominance pour les bols à rainures, sans oublier ceux à décor perlé ou végétal ou cannelé. Leur homogénéité et leur uniformité laissent penser qu'ils sont fabriqués en Syrie-Palestine, peut-être sur la côte, comme le suggèrent les auteurs anciens comme Strabon, Pline et Flavius Josèphe.[19]

L'analyse élémentaire de la coupe du Louvre montre qu'elle est fabriquée à partir d'un verre obtenu par fusion d'un sable avec une soude d'origine minérale (natron). La composition de ce verre présente toutes les caractéristiques de celles des verres issus des ateliers primaires syro-palestiniens autour du début de notre ère. Les teneurs élevées en oxydes de manganèse (MnO 0,55%) et d'antimoine (0,21%) suggèrent que ces deux éléments ont pu être utilisés comme décolorant. (Analyses faites par Bernard Gratuze que je remercie).

Conclusion

Cette pièce luxueuse appartient au répertoire du vaisselier hellénistique en verre moulé monochrome de la fin du IIe siècle et du début du Ier siècle: à côté des bols à décor perlé constituant une catégorie assez rare, les bols à décor cannelé sont assez abondants en particulier à Délos et dans toute la partie orientale de la Méditerranée; l'exemplaire du Louvre appartient à la série plus rare à décor végétal. La pièce étudiée ici offre un motif composé uniquement de feuilles, mais qui renvoie néanmoins au groupe plus large des bols à décor végétal, le plus souvent de forme hémisphérique profonde, décoré de feuilles larges et pointues à leur sommet alternant avec des faisceaux de joncs (ou cannelures). Le fond est orné de rainures concentriques ou d'une rosette à 6 ou 8 branches. Ces pièces raffinées et de grande valeur impliquaient probablement la présence d'artisans graveurs au sein des ateliers de verriers et s'adressaient certainement à une clientèle très aisée, raffinée et cultivée.

Remerciements

Je tiens à remercier Jean-Luc Martinez, alors directeur du département des antiquités grecques, étrusques et romaines, qui m'a accordé sa confiance pour l'étude de ce mobilier. Un grand merci également aux conseils avisés et amicaux de Marie-Dominique Nenna, ma complice depuis longtemps pour l'étude du verre.

18 Nenna 2007.
19 Jackson-Tal 2004, 11, note 2.

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EVIDENCE ON THE SEALING OF GLASS GLOBES (ISINGS FORM 10). A SHORT NOTE

One of the earliest forms of free blown unguentaria – dated from the first century AD-, are small globes, with a very short neck and no rim, known in Clasina Isings' typology as form 10.[1] They appear in quite big numbers in Thessaloniki, usually accompanying bird-shaped glass unguentaria.[2] Just like in most cases with vessels, and particularly with glass unguentaria, no traces of their stoppers survive. An exceptional example of an ornate lead sealing system was found in the excavation of a tomb in the region of Thessaloniki, which shed light on this puzzling question and facilitated the identification of three very fragmentary examples from the eastern necropolis of Thessaloniki.

To the west of Thessaloniki, in the area of Drymos village, an extended cemetery has been unearthed in salvage excavations, dating from the 6th century BC to 3rd century AD. There, in the salvage excavation at the plot property of Kanakis and within 138 m², a densely arranged group of forty graves were excavated. Thirty-two were inhumations and eight cremations, the dates of which range from archaic, through Hellenistic and up to Roman times and bear the features of plain pit-, cist- and tile- graves. Both inhumations and cremations occur during Roman times, both oriented E-W. Inhumations were conducted in rectangular pits covered with schist slabs, whereas cremations were conducted in different spots, which have not been located. The remains of the cremation were placed in tile-covered pit graves.[3]

The grave No. 1 - a secondary cremation of a male individual - which contained the glass unguentarium with the lid was oriented NW-SE, and apart from the glass vessel contained the following: an iron pick, an iron nail and two iron spatulas, a smaller and a bigger one, three bulbous clay unguentaria and one small clay bowl, one knucklebone, unidentified seeds and a lead element – identified as a lid as well as a bronze coin of Vespasian (69-79 AD), which enabled the cremation to be dated (Fig. 1).

1 Isings 1957, form 10.
2 Antonaras 2009b, 27-33.
3 Keramaris 2009, 227.

Fig. 1: Findings from Grave 1. Kanakakis plot, Drymos.

Fig. 2: Glass unguentarium with lead lid from Grave 1. Kanakakis plot, Drymos.

Fig. 3: Glass unguentarium with lead lid from Grave 1. Kanakakis plot, Drymos.

The Glass vessel is 9 cm high (body diam. 7.5cm, neck H. 1.4cm) and it is made of colorless, slightly greenish glass.

Lid

Body height 2cm, Body diam. 2.4cm
Handle height 1cm internally and 2cm in total
Max. preserved length of shafts/stems c. 7.5cm

The lid is cast in a bipartite mold, which was partly misplaced, rendering visible a prominent seam along the body's height. The bell-shaped body is covered by eighteen vertical ribs and on its lower end runs a horizontal groove. On the top of the lid is an inherent ring handle, which

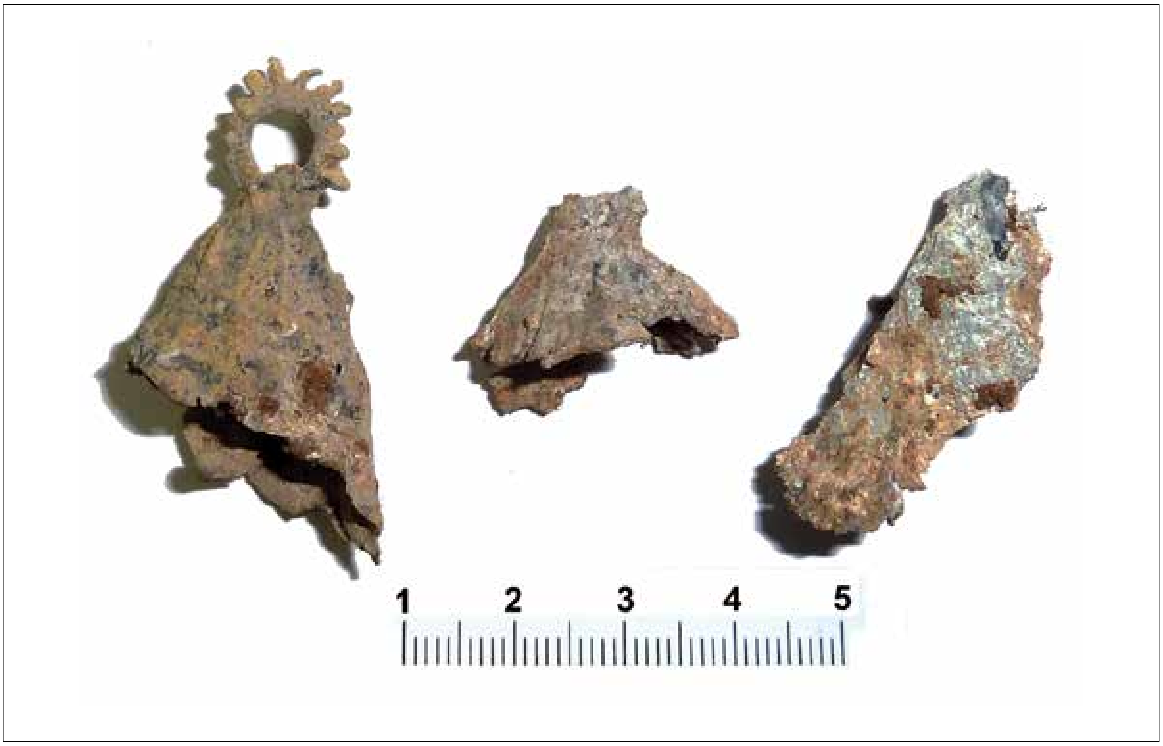

Fig. 4: Lead lids of unguentaria from the eastern necropolis of Thessaloniki.

is decorated with eleven ray-like projections. The lid was secured at the mouth of the vessel with probably four inherent shafts, which spring cross-like and are bent so they tightly clasp the body, almost reaching its base. Only three of the shafts are preserved. Six curved thorny shoots sprout from and end at the first shaft, which has a thickened ending/termination. The other two preserved shafts are decorated by seven pairs of tiny tri-partite leaves which sprout from both sides in regular intervals, and the single preserved ending is also thickened. (Figs. 2-3)

The lid from Drymos is the single almost fully preserved example of a type of lid that was apparently widely used, since three more, partly preserved, examples have been identified among the finds of a grave in the eastern necropolis of Thessaloniki (Fig. 4). In this grave, the lids were used on identical, spherical unguentaria, two of which contained a red powder and the third one probably a white powder. In the same grave were also placed five bird-shaped glass unguentaria.[4] Only one of these parallel finds preserved intact the ring-shaped handle, which is only partly visible on the second example. All three of them bear the same motif of vertical ribbing, which was possibly divided by a plain horizontal register, hardly traceable today.

4 Antonaras 2009a, 400, nos. 472-475 and 518-522.

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'TRUE' ROMAN GLASS. EVIDENCE FOR PRIMARY PRODUCTION IN ITALY

Introduction

The centralized production model is frequently used to describe the Roman-Byzantine glass industry. This production model states that raw materials were used to make raw glass in a limited number of so-called primary production centres.[1] Large quantities of this raw glass were produced in a single firing and then traded in the form of chunks or ingots throughout the Roman Empire[2] before being remelted, coloured and/or decoloured, and finally shaped into finished objects in secondary workshops. Primary production centres, active from the 4th-8th century AD, have been identified in Egypt and Syro-Palestine.[3] However, the location of primary production centres in the Hellenistic and Early Roman world is still a subject of intense debate. Ancient authors, such as Strabo and Pliny the Elder, suggest that glassmaking sands were located near the Belus River (Israel) and in Egypt, but also along the coasts of Spain and France and near the mouth of the Volturno River (Italy). Primary production in the Western Mediterranean is not supported by any direct archaeological evidence so far, but the possibility of glass production using raw sand materials from these regions has recently been evaluated.[4] Results show that suitable glassmaking sands are far from common and are found mainly in a few locations, such as Basilicata, Apulia (SE Italy) and Tuscany (W Italy) as well as in southern Spain and Provence (France).[5]

Over the past decades, different approaches have been attempted to provenance the raw materials used in glassmaking and to determine the locations of primary production centres. Particularly promising is the combined use of Sr and Nd isotopic analyses and elemental analyses, with particular attention having been paid

1 Gorin-Rosen 1995, 2000; Freestone et al. 2000; Freestone *et al.* 2002; Freestone et al. 2002b; Nenna *et al.* 2000; Nenna et al. 2005; Picon and Vichy 2003.
2 Foy *et al.* 2000.
3 Gorin-Rosen 1995; Gorin-Rosen 2000; Freestone and Gorin-Rosen 1999; Picon and Vichy 2003; Tal *et al.* 2004.
4 Brems *et al.* 2012.
5 Brems *et al.* 2012.

to sand-related trace elements such as Ti, Cr, Sr, Zr, Ba and alumina contents.[6]

The aim of this work is to investigate the possible existence of primary Roman Italian glass-making centres in the Eestern Mediterranean from the 1^{st}-4^{th} century AD. A combined approach, using elemental chemical composition and radiogenic isotopes, has been applied to the study of 117 glass samples, both coloured and colourless, that were discovered along the Italian peninsula. The samples consist of the following: 30 glass objects excavated in Augusta Praetoria (modern Aosta, north-west Italy), 39 from Pompeii (25) and Herculaneum (14) (central Italy, west coast) and 48 specimens excavated in Potentia (modern Porto Recanati, central Italy, east coast).

Methodology

After the removal of any external layer to avoid possible contamination from burial and corrosion, a small fragment was sampled using a low speed diamond-coated wheel, washed twice in an ultrasonic bath with Milli-Q water, rinsed and then dried at 100˚C.

Part of the glass fragment was embedded in epoxy resin and analyzed for elemental chemical composition by LA-ICP-MS. The analyses were performed at Cranfield University (UK) in collaboration with Dr. Andrew Shortland and Rita Giannini, using a Thermo Corporation X-Series 2 ICP-MS coupled to a New Wave Research UV-213 laser ablation system. External calibration was performed by ablating NIST SRM 610 and 612 glasses. Corning A, B and D glass standards were run throughout the analysis to check for accuracy (generally better than 10%). Data was reduced following the procedures of Gratuze et al. (2001) for laser ablation generated aerosols, using Si as a normalizing factor, slightly modified.[7]

For isotope analyses, sample preparation was performed in a class 10 clean lab with horizontal laminar flow hoods at Ghent University, Belgium. 100 mg of a powdered sample was weighed in Savillex screw-top beakers and dissolved in a 3:1 mixture of 22 M HF and 14 M HNO_3 on a hot plate. Solutions were dried and the residues re-dissolved in aqua regia. After digestion was completed, the sample was evaporated until almost dry and the residue taken up into 7 M HNO_3. Sr and Nd were isolated from the concomitant matrix using extraction chromatographic methods described in the literature.[8] All Sr and Nd isotope ratio measurements were performed on a Thermo Scientific Neptune multi-collector ICP-MS equipped with a micro-flow PFA-50 Teflon nebuliser and run in static multi-collection mode. A concentration-matched solution of NIST SRM 987 $SrCO_3$ isotopic reference material was used as external standard ($^{86}Sr/^{88}Sr$ = 0.1194) to correct instrumental mass discrimination (sample-standard bracketing). The signal intensity obtained for ^{83}Kr was used to correct the Kr interference at m/z = 86. Repeated measurements of the NIST SRM 987 $SrCO_3$ standard yielded $^{87}Sr/^{86}Sr = 0.71024 \pm 0.00007$ (2σ, n=137). JNdi-1 reference material (Geological Survey of Japan) was used as an external standard for measuring $^{143}Nd/^{144}Nd$ ratios. The intensity obtained for ^{147}Sm was used to correct the interference of this element on the Nd signal obtained at m/z = 144. Repeated measurements of the JNdi-1 Nd standard yielded $^{143}Nd/^{144}Nd = 0.51211 \pm 0.00006$ (2σ, n=150).

The ratio is also expressed as εNd, defined as: where $^{143}Nd/^{144}Nd_{CHUR}$=0.512638, according to De Paolo and Wasserburg (1976).

Results and discussion

Elemental analysis

Elemental analyses highlight a great homogeneity in the major and minor element compositions for the analysed glass samples, regardless of their archaeological provenance.

Among the 117 analysed glass samples, seven different colours are represented: colourless (n = 70), blue (n = 12), green (n = 8), naturally coloured pale blue (n = 12) and pale green (n

6 Wedepohl and Baumann 2000; Freestone *et al.* 2003; Henderson *et al.* 2005; Shortland *et al.* 2007; Degryse and Schneider 2008; Degryse and Shortland 2009; Brems 2012.

7 Walton *et al.* 2009.

8 De Muynck *et al.* 2009; Ganio *et al.* 2012b.

= 5), yellow and amber (n = 7), purple (n =2) and red (n =1). Most of the samples are made from silica-lime-soda glass, with SiO_2 ranging between 62.30 and 74.72 wt%, CaO between 4.58 and 11.99 wt% and Na_2O between 14.31 and 23.63 wt%. The red samples, characterized by lower concentrations of silica (SiO_2 = 40.74 wt%), lime (CaO = 3.28 wt%) and soda (Na_2O = 9.32 wt%) and a high concentration of lead (PbO = 30.75 wt%), represent an exception and possibly suggests the use of lead-based glass.

Looking for a comparison with data published in literature, the majority of samples (Fig. 1) are similar in composition to the so-called 'typical Roman composition', first defined by Foy et al. (2003) and characterized by the use of relatively pure sands, possibly Belus River sands. This group includes coloured and naturally coloured glass samples as well as Mn-decoloured glass. Instead, Sb-decoloured glass shows systematically lower concentrations of lime and alumina, as well as iron and titanium, which point to the use of a more mature silica source.[9] The compositions of some glass samples are similar to the Levantine I group[10] related to glass dating from the 4th-8th century AD. This could suggest that these glass producing areas were already active in the earlier Roman period.

Significant compositional differences can be identified based on colour. Colourless glass shows clear compositional differences if decoloured with manganese or antimony (Fig. 2). While Mn-decoloured samples have relatively high contents of lime and alumina, the Sb-decoloured samples are characterized by the use of a rather pure silica source. Moreover, different typologies are strictly related to the decolouring agents, for example 'higher status' vessels such as cups and plates are generally decoloured with antimony[11] whereas manganese is used more for everyday life objects, such as plates and window panels.[12] The use of mixed decolouring agents, together with elevated concentrations of lead and copper, is most likely related to recycling.[13] Looking at a timeline for these decolourants, it is possible to draw some interesting conclusions. It is commonly accepted that the use of manganese as a decolouring agent in the Mediterranean started sometime in the 3rd century AD. However, the results presented here indicate that manganese was already in use at an earlier time, as shown by the Pompeii and Herculaneum samples, to which an *ante quem* date of AD 79 (eruption of Mount Vesuvius) can be attributed. Manganese is again used from the end of the 2nd to the end of the 3rd century AD. Antimony decoloured glass instead, is typical of the 2nd-3rd century AD, as illustrated by the dataset, and are strictly related to the use of a purer silica source, low in lime and alumina.

The emerald green glass specimens are significantly different from the other colours. Their differences lie in the magnesium and potassium oxide contents (MgO = 1.7 ± 0.5 wt%; K_2O = 1.5 ± 0.2 wt%), as already reported in literature for other emerald green glass samples.[14] The reason why this particular colour, typical of the 1st century AD, is associated with such a different composition is still unclear. Jackson (unpublished) hypothesises that it may have been produced in specialized production centres - or that the use of plant ash rather than natron as a flux - could promote better development of the emerald green colour. Further studies are needed to fully understand the use of a different fluxing agent as well as the possible existence of centres dedicated to the production of this colour.

If major and minor elemental compositions of Roman glass are relatively uniform, trace elements such as zirconium, hafnium, titanium, chromium and lanthanum[15] have proven to be particularly promising as provenance indicators. Their inter-element ratios are not affected by the high temperatures involved in either manufacture or subsequent reprocessing and therefore, their variation is most probably a re-

9 Jackson 2005.

10 Freestone *et al.* 2000.

11 Jackson 2005; Paynter 2006; Foster and Jackson 2009.

12 Foster and Jackson, 2010.

13 Jackson 1997; Freestone *et al.* 2002a.

14 Henderson 1996; Lemke 1998; Jackson *et al.* 2006; Gallo 2012.

15 Shortland *et al.* 2007; Brems 2012.

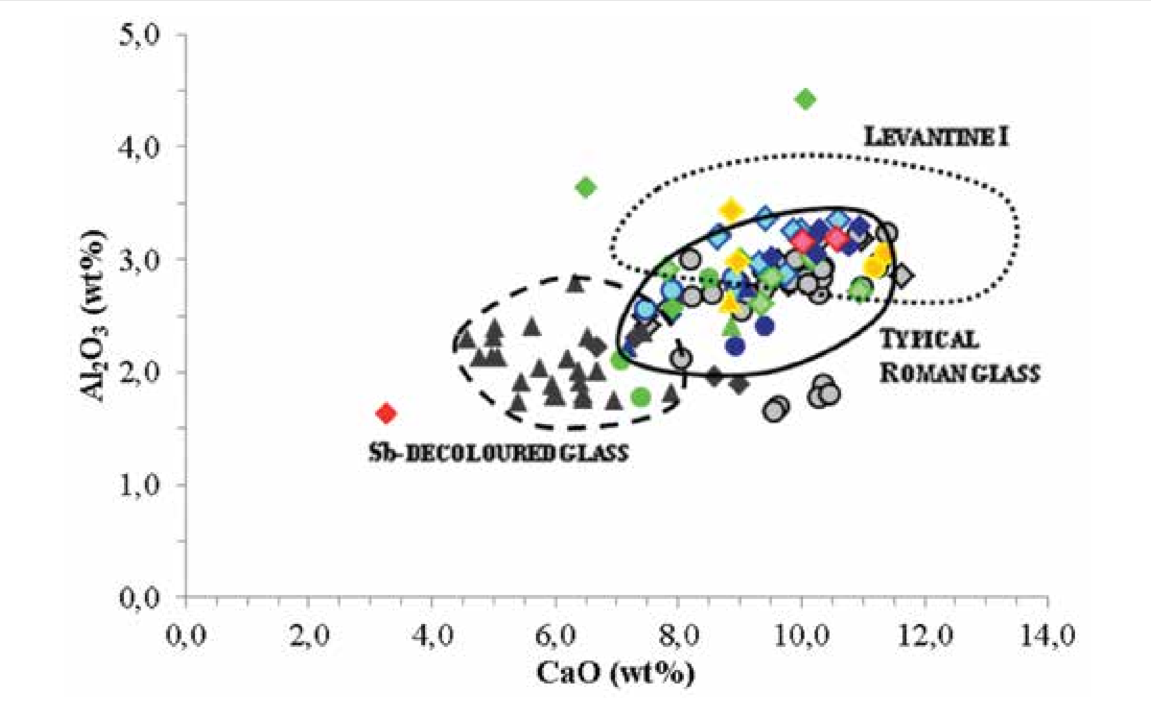

Fig. 1: Al2O3 vs. CaO plot for the analysed glass samples. Symbols: ◊ Potentia, ○ Pompeii-Herculaneum, Δ Augusta Praetoria; colors refer to the original colour of the samples, with light grey for Mn-decoloured glasses and dark-grey for Sb-decoloured glasses. The typical Roman glass composition (Foy et al. 2003), as well as the Sb-decoloured glass range (Jackson 2005; Paynter 2006) and the Levantine I composition (Freestone et al. 2000) are also indicated.

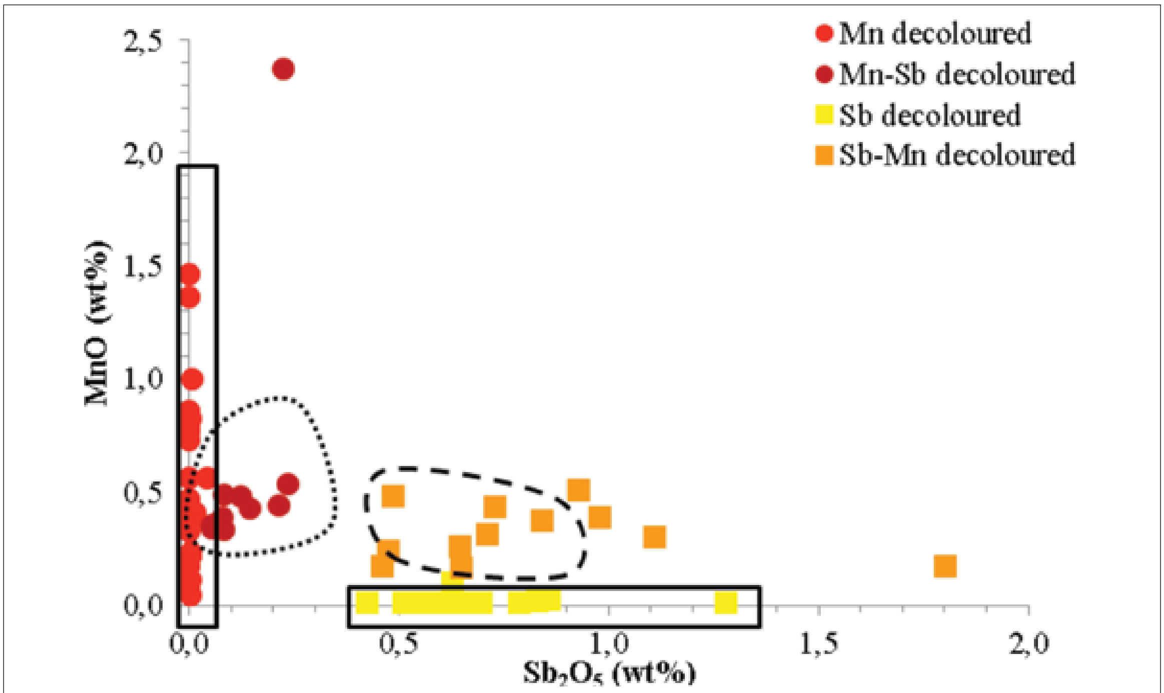

Fig. 2: MnO vs. Sb2O5 for the analysed colourless glasses. Mn-decoloured (Foster and Jackson 2010) and Sb-decoloured glass groups (Jackson 2005; Paynter 2006; Foster and Jackson 2009) also are shown, as well as glasses decoloured by a mixture of the two decolourants (Silvestri et al. 2008; Foster and Jackson 2010).

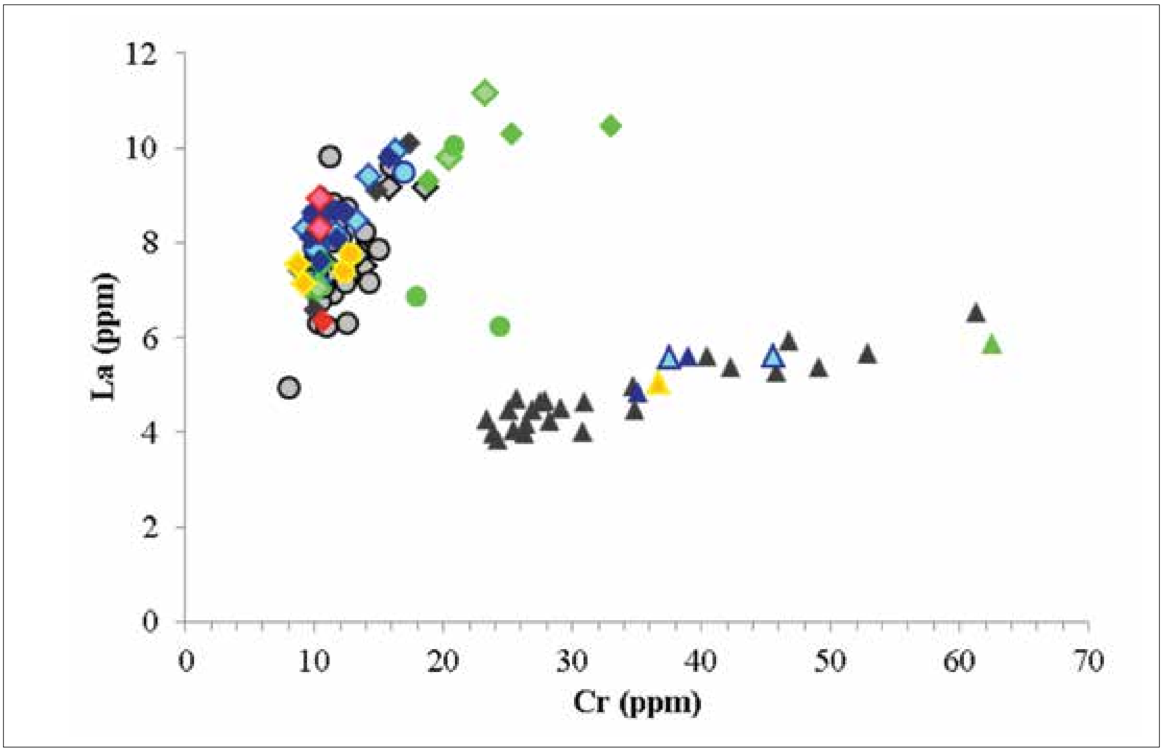

Fig. 3: La vs. Cr plot for all analysed samples according to their archaeological site. Symbols: ◊ Potentia, ○ Pompeii-Herculaneum, Δ Augusta Praetoria; colors refer to the original colour of the samples, with light grey for Mn-decoloured glasses and dark-grey for Sb-decoloured glasses.

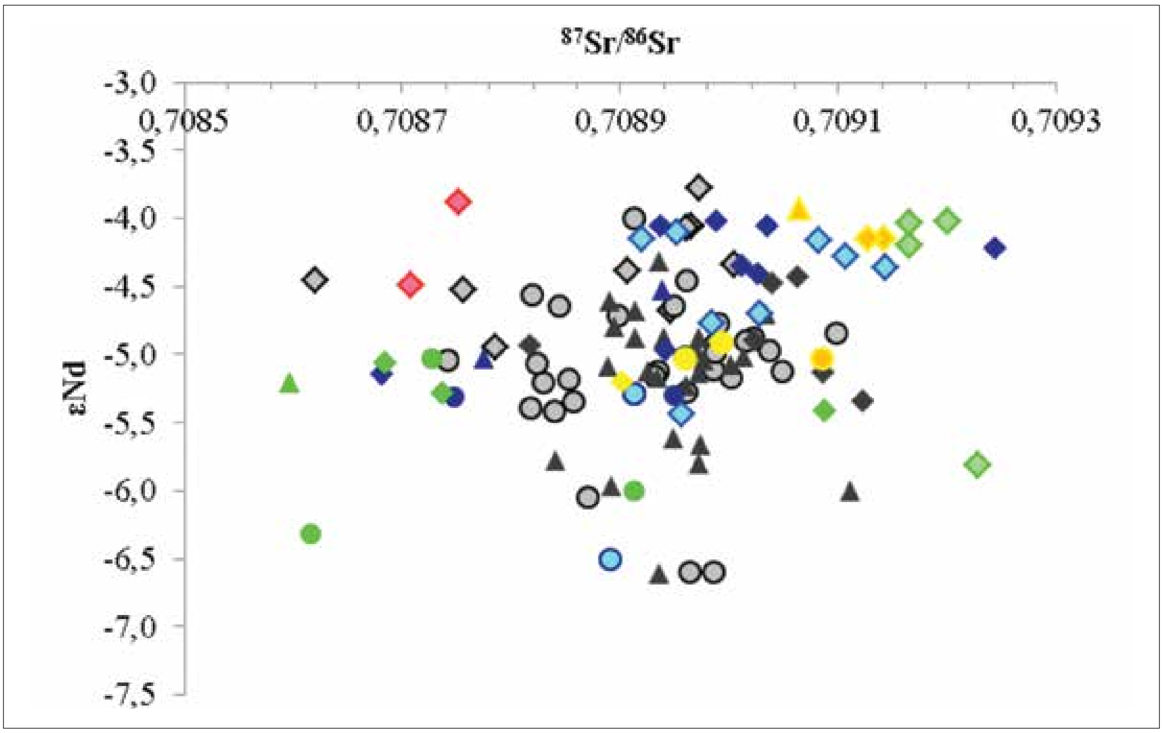

Fig. 4: εNd vs. Nd plot for all analysed samples according to their archaeological site. Symbols: ◊ Potentia, ○ Pompeii-Herculaneum, Δ Augusta Praetoria; colors refer to the original colour of the samples, with light grey for Mn-decoloured glasses and dark-grey for Sb-decoloured glasses.

flection of the differences in the original raw materials.[16]

Of particular interest is chromium (Fig. 3), which separates the dataset into two groups. Most of the samples show low levels of Cr (< 25 ppm), with La ranges between 6 and 11 ppm and Cr/La ratios always lower than 4.0. However, the Augusta Praetoria glass specimens, regardless of colour, are characterized by higher concentrations of Cr (22-63 ppm), with La ranging between 3.9 and 6.5 ppm and Cr/La ratios between 5.46 and 10.63, suggesting the use of different silica sources for their production. Although not commonly found in literature, high Cr contents are present in a small group of glass samples from Adria, dated to between the 1st and 4th century AD,[17] possibly suggesting a common origin. From an archaeological perspective, this could represent evidence of trade occurring between the northeast side of Roman Italy, where Adria and Aquileia are located, and the northwestern area of the peninsula through the so-called *Via delle Gallie*, purported to be an important commercial axis of the Roman Empire.

Sr-Nd isotopes

The $^{87}Sr/^{86}Sr$ ratios range between 0.70860 and 0.70924, independent of age, site, colour or compositional group, and are close to the ratio for present-day seawater (0.7092). Combined with high Sr contents, this suggests that the source of strontium was marine shell and consequently, it is highly likely beach sands were used for glass production.[18] The opaque red glass sample, for which a different base glass composition is suggested on the basis of its very high lead content (PbO = 30.75 wt%), contains only 175 ppm of Sr and is characterized by an exceptionally high $^{87}Sr/^{86}Sr$ ratio (1.10155 ± 0.02063) with no comparison among published data.

As is the case for strontium, the Nd isotopic compositions also are relatively homogenous for all the glass samples, regardless of age, site, colour or compositional group. The $^{143}Nd/^{144}Nd$ ratios range between 0.512342 and 0.512444, corresponding to -6.61 to -3.78 εNd, while Nd elemental concentrations vary between 3.37 and 9.91 ppm. A closer examination of the existing published data is necessary in order to better interpret these values. It has been demonstrated that the εNd values of deep-sea sediments in the Eastern Mediterranean vary significantly due to the differential sediment influx from the Nile (fluvial), the Sahara (eolian) and the European continent (fluvial),[19] leading to a decrease in εNd from east to west (Brems, 2012). The Nd isotopic compositions of the Eastern Mediterranean are more known while data for raw natron glass from Egypt and Syro-Palestine have been widely discussed in literature.[20] However, the distribution and range of Nd isotopic compositions in the Western Mediterranean are less well known. Recently, Brems (2012) analyzed the Sr and Nd isotopic composition of 77 beach sand specimens from Spain, France and Italy. His results show that Spanish and French sand has relatively low εNd values from -12.4 to -8.0, in close agreement with data from deep sea sediments. Italian sand shows a wider range of values, with εNd varying between -12.8 and -3.0[21] with only a few samples having been identified as suitable for Roman glassmaking in their current states.[22] Among those, three come from Italy and in particular, from Tuscany, Basilicata and Apulia. While Tuscan sand has a rather low εNd value of -9.42, the other two samples from Basilicata and Apulia in southeast Italy show relatively high εNd values (-6.1 and -4.2, respectively)[23] and coincide with the range of Nd isotopic ratios previously thought to be characteristic for Eastern Mediterranean glass.[24]

Looking at the $^{87}Sr/^{86}Sr$ vs. εNd plot (Fig.4), numerous comparisons for these values can be

16 Shortland *et al.* 2007.

17 Gallo 2012.

18 Freestone *et al.* 2003.

19 Goldstein *et al.* 1984; Grousset *et al.* 1988; Weldeab *et al.* 2002.

20 Degryse and Schneider 2008; Freestone *et al.* forthcoming.

21 Brems 2012.

22 Brems *et al.* 2012.

23 Brems 2012.

24 Degryse and Schneider 2008; Freestone *et al.* forthcoming.

found in literature. Natron glass from the archaeological sites of Sagalassos in Turkey[25] (dated to between the 1st and 5th century AD), as well as Petra and Barsinia in Jordan,[26] Gonio in Georgia,[27] Barcino in Spain[28] and Adria in Italy[29] reflect the same strontium and neodymium isotopic composition range. εNd values between -5.1 and -6.0, with Sr isotopic ratios close to modern-day seawater, are typical of 4th-8th century AD Syro-Palestinian primary glass, while Egyptian glass is characterized by lower $^{87}Sr/^{86}Sr$ ratios, as is expected from glass made with limestone instead of shelly beach sand.[30]

The similarities with Syro-Palestinian primary glass compositions point to an Eastern Mediterranean provenance for the glass samples presented here, although not necessarily from the same geographical area as the aforementioned Late Byzantine glass specimens. However, the existence of suitable sand for glassmaking on the coasts of Italy[31] complicates the picture. The Nd isotopic ratios of the two Italian sand samples (from the Basilicata and Apulia regions) - comparable to the Syro-Palestinian glass and sand ranges - could suggest that natron glass was produced not only in the Eastern Mediterranean, but also along the Italian peninsula.

Was glass produced in Italy?

In his *Naturalis Historiae,* Pliny the Elder, explicitly mentions the use of sand from the mouth of the Volturno River, located between the towns of Cumae and Liternum, for glass production. The elevated aluminium and iron contents make this sand unsuitable for glassmaking in their current states. A significant improvement in the chemical composition of the sand can be obtained following treatment, which involves subjecting the sand to grinding in wooden mortars and washing. However, the limited efficiency of this labour-intense practice seems to be unlikely in Roman times. If the Volturno River sand is to be discarded, alternative beach sand from Italy has proven to be suitable for glassmaking. In particular, two types from the Basilicata (IT85) and Apulia (IT87) regions are particularly relevant to this discussion.[32] Characterized by εNd values of -6.11 and -4.17 respectively, they overlap with the typical isotopic composition of Syro-Palestinian sand and raw natron glass discussed in the literature.

The glass samples discussed here always show εNd values higher than -7.0, which gives more reason to exclude a Western Mediterranean origin and points to the use of silica raw materials from the Syro-Palestinian coast or from southern Italy. To distinguish between the different possible sources, it is necessary to look for alumina contents and trace elements, such as Ti, Cr, Sr, Zr and Ba, mainly related to the silica source itself, and only partially affected by colouring agents or recycling.[33] Less negative εNd values are associated with both Syro-Palestinian origin and IT87 sand from Apulia, but the Al_2O_3 content contributes to the differentiation between the two sand types: whereas Apulian sand is characterized by a rather low alumina content (Al_2O_3 < 1.5 wt%),[34] Syro-Palestinian sand has a typical Al_2O_3 content of 2.2-3.2%,[35] corresponding to 2.5-4.0% in Syro-Palestinian glass.[36] IT85 and Syro-Palestinian sand types are instead distinguished on the basis of their trace element contents, in particular by Cr and Zr, which is significantly higher in Basilicata sand. Sand with low Al_2O_3 and εNd = -6.0 has not yet been characterized.

When comparing the trace element patterns of the glass discussed here with sand types from the Belus River, Apulia (IT87) and Basilicata (IT85), it can be observed that the majority of the glass samples - with the exception of the Augusta Praetoria – agree with data belonging to

25 Degryse and Schneider 2008.
26 Ganio *et al.* 2012a.
27 Ganio *et al.* 2012a.
28 Ganio *et al.* 2012a.
29 Gallo 2012.
30 Freestone *et al.* forthcoming.
31 Brems 2012.
32 Brems 2012.
33 Brems 2012.
34 Brems 2012.
35 Brill 1988; Brill 1999.
36 Freestone *et al.* 2000.

IT87 and Belus River sand types. The alumina contents, however, highlight colour-related differences among the glass samples. In particular, Sb-decoloured glass shows a lower content of alumina, together with relatively lower Nd isotopic signatures, possibly suggesting the use of a different silica source for the production of Sb-decoloured glass, often associated with more elaborate 'high status' shapes.

The Augusta Praetoria results are more difficult to interpret. Although they have similar Sr-Nd isotopic signatures to the whole data set, they differ in their significantly higher Cr levels. When comparing them to trace element patterns and Sr-Nd isotopic compositions available at present, it has not been possible to find a full match. If Basilicata sand (IT85) is characterized by high levels of Cr, even higher than those found in the Augusta Praetoria samples, its REE profile is different. On the other hand, the Belus River and Apulia (IT87) sand types are similar to that of the Augusta Praetoria in their REE profiles and Zr levels, but their Cr contents are significantly lower than those found in the glass samples. Unfortunately, the provenance of such raw materials is still unclear, and neither the Eastern Mediterranean nor the southern Italian hypothesis can be excluded at present.

Conclusion

The combined use of Sr-Nd isotopic values, alumina contents and trace element patterns proved to be a useful tool for defining the provenance of natron glass. It has been proposed that most of the glass samples are of Syro-Palestinian origin, although a southern Italian provenance cannot be excluded at present for the Sb-decoloured glass specimens. The Augusta Praetoria results are more difficult to interpret. Their trace element patterns do not fully match any of the sand types for which alumina, trace elements and Sr-Nd isotopic compositions are available at present, in particular due to the higher Cr and lower Al_2O_3 contents. Overall, the data available at present are not sufficient to fully support the hypothesis of primary glass production in Italy.

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THE GREEN, GREEN GLASS OF ROME

This paper examines emerald green Roman glass of the early to mid-1st century AD from six sites in the western Roman Empire. This glass colour, found predominantly in early contexts, is technologically different from other Roman glasses; it is higher in magnesium, potassium, phosphorus and manganese, suggesting that it was not manufactured with the natron alkali flux common to other glasses of the Roman world.[1] The only other colours of Roman glass to have been found with this base composition are red glass[2] and certain varieties of 1st century AD 'black' glass. This composition is presently thought to indicate the use of plant ashes in manufacture, similar to the ashes used to produce much earlier Bronze Age glasses found throughout the Near East and Mediterranean.

These Roman emerald green and red glasses are both coloured using copper, a metal also used to produce blue in pre- and post- Roman glass, although occasionally used for Roman blue glass. Two possible explanations can be proposed for the link between the unusual base glass composition and the colorant; firstly colour development in these two glasses might be facilitated by the use of a plant ash alkali – providing the right internal redox conditions to produce the vivid green colour; secondly, the composition may relate to the provenance of the raw glass.

An important consideration in our selection of emerald green samples has been the desire to make further progress in establishing whether any connection should be made between the use of emerald green plant ash glass and the production of specific vessel types. If it were established, a link between this unusual composition and the manufacture of certain vessel forms would have considerable potential to inform current discussions about the organisation of the glass industry in the 1st century AD, in particular the relationship between primary glass production and the secondary glass workshop network.

These issues are explored here through the stylistic and compositional examination of 50 emerald green glass vessels. They come from

1 Jackson *et al.* 2009.

2 Nenna and Gratuze 2009.

six early-mid 1st century AD sites, Ribnica and Trojane in Slovenia, Barzan and Fréjus in France, and Colchester and Fishbourne in southern England. These sites cover a wide geographical area and are functionally distinct, encompassing military and urban complexes and a high status villa. These factors may have influenced the repertoire of forms recovered and potentially the compositions of the vessels – different centres receiving different supplies of glass or producing glasses with different compositions depending upon what model of glass production is accepted.[3]

The glasses were compositionally analysed for major and minor elements by Electron Probe Microanalysis (EPMA) and trace elements by Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS). Accuracy and precision data is reported in Nicholson and Jackson (this volume).

Results and discussion of compositional analysis

All 50 emerald green glasses were of a plant ash composition with higher concentrations of potassium, magnesium, manganese and phosphorus than contemporary natron glasses. All were coloured with copper, but also had higher concentrations of iron, the two together causing the green colouration seen.[4] Manganese and antimony were also present which will also influence the internal redox and thereby help colour development. To explore whether the link between colour and composition is related to (1) production technology or (2) location, the compositional data was examined.

Production technology and colour development

Emerald green glasses with higher concentrations of magnesium, manganese, potassium and phosphorus, have also been observed in assemblages dated from the first to third centuries from Fishbourne,[5] Colchester,[6] Pompeii and Lipari,[7] Canton Ticino and Aquileia,[8] Adria region[9] and Chester (in polychrome vessels; Paynter this volume). However, some contemporary 'Scottish' Iron Age (1st century AD) emerald green glass beads are of a typical natron base composition,[10] and much earlier 6th-4th century BC. Etruscan green glasses from Bologna and Spina (labelled green rather than emerald) are also of a 'natron' composition,[11] although conversely there is a published green plant ash Etruscan bead which is not coloured using copper.[12] These results suggest that this particular colour *can* be produced using glasses of quite different compositions and the colour is not wholly dependent upon the use of a plant ash glass, although colour development might be facilitated by using a base plant ash glass. Further experimental work is underway to demonstrate colour development in these glasses by the authors.

Organisation of glass production

Elemental data allows compositional groups to be formed which have the potential to illustrate whether glass may have been produced in a small number of primary centres within a geographically limited locale or a larger number of more geographically dispersed production centres. Figure 1 shows that there are no significant compositional differences based on find location between the green glasses from the six sites studied or other contemporary sites; there are some discrete clusters within the data (e.g. Chester) and some outliers, but generally the groups overlap. Indeed, the distributions in potassium and magnesium are similar to those of Bronze Age plant ash glasses from Egypt and Mesopotamia which might indicate a similar provenance, however, the phosphorus/magnesium concentrations are quite different.[13] The emerald green glasses are also compositionally different to the later

3 See for example Foster and Jackson 2009.
4 Weyl 1953, 164.
5 Henderson 1996.
6 Jackson *et al.* 2009.
7 Arletti *et al.* 2006.
8 Arletti *et al.* 2008.
9 Gallo *et al.* 2013.
10 Bertini *et al.* 2011.
11 Arletti *et al*. 2010.
12 Towle and Henderson 2007.
13 See for example Jackson and Nicholson 2007.

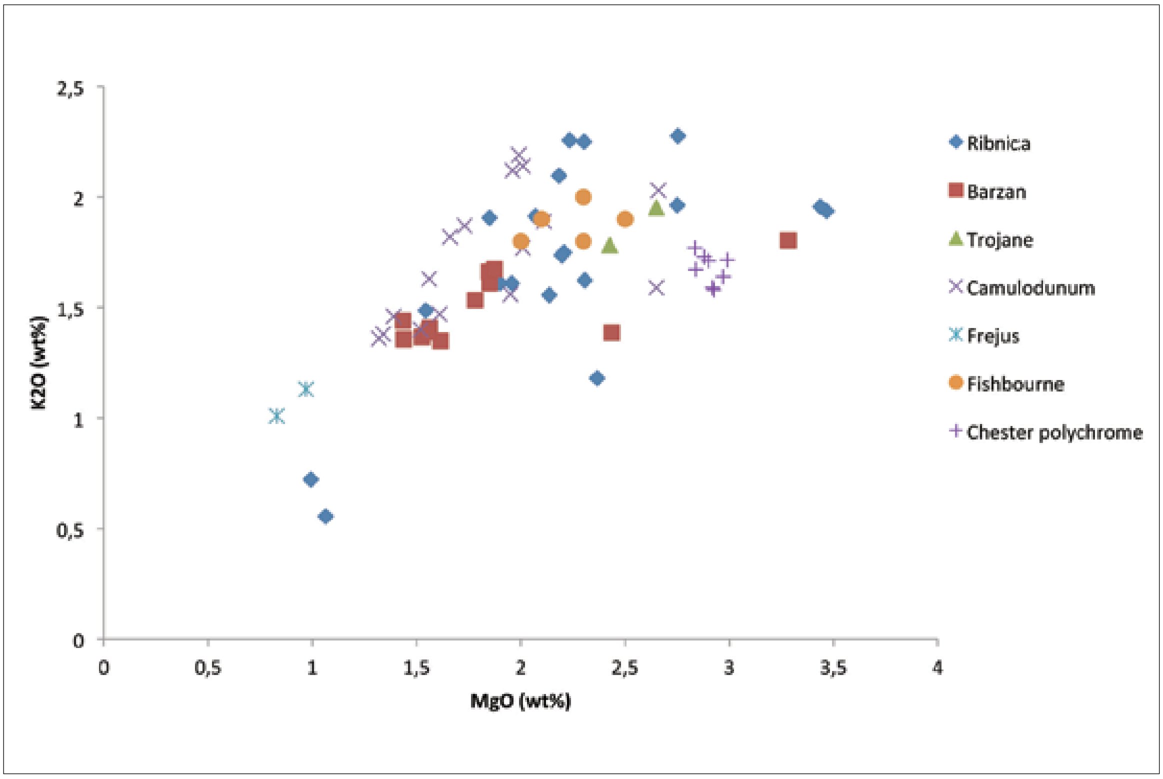

Fig. 1: Potassium and magnesium oxide concentrations for emerald green glass vessels, displayed by finds location.

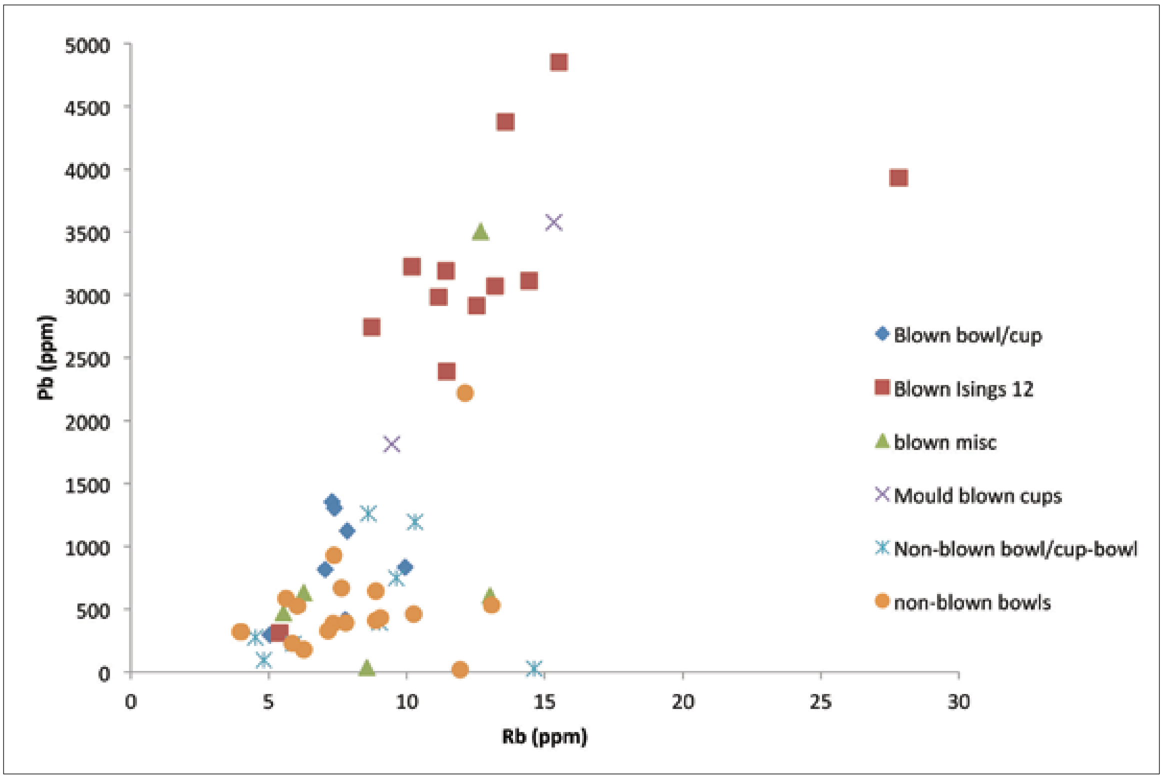

Fig. 2: Lead and rubidium concentrations for emerald green glass vessels, by method of manufacture/vessel form.

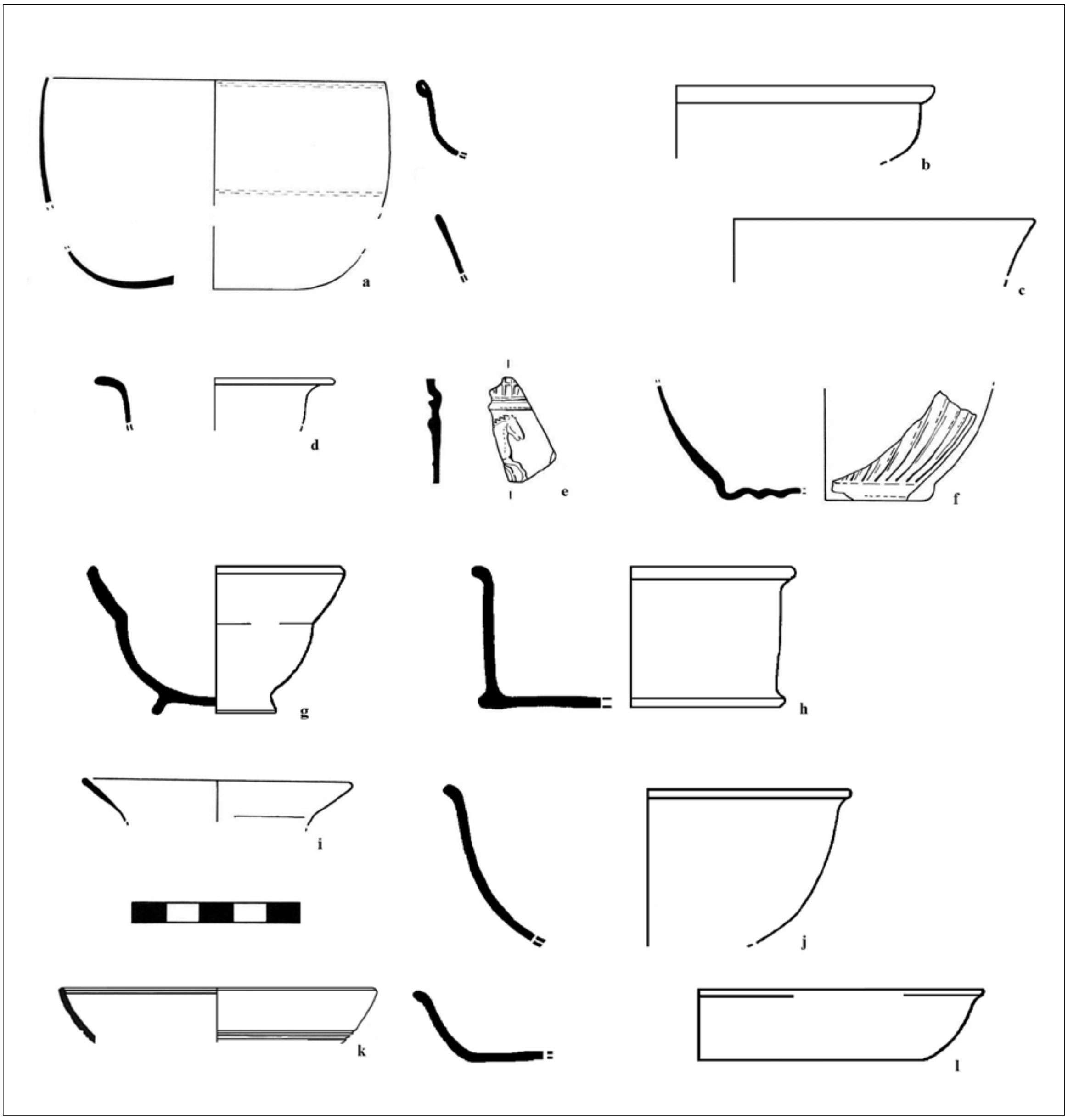

Fig. 3: Forms of emerald green vessels sampled from Barzan, Fréjus, Colchester, Trojane and Ribnica

Sassanian plant ash glasses,[14] again suggesting different provenances. Further examination of the trace elements in the glasses is underway to explore any further patterns in the datasets.

Thus whilst conclusive evidence of the glass provenance cannot be stated at this point, and no geographical patterns firmly established, other compositional patterning is evident which might be related to manufacturing technology and form. Figure 2 shows that, using rubidium and lead as indicators, there are subtle differences in lead concentrations between blown and non-blown forms. For most of the vessels the lead content is below 0.2%, but for two specific groups of blown glasses – the Hofheim cups (Isings 12) and the two examples of mould-blown cups, lead concentrations are higher (up to 0.5 wt%). The pattern is not directly related to blown or non-blown technologies, as some blown forms are low in lead, but seems to concern specific forms. However, the fact that the mould-blown cups and the Hofheim cups are all from the site of Barzan should also be noted.

14 Mirti *et al.* 2008.

Lead is often added to glass in higher quantities to aid melting and cutting, but at such low concentrations is often associated with recycling. However, whilst recycling may be a factor here, this phenomenon has also been noted before in high quality early *colourless* glass forms such as facet cut beakers[15] although its function is not yet fully understood.

Whilst facet cut beakers can easily be described as high status artefacts, the Isings form 12 and the mould blown beakers in this group are neither rare nor 'high status', and their decoration is produced in different ways; one is cut and the other mould blown. Although the presence of lead as a result of glass recycling cannot be discounted, nor as a technological aid for forming, cutting or general aesthetics, its presence in these utilitarian forms is not immediately clear. Moreover, whilst distinctive compositional groupings are usually taken to indicate a common provenance, there is no suggestion based on other evidence, such as distributional patterns, of any particular connection between the production locations for Isings form 12 and mould blown tablewares, which are assumed to be produced widely. However, lead *is* found in opaque copper red glasses, further strengthening the technological link between the two colour groups.

Thus at this point the compositional evidence is intriguing. No secure provenance can be suggested for this plant ash glass, but the technology of production appears to be related more to that of earlier periods from the Near East or Egypt than that of the Roman world - a provenance which would not be surprising as much Roman natron glass is thought to be of Egyptian or Levantine origin. However, that there is such a clear association between emerald green or red glasses and this 'plant ash' composition is curious. The compositional patterning *within* this glass does not yet show discrete groupings which can be linked to geographical provenance. However, some discrete sub-groups do show particular compositional traits which, as yet, cannot be explained by technology, form, function, supply or status.

Emerald green glass and the production of specific vessel types

The dataset includes vessels manufactured by three techniques; blown, mould blown and non-blown (cast). The original vessel form of many of the source fragments could be identified as follows.

Blown forms
- Convex cup (Hofheim cup) Isings form 12 (Fig. 3a)
- Shallow tubular rimmed bowl Isings form 45 (Fig. 3b and Fig. 4a)
- Bowl with flared rim (Fig. 3c)
- Bowl with out-turned rim (Fig. 3d)

Mould blown Forms
- Circus cup (Fig. 3e and Fig. 4b)
- Ribbed cup (Fig. 3f and Fig. 4c)

Non blown (cast) Forms
- Cup with constricted convex side – Isings form 2 (Fig. 3g and Fig. 4d)
- Small cylindrical bowl – Isings form 22 (Fig. 3h)
- Small bowl with out-turned rim (Fig. 3i)
- Small convex sided bowl (Fig. 3j and Fig. 4e)
- Wide convex sided bowl with wheel cutting (Fig. 3k)
- Shallow flat based bowl (Fig. 3l)

Emerald green, though never a common colour, is nevertheless familiar in assemblages of the early - mid 1st century AD. At Fréjus for example emerald green fragments account for just over 2% of the assemblage.[16] It is one of a batch of strong colours in contemporary use during this period and was used in the production of some of the most well known vessel forms, both monochrome and polychrome. All the samples in this dataset come from monochrome vessels.

Blown Convex cups (Isings form 12) and shallow tubular rimmed bowls (Isings form

15 Baxter *et al.* 2005; Paynter 2006.

16 Cottam and Price 2009.

45) are common on sites in many parts of the Roman world . Mould blown chariot cups are frequently noted in the western provinces.[17] Amongst the non blown vessels, cups with constricted curvilinear profiles (Isings form 2) and small cylindrical bowls (Isings form 22) are amongst the most distinctive forms of the early to mid 1st century AD. Non blown cups and bowls with convex sides (Isings forms 5 and 20) are also well documented.

The forms in this group therefore reflect what might be found in a typical assemblage of the period, with however some notable exceptions. It has long been acknowledged that some of the most widespread and common forms of the early - mid 1st century AD, the period when emerald green glass use was at its height, were not produced in monochrome emerald green. This is most clearly demonstrated by the colour range of one of the most ubiquitous vessel forms of the 1st century, the non-blown ribbed bowl (Isings form 3). These were produced most commonly in blue/green glass, but dark blue, purple, yellow/brown are quite frequently found and very rarely opaque colours have been noted. The lack of monochrome emerald green examples is all the more puzzling, as emerald green was used, in combination with opaque yellow and sometimes opaque red in polychrome versions of the form. Non-blown convex sided bowls of the Augustan period with internal wheel cutting (linear cut bowls) also appear not to have been made in emerald green glass. One of the most distinctive blown vessel forms of the early-mid 1st century the convex ribbed bowl (Isings form 17), often decorated with opaque white trails, also appears not to have been produced in emerald green glass. Jugs and amphorisks form another significant category of glass vessel rarely produced in emerald green glass. These absences are all the more remarkable when the volume in which some of these forms were produced is considered. This is particularly true of the non-blown ribbed bowls, the product of workshops in receipt of very large quantities of raw glass.

Emerald green as a colour has been subject to scrutiny before, most notably by David Grose in the context of his research into early Imperial glass, particularly the glass from the city of Cosa on the Italian coast north of Rome.[18] He recognised emerald green as essentially a Roman colour, used from the Augustan period to the mid 1st century AD.

He noted that emerald green, dark blue, deep blue/green and a bright green-blue that he described as "Persian" or "peacock" blue were by far the most common colours used to produce a range of non-blown vessels, often described as fine wares, or ceramic-form vessels. This category includes the cylindrical and constricted convex sided vessels in our dataset. Other translucent colours appeared to be much more rare. Conversely, he noted that, for example, non-blown linear cut bowls and non-blown ribbed bowls "occur most commonly in purple, medium to dark blue, golden yellow to golden brown, natural bluish green and occasionally in decolourised fabrics". Emerald green he said, was to all intents and purposes not used for these vessels, or if it is, only very exceptionally. He gives one possible example of a emerald green non-blown ribbed bowl (a vessel not seen first hand by the authors), in a private collection.[19]

The reasons for this division are, as Grose observed, not fully understood. However, what we can now add to the discussion is the fact that emerald green is curious for another reason - its composition. We would argue the possibility that these factors are linked – a connection that could provide the potential to explore some key questions concerning the organisation of the early imperial glass industry.

One of the first points to address is whether emerald green was deliberately avoided in the production of certain vessel forms, for reasons that are not currently apparent. However, there is no evidence at this point that emerald green

17 Cool and Price 1995, 43-50; Sennequier *et al.* 1998.

18 Grose 1991, 2-11.

19 Grose 1991, 8, pl. IIIa.

Fig. 4: Examples of emerald green vessels sampled from Ribnica and Barzan, showing the distinct colour of the glass.

glass has properties that make it unsuitable for the manufacture of certain forms.

If hypothetical technological limitations of emerald green glass are put to one side, another line of inquiry lies in questions relating to the internal organisation of the primary and the secondary industries. As far as the primary industry is concerned, it is possible that this green glass was a specialist colour, whereby the knowledge of how to produce it was confined to some glassmakers who worked in a specific region and who used atypical raw materials, hence its unusual composition. There are two immediate models that might be proposed for the use of emerald green in the secondary industry.

1. That only certain workshops had access to supplies of emerald green glass, and that these workshops were responsible for the production of particular vessel forms.

2. That workshops producing a wide range of vessel types were only selecting emerald green for use in the manufacture of certain forms.

We therefore have a number of areas for further research. Firstly we would like to expand our inquiries into the reasons behind the selection of a plant ash alkali in the primary production of emerald green glass (as well as some "black", red and, potentially "peacock" colours). We will continue to examine the effect of this alkali in facilitating or enhancing colour production through examination of contemporary glasses and experimental replication. We will also extend our investigations into the place of emerald green glass in the wider context of primary glass production and its relationship to natron-based glasses of other colours. We will consider the possibility of emerald green glass production as a separate enterprise from natron glasses, not necessarily based at the same locations and explore why this might be the case. As part of this project we will examine the distribution of emerald green vessels across the Roman world as a possible clue to the location of the workshops involved. The evidence brought together by David Grose in the 1980s suggested that the fine ware or ceramic type range of forms, forms frequently produced in emerald green glass, might be more prevalent in the western areas of the empire than the eastern. Certainly mould blown sports cups, which regularly occur in emerald green glass, are more common in the western provinces. A wider study of more recently excavated groups from the eastern provinces could potentially be very informative.

This paper describes the latest phase in a programme of research that stretches back a number of years with contributions from many quarters. These endeavours may not as yet have produced definitive answers, but we hope to have demonstrated that the investigation of emerald green glass has the potential to address some of the fundamental questions concerning early Imperial glass products.

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DANS L'ESPACE ET LE TEMPS, DIFFUSION D'UN PETIT DAMIER ANTIQUE EN VERRE MOSAÏQUÉ

Présentation du damier

Le point de départ de cette recherche est une perle en verre mosaïqué (Fig. 1a-b-c), trouvée en Belgique, dans le *vicus* gallo-romain d'Amay, sur la rive gauche de la Meuse, dans un contexte de fouille de la fin du I^{er} à la fin du II^{e} siècle apr. J.-C.[1] De forme presque sphérique, avec un diamètre maximum de ± 2 cm et un poids de 7,54 g, la perle se distingue par un décor à damiers losangés multicolores, très particulier, produit de l'assemblage à chaud de trois damiers identiques. Il s'agit bien de trois tronçons d'une même canne composite (*Composite Bar*), les damiers traversant toute l'épaisseur de la perle.

La canne dont les damiers sont issus met en œuvre 5 couleurs opaques : noir, blanc, rouge, turquoise et jaune. Elle est elle-même le résultat de l'assemblage à chaud d'un faisceau de 121 baguettes dont les parois ont été préalablement régularisées afin d'obtenir une section carrée. L'étirement à chaud de ce faisceau, a eu pour effet la miniaturisation du damier mesurant en finale ± 1,5 cm de côté (Fig. 2a).

Lors de la confection de la perle, c'est-à-dire sa mise en forme impliquant l'écrasement et l'étalement du motif, ainsi que les soudures des tronçons de canne autour d'un mandrin, les petites cases carrées au départ se sont déformées en rectangles, surtout à leurs extrémités (Fig. 2b). L'aspect plus “carré” est encore détectable par l'intérieur du trou de fil (Fig. 1c).

C'est donc ce damier un peu météoritique, avec cette ordonnance et cette séquence précises de couleurs (centre noir entouré de blanc/ puis rouge/ noir/ turquoise/ jaune/ noir/ blanc/ rouge/ noir/ turquoise), que nous avons tenté de pister afin de le resituer dans un contexte plus large. Bien sûr, il existe d'autres types de damiers avec d'autres couleurs et agencements, mais le damier de la perle d'Amay surprend sur bien des points : complexité technique, grand étalement chronologique et large diffusion, variété d'emplois et de réemplois.

1 Musée Grand Curtius, Liège, no. inv. 61/50 : Willems *et al.* 1997.

Fig. 1a-c : Perle d'Amay, Grand Curtius Liège, no inv. 61/50, Ø ± 2 cm;a : Mise en évidence du damier; b : Mise en évidence d'une jonction de deux damiers; c : Vue de l'intérieur du trou de fil (© IRPA, Bruxelles).

Sur la base des pièces antiques recensées, le plus souvent fragmentaires et quelques fois assez altérées, souvent de provenance inconnue et issues d'anciennes collections, on peut voir les mises en oeuvre du damier se décliner en grosses perles, mais aussi en plaquettes d'incrustation ou plaques de revêtement mural, en vaisselle, ou encore en grosse bille et en jeton de jeu, à l'instar de nombreux autres verres mosaïqués antiques. Le texte succinct qui suit renvoie à une version longue avec un inventaire détaillé, des tableaux avec descriptions et références précises aux études, sites et/ou lieux de conservation.[2]

Perles et pièces de jeu

Concernant les perles, 19 exemplaires ont été repérés, dont 16 de provenance connue. À une exception près, elles relèvent de la technologie évoquée plus haut. Les provenances sont variées et parfois vagues: mis à part Amay en Belgique, 3 perles proviennent de Panticapée,[3] 2 d'Égypte dont une fragmentaire à Medinet Madi[4] (dans le Fayoum), et 3 de la province de Gilan en Iran[5] dont une sphérique tronquée à damiers enroulés sur un support-verre bleu clair (technique des perles dites "à décor de visage"). Ce sont les tombes d'Alania dans le Caucase central qui fournissent les contextes les plus tardifs pour 2 perles datées de la première moitié du III[e] siècle.[6]

Les 5 plus anciennes ne sont pas sphériques comme toutes les autres, mais bien lenticulaires (probablement le résultat de l'association de 2 damiers). Elles composent un collier trouvé dans le cimetière romano-nubien de Karanog, déposé dans une tombe d'enfant du début du I[er] siècle.[7]

De provenance incertaine (Iran ou Égypte), 2 perles sont conservées à l'Israël Museum

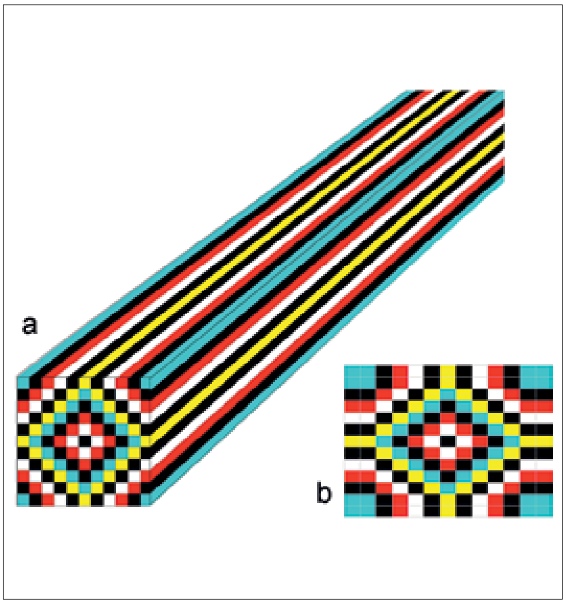

Fig. 2a-b : a : Reconstitution de la canne composite du damier de la perle d'Amay; b : Déformation du damier carré en damier rectangulaire (dessins Ch. Fontaine).

2 Fontaine-Hodiamont et Wouters 2014.

3 Louvre, Paris, nos inv. MND 1244 Bj 670 : Arveiller-Dulong et Nenna 2011, 158, no. 203, 1, 13, 16.

4 Silvano 2012, no. 859.

5 Fukai 1977, pl. 47, nos. 1, 3, 4.

6 Rumyantseva 2009, 399, no. 1.12, 419, no. 1.5.

7 Woolley and Randall-Maciver 1910, III, 252, no. 7811, tombe G 134 ; IV, pl. 40.

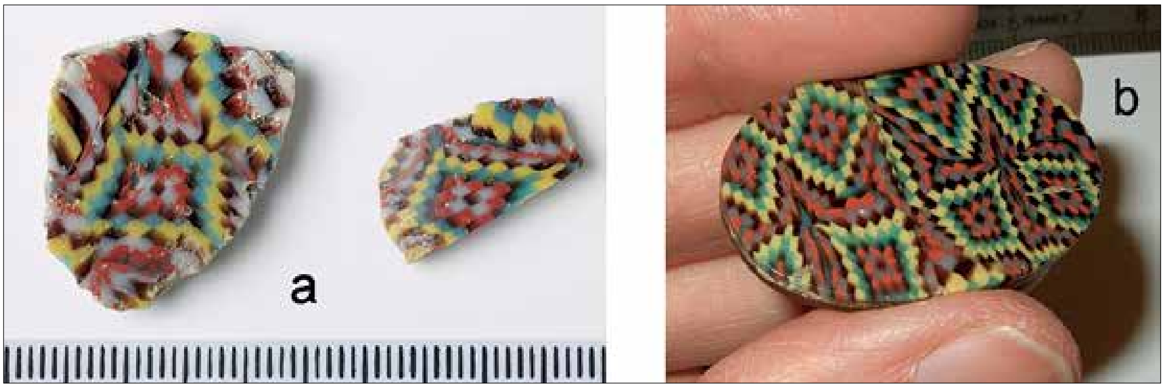

Fig. 3a-b : Fragments plats à damiers; a : MRAH, Bruxelles, Coll. de Ravestein, nos inv. R.1616a-b, L max. : 2,1 cm (© IRPA, Bruxelles); b : Louvre, Paris, no inv. CP 8727, L : 3,1 cm (photo Ch. Fontaine, avec l'autorisation de V. Arveiller-Dulong).

de Jérusalem,[8] et une autre, de provenance inconnue, se trouve au Louvre.[9]

Par ailleurs, une bille, petite sphère massive, de provenance égyptienne, offre une variante sphérique au nombre de damiers imprécisable : elle fait aussi environ 2 cm de diamètre, comme la plupart des perles. C'est l'unique spécimen repéré.[10] À cela s'ajoute un *calculus*, jeton de jeu en forme de calotte sphérique, qui a été trouvé dans une tombe au nord de l'Écosse, à Tarland.[11]

Verres plats

Parmi les verres plats, il faut distinguer les plaques à plusieurs damiers, des sections à un seul damier souvent tronqué d'ailleurs et que l'on pourrait interpréter comme des tronçons de canne. C'est ce qui semble être le cas au moins pour un des six exemplaires du Toledo Museum of Art (Ohio), de provenance inconnue, qui fait de 1,4 cm de côté et 3 cm d'épaisseur.[12]

En comptant ceux de Toledo, 10 tronçons ont été repérés, dont 3 avec une origine égyptienne relativement sûre, ceux de la Coll. Per-neb (A. Groppi), mais le contexte est inconnu.[13] Ils sont datés, un peu arbitrairement de la période hellénistique (IIIe-Ier siècle av. J.-C.). L'exemplaire de la Coll. Gorga a vraisemblablement été acheté à Rome sur le marché des antiquités.[14]

Quant aux plaques, incrustations ou revêtement mural, d'une épaisseur de 2 à 6 mm, elles sont les plus nombreuses et présentent plusieurs damiers disposés côte à côte : 44 fragments ont été comptabilisés. Comme lieux de provenance sûrs, c'est l'Italie qui revient le plus souvent avec Rome : 32 exemplaires dont une douzaine appartenant à la Coll. Gorga[15] et deux à la Coll. de Ravestein (Fig. 3a).[16] Le plus récemment exhumé, triangulaire, provient de la *villa* impériale de Villa Magna dans le Latium (fin IIe – début IIIe siècle).[17] Un petit carreau de 2,5 x 3 cm a été trouvé en d'Égypte.[18] Autun a livré 3 exemplaires dont un bombé sur une de ses faces (Fig. 4a-c).[19] De provenance inconnue, le plus grand fragment fait 9,4 cm de long sur 6,5 cm de large (Fig. 5).[20] À signaler encore, des petites plaques travaillées en symétrie,

8 Nos. inv. 91.90.355 et 86.69.25.
9 No. inv. E 23724 : Arveiller-Dulong and Nenna 2011, 205, no. 277, 13.
10 Coll. Per-neb 1993b, 26, nos. 33-34 (2e rang en bas, au milieu).
11 J. Price pers. comm.
12 Nos. inv. 80-213a-f.
13 Coll. Per-neb 1993a, 67, no. 66 (e) ; 1993b, 33-34, nos. 66 (a, d).
14 Saguí *et al*. 1996, 215, fig. 2 (en bas au centre) et pers. comm.
15 Id., fig. 2 (autres fragments).
16 MRAH, Bruxelles, nos. inv. R1610a-b.
17 B. Hoffmann, comm. AIHV Piran 2012.
18 MET, no. inv. 26.7.1243, Coll. Carnavon.
19 Musée Rolin, nos. inv. B. 1471, B. 1471.4-5.
20 CMOG, no. inv. 66.1.110.

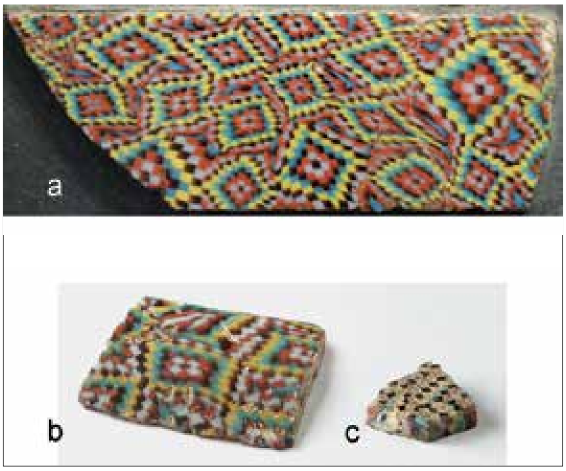

Fig. 4a-c : Fragments plats trouvés à Autun; a: no inv. B.1471, 8 x 2,5 cm; b: no inv. B.1471.4, avec face sup. bombée, 3 x 2,5 cm; c : no inv. B.1471.5, 1,3 x 1,5 cm (© Ville d'Autun, Musée Rolin, J. Piffaut).

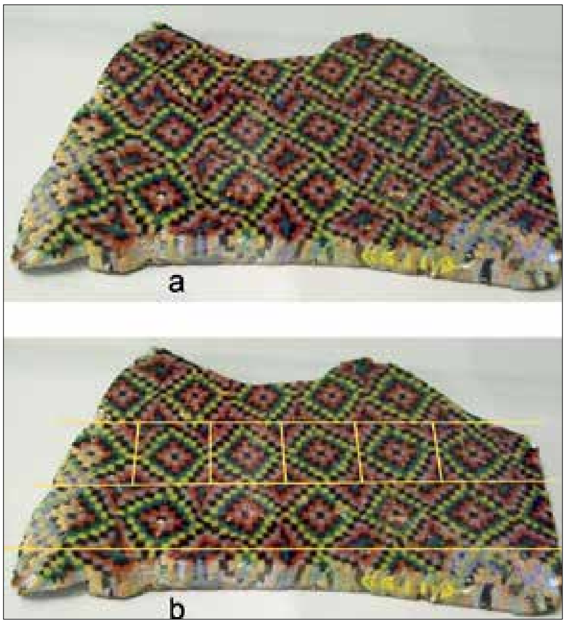

Fig. 5a-b : Fragment plat conservé au Corning Museum of Glass, no inv. 66.1.110 (9,4 x 6,5 cm); a: Etat actuel; b: En jaune, mise en évidence du montage de la plaque par bandes de damiers juxtaposés (photo Ch. Fontaine, avec l'autorisation de M.B. Chervenak).

comme des "ailes de papillons", sans doute des incrustations, dont certaines proviennent d'Égypte.[21] Par ailleurs, le petit médaillon ovale du Louvre, provenant d'Italie, semble avoir été redécoupé à époque moderne (Fig. 3b).[22]

D'un point de vue technologique, dans la plupart des restes de plaques, les damiers semblent être disposés *au petit bonheur la chance*, c'est-à-dire avec beaucoup d'approximation (voir par ex. la plaque d'Autun - Fig. 4a - avec 4 grands damiers intercalés dans de plus petits). C'est en examinant le plus grand des fragments de plaque, celui conservé à Corning (Fig. 5a) que l'on peut comprendre ce qui préside à la réalisation d'une plaque d'une certaine superficie, ainsi que le rôle des écoinçons turquoise dans le motif. Il semble que le verrier a dû procéder par bandes de damiers juxtaposés (Fig. 5b). Il a ensuite assemblé ces bandes en faisant coïncider les écoinçons de façon à créer un motif secondaire à 4 feuilles ou pétales bleus, bien évident sur un fragment du British Museum (no. inv. EA 64165). Les bandes ont ensuite été pressées et soudées à chaud. Dans bien des cas, à partir de damiers déjà déformés ou de bandes incomplètes, ces raccords sont décalés et tronqués, compliquant la compréhension de l'agencement et le repérage.

Vaisselle

D'emblée, il faut préciser qu'aucun récipient ne nous est parvenu entier. Les formes auxquelles il sera fait référence procèdent toutes par extrapolation à partir parfois d'un seul petit fragment. Concernant les lieux de provenance, aucune forme de vaisselle ne semble à ce jour avoir été signalée en Égypte, mais bien plutôt en Italie, en France et en Angleterre. Force est de constater que l'Angleterre se taille la part du gâteau avec 9 individus sur les 17 recensés. Il ne fait aucun doute que ceci est le reflet d'un état de la recherche, car Jennifer Price a déjà travaillé sur ce sujet.[23]

Malgré leur état parfois très fragmentaire, quelques formes peuvent être identifiées (Fig. 6):

21 Par ex. celle du MET, no. inv. 26.7.1242, Coll. Carnavon.

22 No inv. CP 8727: Arveiller-Dulong and Nenna 2011, 390, no. 644.

23 Comm. AIHV 17, Anvers 2006 (non publiée).

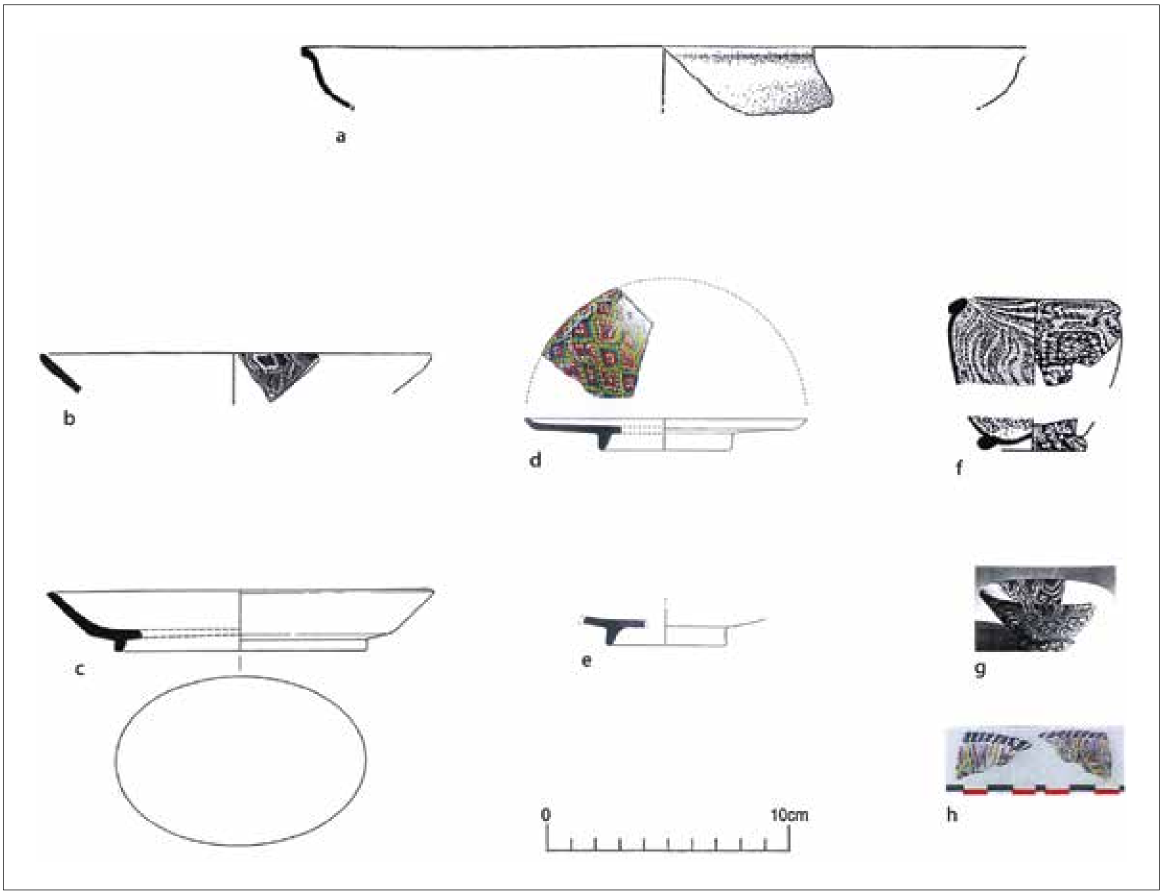

Fig. 6a-h : Récipients à décor de damiers: a. Adria (d'après de Bellis 1998, 118, no 99); b. Inveresk (présenté par J. Price, comm. AIHV 17); c. Londres (d'après Shepherd 2000, 187, fig. 1); d-e. Autun (dessins Y. Labaune, SAVA 2012 / DAO M. Gaudillière); f. Holne Chase (d'après Price 1985, 470, fig. 10); g. Provenance inconnue, coll. privée (d'après Rütti 1981, 65, no 78); h. Rome, coll. Gorga, face et revers (B. Gratuze et M.-D. Nenna) CNRS Orléans, rapport.

- un large plat à panse convexe, trouvé à Adria, Italie, Ø reconstitué : 30 cm (Fig. 6a)[24]
- deux petits plats circulaires peu profonds, sur anneau de base, repérés à Autun, France, Ø reconstitué : 11,7 cm (Fig. 6d-e, 7)[25]
- un petit plat ovale à panse carénée, sur anneau de base, trouvé à Londres dans une tombe, L: 16 cm (Fig. 6c)[26]
- une coupe dont il ne reste qu'un fragment à bordure filigranée (type *réticelli*) présentant un demi damier étiré, appartenant à la Coll. Gorga et provenant de la *villa* de Lucius Verus, près de Rome (Fig. 6h)[27]
- une coupe miniature tronconique, sur pied, H.: 2,5 cm / Ø: 5,7 cm, Coll. privée (Fig. 6g)[28]

À cela s'ajoutent pour l'Angleterre, deux coupes (ou plats?), l'une à Inveresk (Fig. 6b), l'autre à Carlisle avec pour cette dernière un doute sur la forme, ovale ou circulaire (si circulaire, Ø: 16 cm); aussi deux petits fragments dont un avec anneau de base à Wroxeter, bien qu'ici le motif soit incomplet et perturbé.[29]

Une donnée chronologique très intéressante concerne la tombe de Londres. C'est une tombe de jeune fille dont l'ensevelissement, sur la base du matériel le plus récent, remonte à la fin du

24 Rijksmuseum van Oudheden, Leyden, no. inv. F1934/10.55.397 : De Bellis 1998, 118-119, no. 99.

25 Musée Rolin, nos inv. B. 1471.2-3.

26 Shepherd 2000, 186-187.

27 B. Gratuze et M.-D. Nenna, comm. pers.

28 Rütti 1981, 65, no. 178.

29 Je remercie Jennifer Price pour ces informations.

III[e] – début IV[e] siècle. Dans cette sépulture ont été déposés en guise d'offrande funéraire, ces quelques fragments de petit plat ovale déjà à l'état fragmentaire et lacunaire. Cela montre à quel point de tels petits morceaux de verre (un héritage familial ?) étaient encore prisés à cette époque.

Tous les récipients évoqués jusqu'ici sont des verres pressés-moulés obtenus par thermoformage (moulage par affaissement à chaud d'une surface plane, disque ou autre). À ceux-ci, vient se joindre un petit gobelet trapu trouvé à Holne Chase, en Angleterre, qui lui a été soufflé (H. reconstituée: ± 6,5 cm ; Fig. 6f).[30] C'est un verre doublé: la couche extérieure décorée de damiers a été captée par une paraison, puis l'ensemble a été soufflé et dilaté en gobelet, d'où la déformation et la distorsion importantes des petits damiers.

Nombre de verres anglais donnent aussi des contextes de datation. Mis à part les fragments de la tombe de Londres qui à la fin du III[e] siècle devaient être considérés comme des antiquités, les autres contextes démarrent tous au moins au II[e] siècle (souvent fin II[e]) et vont au-delà : milieu et fin II[e] siècle pour Inveresk et Wroxeter, fin du II[e] pour un des spécimens de Carlisle, et fin du II[e] – III[e] siècle pour le gobelet de Holne Chase.

Sur la base de ces fragments de vaisselle, il n'est pas aisé de faire de la typo-chronologie. Seule la coupe Gorga (Fig. 6h), par sa bordure en bandeau filigrané, peut s'intégrer dans le répertoire de formes des productions en verre mosaïqué dit rubané, à bord filigrané, d'origine italienne, de la fin du I[er] siècle av. J.-C. – première moitié du I[er] siècle apr. J.-C. Par ailleurs, la coupe tronconique miniature, dont on ignore le contexte, est datée dans une fourchette du I[er] siècle av. J.-C. au I[er] siècle apr. J.-C. Quant au petit gobelet soufflé de Holne Chase, à lèvre ourlée vers l'extérieur, il est assez atypique, malgré le fait que son allure générale renvoie à la forme Isings 85, datée de la fin du II[e] au milieu du III[e] siècle. Les plats à pied, ovale et circulaire, étonnent aussi. Celui de Londres ne semble pas encore connaître d'équivalent. En revanche, les petits plats circulaires d'Autun

Fig. 7 : Fragment de petit plat circulaire, trouvé à Autun, no inv. B.1471.2, Ø 11,7 cm (© Ville d'Autun, Musée Rolin, J. Piffaut).

s'apparentent typologiquement, mais en modèle très réduit, à la série des quelques très grands plats pressés-moulés du début du II[e] siècle (par ex. celui d'Olbia de Provence), dérivés de prototypes métalliques, et pour lesquels une origine égyptienne a été proposée.[31] Le profil du petit plat d'Autun peut aussi être comparé au spécimen trouvé à Herstal en Belgique, dans un contexte du dernier quart du II[e] siècle.[32]

Origine du motif et datation

Sur ces bases et dans l'état actuel de la documentation, les damiers des perles lenticulaires de Karanog, en Nubie, datées du début du I[er] siècle, sont les plus anciens. Jusqu'à preuve du contraire, la création de ce motif précis remonte donc au début de l'Empire romain. Pour l'origine géographique, c'est vers l'Égypte que l'on se tourne très naturellement, elle qui a excellé dans la production du verre mosaïqué à damiers, et dont plusieurs perles et verres plats étudiés ici sont originaires. Signalons que déjà à la fin du IV[e] siècle av. J.-C., un damier complexe à 100 cases et 4 couleurs, issu d'une canne (*Mosaic Composite Bar*) et construit sur le principe de la double symétrie,

30 Price 1985.

31 Massabò 2004, 34, fig. 1d (Ø plat vert d'Olbia: 54 cm).

32 Massart 2001, 198, 210, fig. 8, no 36 (Ø plat incolore d'Herstal: 50 cm).

décore une corbeille *neb* en verre incrusté dans le sarcophage en bois de Djed-Thot-iuefanch,[33] frère de Pétosiris (Turin, Museo Egizio, no inv. Cat. 2241 RCGE 8109). Toutefois, le damier qui nous préoccupe ici a lui été créé d'emblée à 121 cases.

Pièces plus récentes et réemplois

La conception du damier d'Amay n'est pas le fruit du hasard, personne ne le contestera. Il n'est donc pas anodin de constater que ce damier "fait un saut" de plusieurs siècles pour réapparaître sur une plaque de revêtement du palais de Samarra, construit par le calife abbasside al-Mu'tasim entre 836 et 842.[34] Disposés en bande coudée à angle droit, on compte une dizaine de damiers identiques, un peu déformés, quelques-uns désarticulés et comme brouillés, mais exactement ceux de la perle d'Amay. Ils participent au motif concentrique de la plaque. Pourrait-il s'agir d'un réemploi? Quand on compare aux autres motifs, aucun n'est aussi complexe et raffiné : à côté des nombreux motifs à cercles concentriques assez grossiers qui ne soulèvent pas de doute quant à leur origine islamique, il y a bien un autre damier à 5 couleurs, mais c'est un damier à 49 cases (et non 121). Il est tout à fait chaotique, et ses cases sont deux fois plus grandes. Il apparaît comme une tentative d'imitation peu aboutie…

À plusieurs milliers de kilomètres de Samarra, dans un endroit tout aussi prestigieux, à Trèves, le trésor de la Cathédrale conserve un fragment de petite plaque à damiers, à l'état de réemploi bien avéré cette fois, récupérée comme pierre d'autel.[35] Elle décore le dessus d'un reliquaire, autel portatif consacré à saint André, chef-d'œuvre d'orfèvrerie médiévale, et attribué à l'atelier de l'archevêque Egbert, actif de 977 à 993. La plaque mosaïquée est située juste devant le pied-relique de la sandale du saint. Serti comme un joyau, le verre multicolore est une pièce de choix qui attire le regard telle une icône, au sens actuel informatique du terme. Quand on s'en rapproche, c'est lui qui donne la clé d'accès à la signification de l'objet, par l'inscription qui l'encadre : "HOC ALTARE CONSECRATV EST IN HONORE SCI ANDREAE APL".

Plus proche de nous, dans les années 1825, l'illustre marbrier romain, Francesco Sabilio, a trouvé ce petit damier digne de figurer au centre d'un dessus de guéridon destiné au Prince Friedrich von Hohenzollern-Hechingen.[36] Il est là, à l'état de tesson, noyé dans une sélection de 100 réemplois antiques.

Et pour terminer, j'évoquerais le verrier vénitien Vincenzo Moretti qui lui aussi a été manifestement séduit par le motif et intrigué par sa complexité. Il l'a fait recréer, un peu à sa façon, sur un échantillon de référence réalisé par la Venice and Murano Glass Company en 1881.[37]

Conclusion

On ne peut nier qu'au cours des siècles, ce petit damier a fasciné. Mais bien des questions restent encore ouvertes. Les dates basées sur des contextes nous mènent du début du Ier au IXe siècle et les territoires couverts sont énormes : de Karanog au sud, à Inveresk et l'Écosse au nord, de Wroxeter à l'ouest, à Samarra, Alania et la province de Gilan à l'est. Faut-il pour autant imaginer des siècles et des lieux de production différents? Malgré tout, toutes proportions gardées, le damier reste extrêmement rare : les trouvailles sont éparses, et il est toujours utilisé avec parcimonie. Dans l'état actuel des recherches, l'origine égyptienne du motif est la plus vraisemblable. Par ailleurs, on peut observer que si les perles ont essaimé, sans doute à partir de l'Égypte, la vaisselle y semble absente. Il est évidemment tentant d'imaginer

33 Observation personnelle.

34 Carboni and Whitehouse 2001, 148, no. 61.

35 Krueger 2013/2014. Lors du congrès de Piran, Ingeborg Krueger m'a annoncé qu'elle venait d'achever l'étude de ce fragment de verre récupéré comme *altarstein*. Par le plus grand des hasards, elle a mené une recherche en parallèle à la mienne, mais à rebours de mon point de vue. Nos contributions se croisent et se complètent. Je la remercie infiniment pour la documentation et les renseignements qu'elle m'a si aimablement transmis par la suite.

36 Newby 2005, 402-403, no. 6, fig. 130-131.

37 Sarpellon 1995, 112, fig. 859.

un atelier-relais en Italie, au Ier et peut-être au IIe siècle, atelier qui aurait en outre assuré une diversification de la mise en forme du motif. Pour les contextes plus tardifs, il faut être prudent. Contexte de datation ne veut pas dire datation. Il n'est pas impossible qu'il s'agisse de joyaux de famille - c'est d'ailleurs le cas avéré de la trouvaille de Londres. Il peut y avoir des récupérations, même à Holne Chase. Un verrier peut "jouer" avec des fragments récupérés. Le verre se recycle…

Ce rapide tour d'horizon montre aussi que l'enquête devrait être poursuivie. D'autres fragments dorment encore certainement dans quelques réserves et strates archéologiques, ou comme prestigieux réemplois. À notre avis, des analyses de composition réalisées sur les pièces certifiées égyptiennes devraient permettre un jour d'éclairer la problématique des origines et de la chronologie.[38]

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38 Les seules analyses effectuées concernent le fragment de la coupe Gorga (B. Gratuze, CNRS Orléans, rapport interne), la perle d'Amay et les 2 fragments plats des MRAH (H. Wouters, IRPA). Leur résultat divergeant semble plaider pour des origines différentes : voir Fontaine-Hodiamont and Wouters 2014, 31-36.

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HOW GLASS WAS COLOURED IN THE ROMAN WORLD, BASED ON THE GLASS CAKES AND TESSERAE FROM ESSEX, ENGLAND

Over 200 coloured glass tesserae plus fragments of two cakes of coloured glass were excavated in 2007 at West Clacton Reservoir, Great Bentley, Essex in the UK by CAT (Colchester Archaeological Trust). The glass was recovered from a pit containing a sherd of Iron Age pottery. The assemblage was studied by glass specialist Hilary Cool and is thought to date from the 2nd century AD, based on comparisons with similar finds. A proportion of the assemblage was analysed by Thérèse Kearns and Sarah Paynter at English Heritage.

Thirteen different colours and shades of glass were identified and most of the tesserae are roughly cubic in shape. There are also a small number of triangular fragments and some flakes. One cake fragment is opaque turquoise blue and the other is opaque mid-blue. The curvature of the fragments indicates that both cakes were originally round, the turquoise example having a radius of perhaps 160mm and the mid-blue specimen a radius of about 80mm; the cakes were 150mm and 20mm thick respectively. The smooth surfaces of the cake fragments suggest that they were made from a gather of coloured glass, which was allowed to cool on a flat surface rather than in a container (Fig. 1).

Background

Glass tesserae

The mosaics found at Romano-British sites in the UK are made mostly from stone tesserae;

Fig. 1: The fragmentary cobalt-coloured mid-blue cake and copper-coloured opaque turquoise cake from West Clacton.

glass tesserae were used only rarely for selected highlights, generally in blue or green. Large numbers of glass tesserae have occasionally been found in the UK, however, and other possible uses have been proposed - such as for enamelling metal vessels or brooches.[1] The largest assemblage of 1268 glass tesserae was recovered during excavations at 27–29 Union Street in London,[2] largely from 2nd century AD contexts. Around half of the assemblage by weight was made up of dark blue semi-translucent tesserae with another quarter being comprised of mid-blue opaque tesserae; 17wt% were opaque green while some were yellow-tinged, with only 3wt% being opaque turquoise and 0.8wt% opaque yellow. Elsewhere in London, 140 tesserae were recovered from 33 Union Street, also originating from the 2nd century AD. At Carlaeon, 134 tesserae were found, thought to date to the Hadrianic or early Antonine period; the majority were opaque or translucent deep royal blue.[3] A smaller collection of 18 recognisable tesserae and 32 random lumps and fragments, which had been melted, was recovered from the vicus area at Roman Castleford. These were all opaque blue apart from one opaque yellow example.[4]

Colourless and self-coloured blue-green Roman glass

Most glass used in the Romano-British period intended for tableware, bottles and windows, was transparent and either completely colourless or was of a weak blue-green colour. The glass was made using carefully selected raw materials, generally with very low levels of iron oxide, but even this small amount was enough to produce the coloured tint. This glass is sometimes known as self-coloured blue-green glass to distinguish it from glass containing intentionally added colourants. Varying amounts of decolourising compounds, such as antimony or manganese oxide, were added to counteract this colour and ultimately produce completely colourless glass.

Analysis of Roman and Byzantine colourless and self-coloured blue-green glass has demonstrated that there were relatively few compositional types in circulation,5 supporting a model where a small number of production centres made raw glass on a large scale. So far, large furnaces have been identified in coastal areas of Egypt and the Near East, but there are others still to be found. The large batches of raw glass were broken up and distributed to workshops across the Roman world and beyond, where the glass was worked into vessels and other items.[6]

The glass was made using evaporitic sodium carbonate, known as natron.[7] The natron was combined with sand, which also contained lime in the form of shell.[8] Natron glass is therefore, a type of soda-lime-silica glass, with characteristically low levels of potash, magnesia and phosphorus relative to glass manufactured using plant ashes.

Of the different compositional types of natron glass identified, those most relevant to this paper, that were in use around the 2nd century AD,[9] are very briefly the following:

- Some colourless and blue-green glass, which is distinctive because it contains a low ratio of soda to lime relative to other glass in circulation at the time. This glass contains varying amounts of manganese oxide as a decolouriser and so is labelled here as ‘manganese-only’ (Fig. 2).

- The other types of weakly coloured glass and colourless glass have higher ratios of soda to lime and contain antimony. The blue-green glass contains small amounts of antimony and manganese oxide, labelled ‘both antimony and manganese’, whereas colourless glass is decolourised with ‘antimony-only’ (Fig. 2).

1 Cool *et al*. 1995; Cool *et al*. 1592; Cool and Price 1998.
2 A. Wardle pers. comm.
3 Zienkiewicz 1993, 105-106.
4 Cool and Price 1998, 193.
5 Freestone *et al*. 2003; Jackson 2005; Nenna *et al*. 1997; Nenna *et al*. 2000.
6 Foy *et al*. 2000a; Foy *et al*. 2000b.
7 Freestone 2005; Sayre and Smith 1967.
8 Freestone *et al*. 2002; Freestone *et al*. 2003.
9 Foy *et al*. 2000a; Foy *et al*. 2000b; Freestone *et al*. 2002; Freestone 2005; Jackson 1994; Jackson 2005; Paynter 2006.

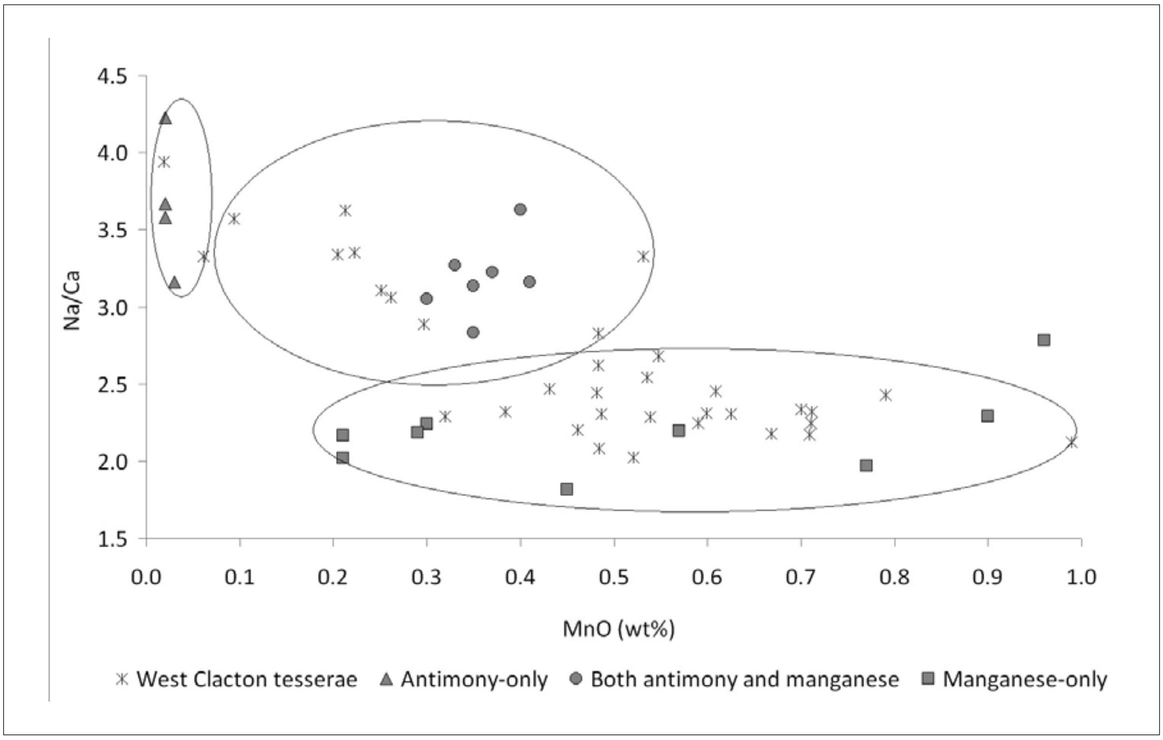

Fig. 2: A plot of the ratio of sodium to calcium against manganese oxide for different types of colourless and self-coloured blue-green glass relevant to the 1st to 3rd centuries AD (from Jackson 1994 and 2005) and also the West Clacton tesserae and cakes from this study. The ellipses are not statistically derived but have been drawn so that they encompass the samples that group together in multiple elemental plots.

Strongly coloured Roman glass

Previous studies have identified the compounds responsible for the colour and opacity of strongly coloured Roman glass,[10] but it has proved more difficult to establish the form in which they were added, or where these colourants came from.[11] Links with the metallurgical industries of the time are likely, because the colourants and opacifiers are metal oxides but the exact nature of those links has yet to be established.[12] Compositional data for tesserae and opaque coloured vessel glass[13] are also more difficult to interpret, because the added colourants and opacifiers often have associated contaminants, resulting in a more complex composition. These contaminants are generally dominated by gangue minerals that were present in the ore from which the colourant was obtained, but also include others introduced during processing of the colourant, for example from ceramics, in which colourants were prepared.

Opaque glass colours can be difficult to make and easily spoiled because the type, size and distribution of the opacifying particles must be controlled to obtain the desired colour. For example, the yellow opacifier lead antimonite, found in Roman opaque yellow and some opaque green colours, will eventually dissolve in soda-lime-silicate base glass, leading to the formation of white calcium antimonate instead. Similarly, if lead and antimony compounds are added to the glass independently, without previously having produced lead antimonate, the result will be white glass. Therefore, glassworkers would have made the lead antimonate colourant or 'anime' beforehand, using the sort of process described by Lahlil *et al.* (2008) before adding it to a base glass. They used an excess of lead and avoided working the glass for too long or at high temperatures, so as not to dissolve the lead antimonate and spoil the yellow colour.

10 For example Henderson 1991.
11 Mass *et al.* 2002; Rehren 2003.
12 Freestone 1987.
13 Mass *et al.* 1998; van der Werf *et al.* 2009.

Uniform red glass would also have been difficult to make and shape. Red glass is coloured largely by crystals of cuprite (Cu_2O), formed under reducing conditions. However, if the glass oxidises, the cuprite changes to copper oxide (CuO), which dissolves to give a transparent turquoise or green colour.

Lastly, calcium antimonate compounds $Ca_2Sb_2O_7$ or $CaSb_2O_6$ are the opacifiers found in turquoise, blue and white glass. These opacifiers have been recreated experimentally by adding antimony compounds, such as stibnite or antimony oxide, to a soda-lime-silica glass similar to Roman natron glass.[14] In these experiments, the calcium antimonate crystals formed in situ by reacting with calcium from the glass itself. Alternatively, Lahlil *et al*. (2010) have described making an anime containing calcium antimonate crystals beforehand; for example, by facilitating a chemical reaction between calcium and antimony compounds, which was then added to the glass.

Analytical methods

34 small samples were removed from the tesserae and cakes, mounted in epoxy resin and polished to a 1μm finish for examination using an FEI-Inspect scanning electron microscope (SEM) along with an attached energy dispersive spectrometer (EDS). The conditions included the presence of an electron beam current of approximately 1nA and a voltage of 25 kV. The EDS data was quantified using Oxford Instruments INCA software. The accuracy and precision of the results was checked by analysing Corning and NIST glass standards.

Results

Assuming coloured glass was made by adding colourants to a transparent colourless or blue-green base glass, the theoretical composition of that base glass can be calculated by subtracting all of the compounds that are likely to have been added with the colourants and normalising the remainder. Alternatively, the ratios of key elements can be plotted against each other, taking care to avoid elements heavily influenced by the added colourants or any contaminants incorporated into the mix.

In Figure 2, the ratio of soda to lime is plotted against the weight percent of manganese oxide (corrected to compensate for the diluting effect of the colourants on the concentration mentioned above) for the West Clacton tesserae, excluding the red and peacock green specimens. These are compared to literature data for the relevant types of colourless and self-coloured blue-green glass from Jackson (1994 and 2005). Plots of other element ratios give similar groupings. The data can be found in full in Paynter and Kearns (2011).

Colours produced from a natron base glass

The results show that all of the West Clacton tesserae and cakes (with the exception of the red and transparent peacock green colours) were produced by adding colourants, either as raw materials or 'anime' mixtures, to previously made transparent natron glass. This conclusion has been reached, because the calculated base glass compositions closely match those of the major types of natron glass in circulation at this time, which were widely available to numerous glass workshops in the form of raw glass or cullet. There are also practical benefits to adding colourants to previously made glass rather than during production of glass from raw materials, because the prolonged heating required to melt and homogenise the batch would spoil some of the colourants described here. Amongst archaeological and documentary sources, there is little to suggest that coloured glass was made on the same large scale as was the case with manufacturing centres producing raw glass from batches of raw materials.

The great majority of the tesserae, towards the bottom right corner of Figure 2, were made by adding colourants to self-coloured blue-green manganese-only natron glass. This type of glass is thought to have been made from eastern Mediterranean coastal sand and transported from furnaces in that region. This composition is typical of most Roman glass in the western Mediterranean and is found from

14 Foster and Jackson 2005.

the end of the 3rd century BC to the 3rd century AD.[15] Significantly, this base glass was used for all of the cobalt-coloured, opaque mid-blue glass, including the cake, but only for some of the cobalt-coloured pale grey tesserae.

There were two cobalt-coloured translucent blue tesserae, which were both made from transparent colourless, 'antimony-only' glass of the type used for high quality tableware[16] to which a cobalt colourant has been added, but without an opacifier. These are plotted on the top left of Figure 2.

All of the copper-coloured turquoise glass, including the turquoise cake and three turquoise tesserae, were probably made from blue-green self-coloured glass containing both antimony and manganese; these tesserae are plotted on Figure 2, towards the middle. Some of the pale grey-blue tesserae, and possibly some of the yellow tesserae and a yellow-green tessera, may also be made from this base glass.

The composition of the base glass has an effect on the solubility of calcium antimonate opacifiers. Where the manganese-only base glass has been used, with a low ratio of soda to lime, $Ca_2Sb_2O_7$ has precipitated. Where one sample of antimony-containing base glass has been used, with a higher ratio of soda to lime, $CaSb_2O_6$ has precipitated instead together with alkali antimonates or alkali antimony silicates. These glass samples also tend to contain more antimony and more immiscible phases, suggesting that they were heated and worked less; these observations may all be related to the greater solubility of the opacifiers in this composition of base glass. The composition of the base glass does affect the hue obtained with a particular colourant, and it is probable that this was a factor in the choice of base glass.

Colours produced with a plant ash component

In contrast, the red and some of the green glass contained a large plant ash component, indicated by raised levels of potassium, phosphorus and magnesium oxide. The red glass also contained high levels of lead and copper, but if these are subtracted, the theoretical base glass composition is very similar to a contemporary type of emerald green vessel glass.[17]

Conclusions

The results show that the glassworkers making this strongly coloured glass made use of existing supplies of transparent natron glass, predominantly the self-coloured blue-green types, to which they added the required colourants and opacifiers. The colourants were not necessarily added at the raw glass manufactory however, but could have been mixed into the base glass at workshops receiving supplies of raw glass, or even during the recycling of available vessel and window glass. In many cases, the colourant would have been prepared as a glassy anime which was then added to the base glass. The opacifiers were often soluble in the glass to some extent while to preserve the colour, the glass would have been worked as little as possible. There are interesting differences in the types of base glass used for different colours; for example, a more soda-rich base glass was selected for turquoise.

Although two partial cakes of coloured glass were found with the tesserae, a turquoise example coloured with copper oxide and a mid-blue specimen coloured with cobalt, not all tesserae in the assemblage in matching or similar colours derive from these cakes. For example, there are at least three different sources of cobalt-coloured glass (mid-blue, deep translucent blue and pale grey-blue). Similarly, there are at least three different types of green glass (translucent natron peacock green, opaque plant ash green and opaque lead antimonate opacified natron green) and probably at least two sources of yellow (using different types of base glass). This suggests that the West Clacton assemblage was collected in a persistent, but piecemeal fashion from a variety of sources and possibly over sometime. The presence of translucent blue tesserae, which are found in mosaics but not in enamels, suggests that the assemblage may have been intended for use in mosaics.

15 Foy *et al.* 2000a; Foy *et al.* 2000b.

16 Jackson 2005; Paynter 2006.

17 Henderson 1996.

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BARBERA Maria

ROMAN GLASS FROM THE AREA OF NORA (CAGLIARI, SARDINIA)

The ancient town of Nora stands on the most western point of the Gulf of Cagliari, in Sardinia, on a volcanogenic triangular promontory called Capo di Pula, which is linked to the mainland by a narrow isthmus.[1]

The site shows a quite complex stratigraphy due both to historical events and excavation methods adopted since the fifties. The first phase is Phoenician, supported by the discovery of inscriptions from the 8th century BC,[2] and of ancient pottery dated at between the 7th and 8th century BC. A punic phase then followed, which began in 238 BC - the year the Romans conquered Sardinia - and lasted until the last quarter of the 7th century.

During the Republican Age the city structure did not change dramatically[3] although the construction of the *domus* with perystile began[4] and the city was elected *caput viae* of the road running through the south-eastern coast up to Cagliari and Chia. An inscription reused for the Roman *forum* floor[5] attests that Nora became the *municipium* between the 1st and 2nd century BC.[6] The first phase of the theatre[7] occurs in the 1st century AD, between the first Augustan Age and the Julio Claudian Age.

There are thermal buildings, including the Central Baths, built above a late Republican neighbourhood that reflect different phases, with the most recent having been dated at between the 2nd and 3rd century AD.[8] The Sea Baths, along the western cove, date back to the late 1st century AD; its final collapse phase having been attributed to a period between the 7th and 8th century AD.[9] The Small Baths date from the beginning of the 3rd century AD[10] and

1 Tronchetti 1986, 7-9; Botto, Melis, Rendeli 2000, 255-284.

2 Moscati 1969-1970, 53-62; Moscati 1970.

3 Bejor 1994a, 109.

4 Bejor 1992, 125-132.

5 Its first implant dates back to the 1st century BC.

6 Pesce 1972, 52-55.

7 Bejor 1993, 129-139; Bejor 2000, 177-182.

8 According to the mosaic works of the *apodyterium* and the *frigidarium*.

9 Tronchetti 1985, 71-81.

10 Bejor 1994b, 219-224.

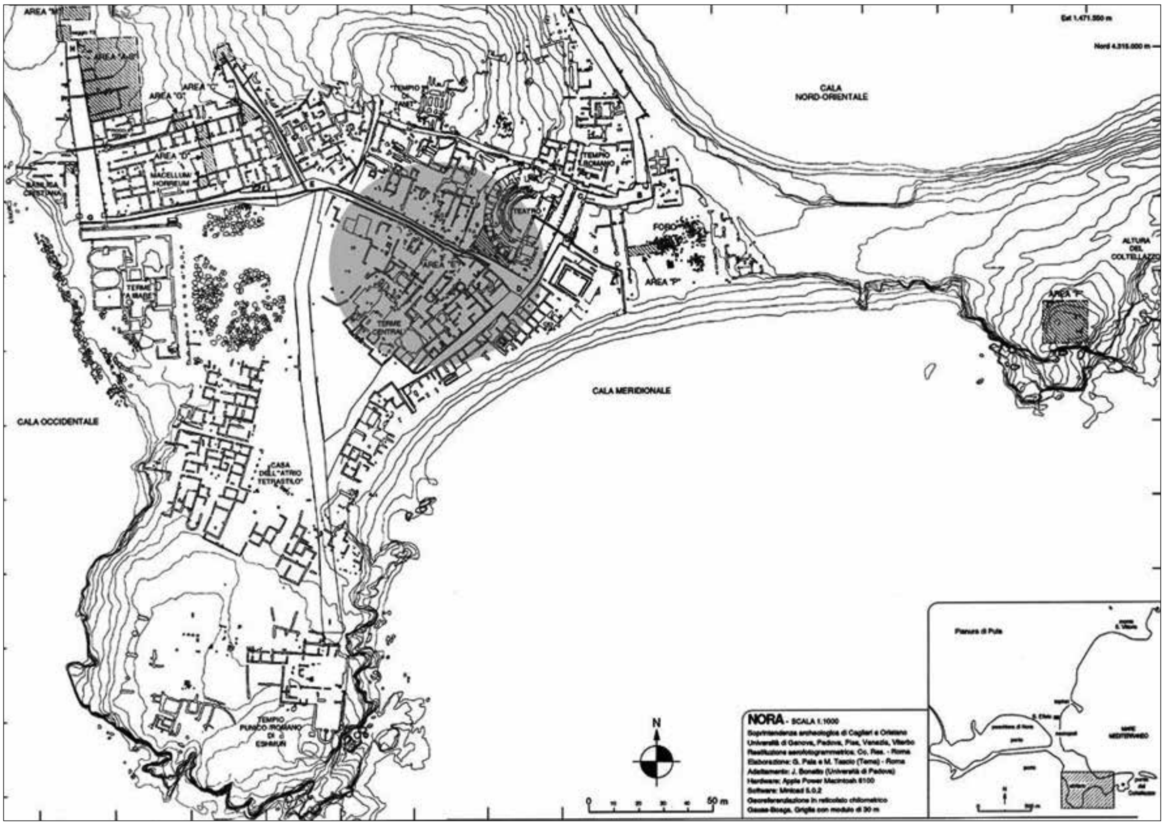

Fig. 1: Nora site map, with E Area highlighted (Bejor, Miedico, Armirotti 2005, 4, no. 1).

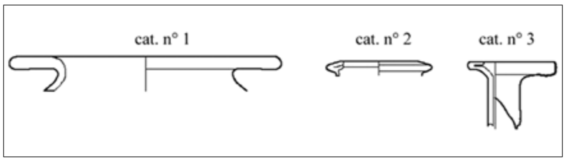

Fig. 2: Some examples of toilet bottle rims. From left to right: Isings 68, De Tommaso 32, and Isings 82a.

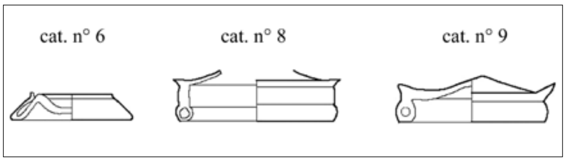

Fig. 3: Three examples of ewer bases Isings 123a/ Trier 129.

the East Baths the 4th century AD. Some of the latest findings regarding the city testify to the renovation of the aqueduct during the times of Teodosio II and Valentiniano III in 425 AD.[11]

The progressive reduction of the fabric of the city began in 455 AD with the Vandal invasion, and continued under Byzantine domination from 533 AD until the 7th century AD.[12] The city then progressively declined up until and throughout the 11th century AD.

In 1949 the whole territory was cultivated with wheat, except where the top of the cavea of the theatre emerged, and on the western coast, where ruins of brick walls remained.[13]

The site was excavated from the end of the 19th century until the beginning of the 20th century,[14] but the most substantial developments took place in 1952 when Gennaro Pesce,[15] Soprintendente alle Antichità della Sardegna, obtained regional funding that enabled approximately three hectares of the site to be unearthed. These excavations subsequently caused different

11 Zucca 1994, 871-881; Ghiotto 2004, 148.

12 Bejor 2008, 103.

13 Pesce 1972, 25.

14 For the campaigns started in the 19th century see: Spano 1863, 96-105; Vivanet 1891, 299-302; Patroni 1901, 365-381; Patroni 1902, 71-82.

15 Pesce 1972.

Fig 4: Upper part of the Isings 50/51 glass bottle found during the 2011 campaign, inside the A1 building.

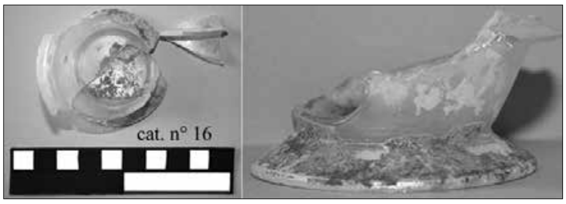

Fig. 5: Truncated conical cup similar to the Aquileia Group F cups. On the surface signs of alterations.

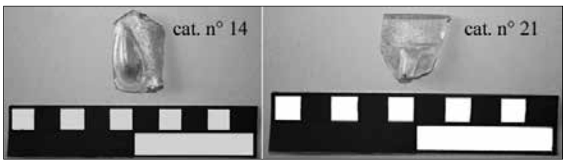

Fig 6: Two examples of qualitatively high products. On the left a fragment of Isings 31 beaker, on the right a fragment of Isings 3b ribbed cup.

problems with the stratigraphy.[16] The first action which allowed to acquire a complete stratigraphy was the one undertaken in 1977 by Carlo Tronchetti in the Sea Baths area.[17]

In 1990, the Soprintendenza alle Antichità delle province di Cagliari e Oristano entrusted the excavation to the University of Pisa. In 1991, the task was extended to the Universities of Genoa, Padua and Viterbo; and between 1998 and 2001, to Venice, which was then replaced in 2002 by Milan. At present, the Universities involved are Genoa,[18] Milan, Padua[19] and Viterbo.[20] Each one is responsible for investigating a specific area.[21]

Professor Giorgio Bejor, with the University of Venice from 1998 until 2001, and with the University of Milan since 2002, centred his searches on the theatre and on the central block, in the so called E area.[22] This sector, from which the glass subject of my study comes from, includes the Roman theatre, which dates back to the 1st century AD; the block to the south of the paved road D-E; the Central Baths and the house block facing the southern cove.

Approximately 380 glass fragments were found in this area, but due to the precarious

16 And also to the dating of the glass.

17 Tronchetti 1985.

18 Giannattasio 2000, 77-94; Giannattasio 2003; Giannattasio 2004, 135-141; Giannattasio-Grasso 2003, 41-56; Grasso 2000, 151-157; Grasso 2001, 137-150; Grasso 2003, 46-51; Grasso 2004, 143-153.

19 Bonetto, Ghiotto, Novello 2009a; Bonetto, Ghiotto, Novello 2009b; Bonetto, Falezza, Ghiotto 2009a; Bonetto, Falezza, Ghiotto 2009b; Bonetto, Falezza, Ghiotto 2009c.

20 See footnote 3.

21 Under the guidance of Professor Bondì, Tuscia University attends to the research concerning the Phoenician and Punic periods of the city. The excavation area, denominated F, is set on the slopes of Coltellazzo and on Tanit hill. The University of Genoa, under the scientific responsibility of Professor Giannattasio, concentrated its attention on the so-called C area, set to the north of *macellum* along the north-eastern side of Tanit hill and crossed by the E-F road. The excavations of the University of Padua, supervised by Professor Ghedini and Professor Bonetto, were concerned at the start with the sector between Small Baths and *insula* A, denominated G area. Afterwards, the University moved its search towards P area, including the Roman *forum* and Capitoline Temple

22 Bassoli 2010, 87-108; Bejor 1992, 125-132; Bejor 1993, 129-139; Bejor 1994a, 109-113; Bejor 1994b, 219-224; Bejor 1994c, 843-856; Bejor 2000, 177-182; Bejor-Campanella-Miedico 2003, 88-124; Bejor, Carri, Cova 2007, 127-138; Bejor, Condotta, Pierazzo 2003, 60-87; Bejor, Miedico, Armirotti 2005, 3-17; Panero 2010, 45-59; Simoncelli 2010a, 61-66; Simoncelli 2010b, 67-85; Frontori 2012, 105-114; Iacovino, Mecozzi 2012, 115-124; Panero 2012, 91-104.

preservation only a restricted sample of 39 pieces could be catalogued.[23] Included in the catalogue are another 29 pieces for which only an attributive hypothesis can be formulated. The study implied several problems and raised important questions.

The first concerns the precarious preservation caused by weathering, which led to consequent deterioration of the glass surface and impossibility to reconstruct whole shapes. This made it necessary to adopt special care during the design and typological study phases. Other peculiarities are the iridescence, the crizzling, the reduction of the original thickness and the formation of lacteous or dark opaque patina. The alterations affect all glass material unearthed from a site with high dampness and presence of chlorides.[24] The only recommended actions to avoid a further deterioration would be an improvement of the environment where they are conserved and a stabilisation with consolidants.

Moreover, the fragmentariness of Nora glass is linked with its provenance from the excavation of an inhabited area affected by massive rearrangement both in ancient and in recent times. The larger part of it comes from layers which were scarcely useful for dating purposes. The sectors where the greatest findings were made are those marked with letters A, B, C[25] and T.[26] This area, which Pesce had once described as a sort of labyrinth,[27] presented quite a complex stratigraphy due to several building phases begun in ancient times, which followed one another without a break, and was further complicated by the analysis of the wall structures carried out in the fifties. They were in fact excavated below the original layer of use, left on contact with floors belonging to different phases, and consolidated with reinforced-concrete floor slabs.

Inside A sector, a block dedicated to productive and craft activities,[28] the rooms that brought back the greatest quantity of glass are Ad e Af, which were investigated in 2003.[29] The first belonged to a post-Constantinian building (A2) and was characterized by the presence of mosaic fragments whose connection with the demarcation walls was complicated by Pesce's concrete floor slabs. The catalogued fragments come from a pit made inside the above-mentioned space. Af room, located to the south of Ad, presented similar reading problems: the concrete floor slabs were in fact at the same level of the layer from which the catalogued fragments came from.

The largest number of glass fragments come from the B sector,[30] located to the west of the previous one, and with similar structure and destination. Inside this sector, the Bf room stands out for its considerable quantity of glass. It presents traces of ancient rearrangements, dating back to the second half of the 2nd century AD[31] and restoration work undertaken during the fifties. The stratigraphic units from which the diagnostic fragments come from are mostly cut backfills.

The C sector, gravitating around a peristyle, revealed back more or less the same quantity of glass as B sector, especially room Cf,[32] located between the peristyle and the Central Baths. This room presented a series of layers followed by a period of neglect which had involved the levelling of former structures and ruins, to allow the building of the Baths. In this case, thanks to the pottery materials, it was possible to date the stratigraphic units at between 240-300 AD.[33]

23 The study was undertaken while attending the Scuola di Specializzazione of the University of Milan (postgraduate studies). The results and the catalogue are in the thesis: "Nora, Area E: il materiale vitreo (2000-2008)".

24 And these are constant elements on the Nora site, directly overlooking the sea.

25 For a map of A and B sectors see Bejor, Campanella, Miedico 2003, 111-112, pl. 1-2.

26 For a map of T sector see Panero 2010, 46-47, nos. 1-2.

27 Pesce 1972, 75.

28 Bejor and Condotta-Pierazzo 2003, 60-87.

29 Bejor, Miedico, Armirotti 2005, 8-10, 13-16.

30 Bejor, Campanella, Miedico 2003, 62-63, 65-76.

31 At the same time as the construction of the paved D-E road.

32 Bejor, Campanella, Miedico 2003, 104; Miedico, Facchini, Ossorio 2005, 65; Miedico, Facchini, Ossorio, Marchesini 2007, 90-97.

33 Bassoli, Facchini, Massaro 2007, 99-126.

The other important sector for the great quantity of materials is the Central Baths, especially the small triangular yard to the south-east of D-I road, where the Tα sample was opened.[34] Here came to light the remains of a basalt road[35] and part of the sewer system.[36] The glass came mainly from superficial layers or backfills containing modern material.

One great problem is the scarcity of stratigraphic units usable for dating purposes;[37] for this reason, the study was mainly typological. The sample studied consists mostly of tableware shapes with a predominance of open rather than closed shapes. Five necklace beads and some window glass have also been found, especially near Cf room.

For the closed shapes, four toilet bottle rims have been identified: a jar-shaped toilet bottle Isings 68[38] (cat. no. 1); a candlestick unguentarium Isings 82A[39] (cat. no. 2) and two rims belonging to the De Tommaso 32 category[40] (cat. nos. 3, 4).

During the excavation campaign that took place in September 2011 inside the post Costantinian A1 building,[41] the upper portion of the handle of a glass bottle was found.[42] This finding can be considered exceptional both for the partial integrity of the object and for the reliability of the original stratigraphic unit. It was identified as an Isings bottle 50/51 b,[43] an object widespread in the Roman world, but the absence of the lower portion with consequent lack of the vitrarius mark, makes it difficult to ascertain its exact origin.

Among the findings were three ewer ring bases Isings 123a44/Trier 129,[45] dating back to the 4th century AD (cat. nos. 6, 8, 9),[46] and a fragment of a ribbon handle with a loop, which belongs to a more ancient typology, that of Isings 56 (cat. no. 7).[47]

Among the open shapes is a fragment of Isings 30 beaker[48] (cat. no. 10), with cut rim, and a fragment of Isings 31[49] beaker with knobs (cat. no. 14); two rims with a rounded lip are supposed to belong to conical beakers Isings 106c[50] (cat. nos. 11, 13).

The typology presenting more variations is represented by cups, among which the most ancient is the ribbed cup Isings 3b[51] (cat. no. 21). In addition, two flat base fragments with foot ring are present and could be referred to cast bowls type to Isings 20 typology[52] (cat. nos. 17, 19). Two ribbon handles[53] testify to the presence of Isings 37 *modioli*[54] (cat. nos.

34 Panero 2010, 45-59.

35 Probably belonging to a small square overlooked by the Baths.

36 Iacovino and Mecozzi 2012, 115-124.

37 This problem emerges from the studies of Genoa and Padua Universities as well. See Contardi 2004, 155-180; Contardi 2010, 17-20; Giannattasio and Montinari 2003, 5364; Marcante 2007, 203-208; Marcante and Silvestri 2009, 765-776; Nervi 2003, 155-180

38 Isings 1957, 88-89; Scatozza Höricht 1986, 70, no. 58; Maccabruni 1983, 86, no. 50; Contardi 2004, 155.

39 Isings 1957, 97-99; Calvi 1968, 141-142, nos. 270-275; Goethert Polaschek 1977, 117-118, no. 72; Maccabruni 1983, 162-163, nos. 211-212; Stiaffini and Borghetti 1994, 53-55, 145; Contardi 2004, pl. I.1.

40 Calvi 1968, 141, no. 273, pl. 21-22; Maccabruni 1983, 161, no. 205; Scatozza Höricht 1986, 64, no. 12; De Tommaso 1990, 58; Stiaffini-Borghetti 1994, 54.

41 Frontori 2012, 105-114.

42 Barbera 2011, 110-121.

43 Isings 1957, 63-67; Calvi 1968, 85-86, cat. no. 211, pl. 12.5; Mandruzzato and Marcante 2005, 71, 75, cat. nos 81, 106-108.

44 Isings 1957, 153-154.

45 Goethert Polaschek 1977, 219, no. 1323, pl. 71.

46 Goethert-Polaschek 1977, 219, no. 1323, pl. 71.

47 Isings 1957, 74-76; Calvi 1968, 61, no. 145, pl. 7.5.

48 Isings 1957, 45; Scatozza Höricht 1986, 40, no. 20; Stiaffini and Borghetti 1994, 141, no. , pl. 108; Massabò 1999, 81, no. 31; Marcante-Silvestri 2009, 767, nos. 3, 5.7.

49 Isings 1957, 45-46.

50 Isings 1957, 126-133; Stiaffini 2000, 118-121; Contardi 2004, 161, nos. 1,2, pl. 7.

51 Isings 1957, 19-20; Stiaffini-Borghetti 1994, 73, pl. 161.

52 Isings 1957, 17; Scatozza-Höricht 1986, 32, no. 7.

53 One of which was entirely reconstructed from two fragments and one half-preserved fragment.

54 Isings 1957, 52-53; Scatozza-Höricht 1986, 42, no. 22.

15, 24). Furthermore, it has been noted that a rim fragment from an Isings 42 cup[55] was in use between the second half of the 1st century AD and 2nd century AD (cat. no. 18). A cup with a truncated conical body does not have strict matches but it is similar to the Calvi Group F Aquileia cups[56] (cat. no. 16). It was casted and appears to have been refined by wheel. A flat bottom with foot ring belongs to an Isings 85a cup[57] (cat. no. 20); an example of Isings 96 cup with rim cut, flared and engraved with shallow lines below the rim, is evident in both E Area and in other variants on the site[58] (cat. no. 22).

Two types of plate have been identified: the AR24.1, also present in C and P areas[59] (cat. no. 25), and the Isings 46a[60] (cat. nos. 26, 27); both were present in Italic territories and in the Mediterranean basin between the 1st and 3rd century AD.

It is impossible to ascertain the typology of the necklace beads (cat. nos. 28, 29, 30, 31, 32) as this category presents a kind of formal uniformity that endures through time. The spherical beads made in molten glass have, in fact, no distinguishing features and were probably hand-modelled on a flat surface.

Most of the window glass found in E area comes from Cf room. It was probably crafted by pouring molten glass into a quadrangular mould, as inferred from its thickness, which increases on the edges, and from traces left by tools which were used to expand the material into the container's shape[61] (cat. nos 33, 34, 35, 36, 37, 38, 39). It is likely to belong to the building dismantled around the 3rd century AD for the construction of the Baths.

It is possible to conclude that the most ancient typologies found in Nora are those present since the 1st century AD, but which were kept in use until the 2nd or 3rd century AD.[62] The lack of more anciently dated exemplars is also demonstrated by the glass colour, prevailingly light blue with more or less consistent green shades.[63] We also have late forms, although glass material does not go beyond the 4th century AD; the beginning of its diffusion in Nora around the 1st century AD seems to coincide with the spreading of the glassblowing technique. In addition, the casting technique is evident for products that were in use from the 1st century AD[64] while mould blowing characterizes products widespread from the 1st century AD, which imitated metal prototypes. Another manufacturing technique consists of the engraving of thin parallel lines under the rim of beakers and cups. This technique, widespread in Nora,[65] persisted from the 1st until the 4th century AD.

Some fragments seem were of high quality, especially the cast or mould-blown examples, while others show a lower quality. It is therefore, possible to support the hypothetical possibility of local production.

The most important clue could be the presence of immediately available sand and wooded regions in southern Sardinia. It is no accident that the sites of Capoterra and Antas are indicated to have been hypothetical glass production centres too.[66]

Another indication is the finding of cullet and vitreous clinker[67] near the theatre, where

55 Isings 1952, 58-59; Fortuna Canivet 1969, 24, no. 22; Roffia 1993, 75-82, nos. 49-50.

56 Calvi 1969, 59, no. 6, pl. 2.

57 Isings 1957, 101-103; Rütti 1991, nos. 1692-1713, pl. 77; Stiaffini and Borghetti 1994, 133, no. 366, pl. 84; Massabò 1999, 84, no. 38; Contardi 2004, 158; Marcante-Silvestri 2009, 767-768, no. 5.5.

58 Contardi 2004, 158-159, pl. 4.2.

59 Rütti 1991, nos. 830-831, pl. 39; Contardi 2004, 157, pl. III.2; Marcante and Silvestri 2009, 770, no. 13.

60 Isings 1957, 61.

61 Contardi 2010, 17-20.

62 As were the toilet bottles, whose shapes were employed until the 3rd century AD.

63 Coloured glass, mosaic glass and marbled glass, typical of former production, is not present.

64 As shown by the truncated-conical cup and by the fragment of ribbed cup Isings 3b.

65 Contardi 2004, 162; Marcante and Silvestri 2009, 768.

66 Rowland 1981, 7, 34; Stiaffini and Borghetti 1994, 31, 91.

67 Vitreous clinker is not very abundant in E Area. We only register the presence of a strained bottle bottom (cat. no. 62) and a bent fragment covered by a metallic alteration (cat. no. 60), probably belonging to a plate.

lay the remains of a structure made with reused materials.[68] It has been interpreted as a furnace and dated from after the 4th century AD[69] although this cannot be the structure where the glass studied was manufactured due to obvious dating reasons.

Moreover the Grose's remark in *History of glass*[70] by Klein and Lloyd has to be considered incorrect. He shows a picture of what he considers to be a small uncovered furnace found in Nora and compares it to the image on a lamp found in Asseria, dated back to the second half of the 1st century AD. The structure, located to the north-west of the Central Baths, is actually a portion of grindstone that Pesce had placed there on a brick support to show the original level of the ground before the beginning of excavations.[71]

The lack of evident traces of more ancient structures does not necessarily invalidate the hypothesis of local production; in fact, those could have been temporary or have been dismantled to obtain building materials. In spite of the great difficulty to identify glass production centres, we could conjecture that in Nora local manufacturing concerned with low quality products coexisted with the importation of high quality examples. However, in order to acquire reliable results, the chemical analysis of glass and sand is required.

68 Pesce 1972, 68-69; Tronchetti 1986, 26-27

69 Giannattasio 1996, 26-27.

70 Grose 1984, 11.

71 Pesce 1972, 69; Tronchetti 1986, 35

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COTTAM Sally

GLASS FROM AN EARLY 2ND CENTURY AD WELL DEPOSIT AT BARZAN, SOUTH WEST FRANCE

The village of Barzan lies on the northern shore of the Gironde estuary in the department of Charente-Maritime in south western France. Nearby are the remains of a large Roman town, the object of a series of excavations since the 1920s.[1] The glass under discussion here comes from an area of public and private buildings situated between a Gallo-Roman sanctuary and the site of a large public bathhouse of the 2nd century AD. Over 2,500 fragments of glass were found during the excavations of this "secteur d'habitat", 1478 of which came from a single deposit, a 20-metre deep stone-lined well.[2] This self-contained and clearly delineated feature produced a closely dateable set of artefacts, including ceramics and coins. The latest coins come from the last decade of the 1st century AD, whilst the ceramics point to a date in the 1st quarter of the 2nd century.[3] Many of the glass vessels survive in substantial portions, and the same is true of the ceramics. Parts of the same vessels have been found in different layers of the well deposit, suggesting that the well was filled rather rapidly. The probable date for this event has been pinned down to sometime around AD 110.[4]

The well produced a large assemblage of glass, comprising just over 50% of the vessel glass (1,126 fragments) and nearly 90% of the window glass (352 fragments) from the site as a whole. Though the assemblage cannot be described as remarkable for the rarity or magnificence of the glass, it is nevertheless an important and useful group on account of its size and its level of preservation and for providing a clear snapshot of glass use at a specific, closely dateable moment in the lifetime of the settlement.

The overwhelming majority of the glass vessels were blown. There were no mould-blown drinking vessels and only three fragments came from non-blown vessels. These were two

1 See Bouet 2011, 23-31 for a summary of previous work.

2 Cottam 2011.

3 Sanchez et al. 2011; Tilhard 2011; Geneviève 2011.

4 Bouet 2011, 202-208.

blue/green ribbed bowls[5] and a small dark green bowl with an out-turned rim. Many of the most diagnostic fragments could be identified as coming from drinking vessels. It became clear during the analysis of the glass that although there was a wide range of different forms of cup and beaker in the well, four types of blown drinking vessel predominated. These can be identified as blue/green undecorated cups with out-turned fire rounded rims (minimum 21 vessels), blue/green yellow/green and pale greenish cups decorated with horizontal wheel-cut lines (minimum 19 vessels), blue/green or pale greenish cups with applied looped trails (minimum 5 vessels) and blue/green cups with indents (minimum 3 vessels). These minimum numbers have been established by the comparison of rim diameters, colour and decoration.

Beakers with fire rounded rims are generally uncommon in the later 1st and early 2nd centuries AD, a period when most drinking vessels have cracked off and ground rims. The beakers of this type in the Barzan well are made of blue/green glass of generally good quality (Pl. 1: fig. a). One of the beakers (Pl. 1: fig. b) has a horizontal abraded line on the upper body, but all the others appear to be undecorated. No complete profile survives, but considerable numbers of applied base rings in similar shades of blue/green glass were also found in the well and it is highly likely that they belong to the same vessels (Pl. 1: fig. c). These bases have pontil marks, suggesting they come from vessels with rims finished whilst the vessel was hot, another reason for associating them with these beakers. Some of these bases preserve part of the lower body, either slightly convex, or with a change of angle and straight side. Given the large quantity of these beakers in the well, it is surprising that few comparable examples have so far been recorded elsewhere in the region. A complete cup that can unfortunately no longer be associated with a burial came from the cemetery of the "Dunes" at Poitiers.[6] Three more examples were found in an inhumation burial at Ronsenac (Charente) in association with ceramics and other artefacts of the late 1st-mid 2nd century AD.[7]

Cups with cracked-off rims and horizontal wheel-cutting were also numerous in the Barzan well. Most have cylindrical bodies and they are made in pale green, greenish or blue/green glass (Pl. 1: figs. d, e). These cups can be immediately identified as one of the more common forms of the later 1st and early 2nd centuries AD and are often recorded in good quality colourless glass.[8] The examples in the well however were rather poorly produced. The glass tends to be thin and sometimes bubbly, the rims were often left uneven without being ground and the decorative wheel-cutting is often untidy.

At least five beakers decorated with looped trails were found in the well (Pl. 1: figs. f, g). Again, no bases could be directly associated with the rim and body fragments, but the only bases in the well of comparable colour and quality were small tubular bases similar to those associated with the wheel-cut cups. Cups and beakers with looped trails are fairly common in the western provinces during the later 1st and early 2nd century AD, most usually in colourless glass and decorated with thick trails.[9] In contrast, the examples from the Barzan well are all pale green or blue/green and are characterised by the thinness of the wall of the vessel and the rather narrow trails.

At least three cups were decorated with indents, and the considerable additional number of indented body fragments indicates that there were probably several more examples (Pl. 1: fig. h). These also have small tubular base rings. Indented cups seem rather rare in this part of France in the later 1st and early 2nd century AD, though there are examples from Niort[10] and Bordeaux.[11] The well deposit produced very few glass drinking vessels that might be considered of good quality. Only a handful of cups from the well were made in un-tinted colourless glass, and they show a distinct contrast in finish

5 Isings 1957, form 3.

6 Simon-Hiernard and Dubreuil 2000, 286, no. 237.

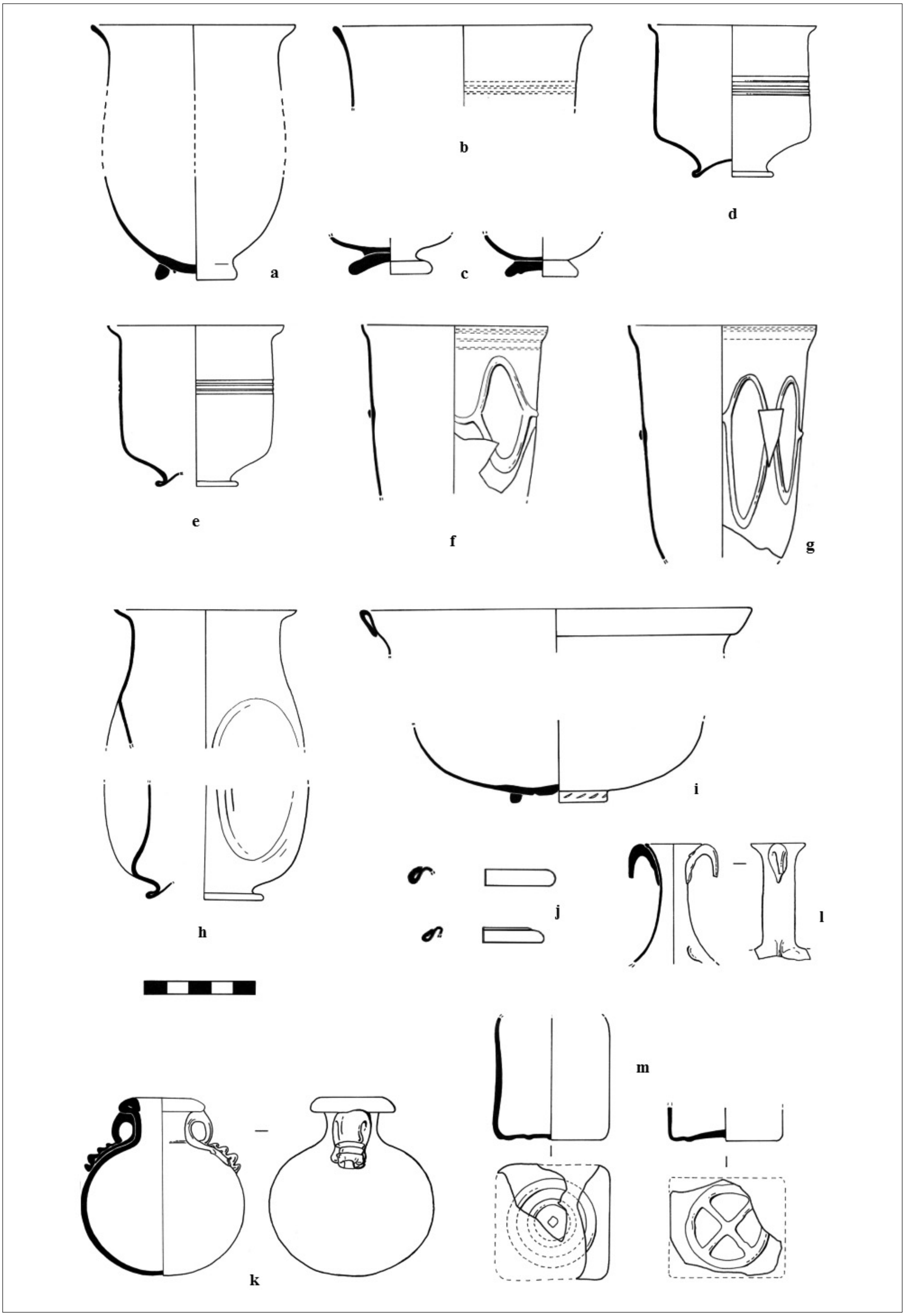
7 Tilhard 2012, 52-53.

8 Price and Cottam 1998, 88-89.

9 Isings 1957 form 33; Lantier 1929, 18 A & B.

10 Mitard 1977, 219, 221, no. 14.

11 Simon 2008, 335, no. 20 fig. 4.



Pl. 1: A Selection of Glass Vessels from an Early 2nd Century AD well, Barzan, France.

with the wheel-cut and trailed cups described above. One is a fragment with facet-cutting and three more are cups of unknown form but with separately blown feet.

There were very few bowls in the well, a minimum of just four. Three of these were bowls with tubular rims (Pl. 1: fig. i) a common and long-lived form of the mid 1st - mid 2nd century AD. Again, substantial parts of these bowls were preserved and they appear to have been broken only shortly before being deposited in the well.

Many forms of container were found in the well. Only five fragments could firmly be identified as coming from a minimum of three jugs of uncertain form. Jars however were very numerous, in particular those with out-turned, often over-hanging rims with a rolled-in edge (Pl. 1: fig. j). At least 11 examples were identified, though none retained much of the body of the vessel, which appears to have been very thin-walled. It seems most likely that these are rims from small jars or pots with convex bodies and flat or slightly concave bases.[12] Some unguentaria have similar rims, but the upper part of these vessels, where it can be determined, appears to be more comparable with the upper body of a jar. These jars are very frequently noted elsewhere in France as complete vessels in burials.[13] The smaller examples are sometimes interpreted as containers for oils or cosmetic or medical preparations. Five examples are already known from Barzan from another well on the site of the later bathhouse.[14]

At least five blue/green globular bath flasks with looped handles were discovered in the well. All were thick-walled, robust vessels. The best preserved is over 50% complete and has unusual pinched trails extending down the body from the handles (Pl. 1: fig. k). This decorative feature has occasionally been noted on other globular bath flasks. An example came from a burial at Saint-Pardoux (Haute-Vienne) in western France.[15] Others are known from the bathhouse at Caerleon in Wales, from a tomb in Bonn and from a deposit dated to around AD 100 at Nijmegen.[16]

There are at least thirteen other flasks and unguent bottles from the well, including a thin-walled two-handled flask that shows traces of a mould-blown body (Pl. 1: fig. l). Very little of the body survives so identification remains uncertain. However, the vessel bears similarities with the upper body of a type of flask with a mould-blown body in the form of a bunch of grapes.[17] These grape-shaped flasks with handles are very well represented in western France in the 2nd century AD. At least six examples in differing sizes are known from funerary contexts in Poitiers, and others are known from Saintes.[18]

There were 118 fragments of blue/green bottles in the well. All the identified fragments came from prismatic bottles. Many sizes of bottle appear to be represented. A few are large, robust bottles, but most of the examples where the full width of the side is preserved are rather small, some only five centimetres wide (Pl. 1: fig. m).

There are several features that make this an intriguing and informative assemblage of glass. The construction and filling of the well have been carefully examined in the context of the surrounding structures and the accompanying material has been analysed and dated. The well is deep (20 metres) and its size has been interpreted as an indicator of a public function. What seems to be clear is that its working lifetime was relatively short, perhaps around 20 years, before being filled in, in about AD 110. At this point a large public bathhouse was built just a couple of metres away. The abandonment and filling of the well has been directly linked to this new construction.[19] It has been suggested

12 Isings 1957, form 68.
13 See for example jars from Harfleur, Sennequier 1994, 14, no. 7 and Gravelotte, Cabert 2003, 166-167, fig.5, structure 69, no. 1.
14 Dubreuil 2003, 337-338, 389, nos. 35-39, fig. 6d-e.
15 Perrier 1983, 141 fig. 10.
16 Allen 1986, 105-106, no. 35 fig. 41; Follmann-Schulz 1988, 34, no. 70 pl. 6; Isings 1980, 319, no. 840, fig. 25 no. 8.
17 Isings 1957, form 91a.
18 Simon-Hiernard and Dubreuil 2000, 363-370; Simon-Hiernard and Dubreuil 2003, 204, fig. 11.
19 Bouet 2011, 188.

that this building probably replaced an earlier bathhouse, not yet located, for which the well formed part of the water supply system. The discovery of building debris characteristic of bathhouses in the well substantiates this theory.[20] The later, larger bathhouse had a different water supply and the well therefore, became redundant.

The glass and other finds provide several clues as to how the well was filled in. Firstly it seems to have been a rapid event, as many of the glass vessels could be reformed from several joining fragments from different levels of the well deposit. The fact that several vessels are substantially preserved also indicates that only a short period elapsed between the vessels going out of use and their arrival in the well. Similar observations have been made concerning the ceramic assemblage.[21] A lack of wear was noted on the terra sigillata, and that again is true for the much of the glass, in particular the drinking vessels. This may suggest that these wares had not been in use for long before being discarded. The deposit therefore, provides us with a rare illustration of a wide range of vessels in contemporary use around the first decade of the 2nd century AD.

The types of glass vessel from the well also provide some insight into the activities taking place in this part of the settlement at this period, with drinking playing a prominent role. A comparison with the ceramics from the well, particularly the terra sigillata, is informative. It has been estimated that around a thousand ceramic vessels were thrown into the well. These include cooking, storage, serving and drinking vessels in course and fine wares, around about a hundred of which were of terra sigillata. The ceramic assemblage was interpreted as the product of several establishments, perhaps an entire block or range of buildings.[22] The terra sigillata comprised a relatively restricted variety of forms, a feature also noted in the analysis of the glass drinking vessels. Most of the glass drinking vessels can be described as being of ordinary or even poor quality and there is hardly any luxury glass. Since two nearby structures have been interpreted as inns, or *hospitia*, it is possible that these vessels were deposited into the well as a consequence of a clearout of those buildings. The standardization of the forms might also indicate they were once the property of that sort of commercial establishment. The presence of a number of globular bath flasks and the large quantity of small jars correspond to the suggestion of an earlier bathhouse in the vicinity. A further possibility is that the drinking vessels relate to leisure activities in this as yet undiscovered bathhouse, which was demolished and cleared in advance of the construction of the huge public bathhouse in the phase immediately following the filling of the well.

Neither the glass nor the accompanying finds from the well have revealed any suggestion of a ritual nature to this deposit. The animal bone, predominantly from cattle, sheep and pigs has been interpreted as corresponding to waste material from consumption.[23]

What is surprising is that the glass was not considered for recycling as both the vessel glass and the window glass from the well might be regarded has having scrap value. There is as yet no evidence of glass making at Barzan itself, but contemporary glass production is known from Saintes.[24] Indeed some of the characteristics of the drinking vessels from Barzan can be compared with the fragments found at the Rue Renaud Rousseau workshop in Saintes, specifically elements of decoration, such as narrow looped trails and the small tubular bases on the drinking vessels. It could be argued that the rather ordinary, even poor quality, of some of the vessels found in the well might point to local or regional production.

This glass assemblage seems to have survived as result of the hurried and seemingly unsystematic disposal of material in the course of the demolition and clearance of buildings in this zone before a major programme of construction, including the new public bathhouse. This deep

20 Bouet 2011, 202.
21 Sanchez *et al.* 2011; Tilhard 2011.
22 Sanchez *et al.* 2011, 400.
23 Rodet-Belarhi *et al.* 2011, 806.
24 Hochuli-Gysel 1993, 86-87; Hochuli-Gysel 2003, 184-185.

well, now no longer needed as a water source as the town around it became larger and grander, took on a new role as a rubbish dump. Perhaps, even in the course of just one day, it became a convenient place to throw an inconvenient collection of rubbish that no one had the time or inclination to deal with more systematically. Thankfully, that random action has left us with a modest, but extremely informative group of glass.

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LIERKE Rosemarie

MANUFACTURING MARKS AND THE PERSUASIVE POWER OF REPLICAS

Archaeologists and glass technologists are usually fascinated alike by the beauty and the assumed superior craftsmanship of certain ancient glasses. All means were employed to reproduce these glasses until a convincing resemblance of replicas and originals was achieved. However, even a striking resemblance may cheat. To search for the secrets of an ancient manufacturing technique, we need to unravel genuine manufacturing marks.

Ribbed bowls

Ribbed bowls combine beauty with sturdiness. They were everyday vessels and mass produced for almost two centuries (Fig. 1).[1] The first replicas were made with moulds,[2] by sagging a ribbed disk prepared with a metal template,[3] or by sagging a ribbed disk made with a grooved stamp of ceramics.[4] Some beautiful bowls were produced, but in reality, no two ribbed bowls are exactly alike. Some irregularities always rule out the use of moulds, templates or stamps.[5]

Without attempting a replica production, two female archaeologists examined the manufacturing marks of ribbed bowls. After investigating a huge number of fragments from Israel, Gladys Weinberg concluded in 1973 that the ribs were made by "furrowing a soft surface." In her words the bowls were "tool-ribbed".[6] Looking at a ribbed bowl with typically curved ribs, Thea E. Haevernick wrote in 1975: "there must have been a turning motion involved during production".[7]

The observations of Weinberg and Haevernick, and experiments concerning reticella

1 Bakker 1989.

2 Schuler 1959 Lost wax method; on replicas: Lierke *et al.*1999, 51.

3 Cummings 1980, 26.

4 Gudenrath 1991, 222.

5 This applies also to assumed "pillar moulded" bowls. An irregular template (Cummings) is not convincing.

6 Weinberg 1973, 37. The more regular bowls she still called "pillar moulded".

7 Haevernick 1975 (English translation R.L.).

bowls, led to the suggestion that a turning wheel was used for glass forming, including the making of ribbed bowls.[8] This was investigated and published in several contexts.[9] In short, the proposed method consisted of slumping (or sagging) a cake of hot glass over an inverted bowl-shaped mould placed on a turning wheel. The rim of the resulting glass bowl is flattened and the surface is furrowed with a suitable tool. This tool may be edgy or round, straight or wedge-shaped to comply with the different shapes and crosscuts of the furrows between the ribs of the original examples.

To test the feasibility of this theory, improvised experiments were executed in several places, the first with Marianne Stern in the glass studio of the Toledo Museum of Art. The experimental bowls which were made with a straight edgy tool (Fig. 2) feature protruding wedge shaped ribs which are slightly curved, depending on the speed and direction of turning, while the ribs have – more or less pronounced – one steep and one slanting side, just like the originals.[10] The tops of the experimental ribs are rounded, like most original ribs. The rib tops are wholly or partly cut off, only if the rim is ground. The rim was not ground if it was even and smooth after tooling. Without grinding, a ribbed bowl was made in less than two minutes. Grinding the rim would require about 10 more minutes. This explains the possibility of mass production. On "grinding" the interior, see below.

Mark Taylor and David Hill, the "Roman Glassmakers", manufacture beautiful tool-ribbed bowls, making a great effort to adapt the process, equipment and material to the assumed ancient conditions.[11] They start with a glass disk - not a cake - and pinch the ribs around the disk with occasional reheating. The ribs are normally thin and straight, but sometimes they slant. The sides are steep and parallel. The rim and the interior of all the bowls need grinding and therefore, this method is less suited to mass production. However, some ancient bowls correspond to this manufacturing method.

Fig. 1: Fragments of at least 100 ribbed bowls found in Augsburg, Jesuitengasse 14. Römisches Museum Augsburg.

Mosaic bowls with thick wedge-shaped ribs usually show a rather chaotic pattern, which indicates the initial use of a glass cake molten from randomly added mosaic bits (Fig. 3). Other ribbed mosaic bowls show neatly arranged pieces of glass, stripes or trails.[12] They have thin, parallel sided ribs which are usually straight or slanted, and their furrows are not horizontally stretched as in the first type (Fig. 4). These mosaic bowls must have been made by pinching the ribs from a flat disk as proposed by the "Roman Glassmakers".

The ancient manufacturing marks thus indicate at least two related methods to make tool-ribbed bowls in a turning motion: a fast furrowing, suitable for mass production; and a more elaborate method, which resulted in special pieces. A foot-ring could be applied to both varieties, but a distinctly flared rim was easier

8 Lierke 1991.

9 Lierke 1993; Stern and Schlick-Nolte 1994, 76, fig. 137; Lierke *et al.* 1999, 51-55; Lierke 2009, 52-56; and others.

10 For manufacturing marks see Lierke 1991 or 1993.

11 www.romanglassmakers.co.uk/ribbed.htm.

12 A mosaic ribbed bowl with trails and thin ribs: Lazar 2004, 19, fig. 6, cat. no. 10.

Fig. 2: Experimental ribbed bowls ca. 1993. R. Lierke.

Fig. 3: Mosaic ribbed bowl from the Wolf Collection, no. 36. Württembergisches Landesmuseum Stuttgart.

Fig. 4: Mosaic ribbed bowl VAM 969-1868. copyright Victoria & Albert Museum, London.

Fig. 5: Fragmentary bucket of Termantia, Madrid Museo Arqueológico Nacional. Photograph RGZM T65/1625.

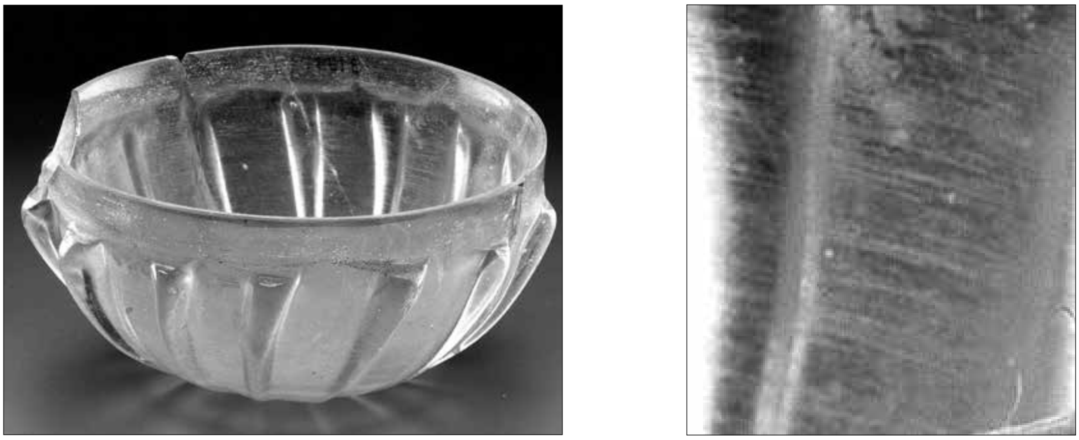

Fig. 6: Ribbed bowl gr. 73 (1160), Narodni muzej Slovenije, Ljubljana with distinct rotary scratches.

to make with an exactly round disk rather than with a slumped cake.

Cameo glass

Cameo glass will be addressed only briefly, since there are recent publications on this topic triggered by the new cameo glass catalogue of the British Museum.[13] The lasting influence of the 19th/20th century Portland Vase replicas,[14] as reflected by this catalogue, provided the initial impetus for this paper. The Portland replicas unfortunately convinced almost everybody – including the author – that cameo glass was cut from a blown overlay blank, but eventually this was proven to be an error, which caused an overestimation of the Roman art of glass cutting and engraving, resulting in the need for rectification.

John Northwood junior wrote about his father and the first attempt in 1873 to reproduce the Portland Vase.[15] He did not hide his strong doubts regarding the possibility of cutting and engraving an overlay blank in Roman times. However, he also described the means John Northwood senior successfully employed to achieve his goal. The initial and final application of hydrofluoric acid, undertaken to etch out the outer shape of the figures and polish the surface, was decisive. However, hydrofluoric acid was not available in Roman times and no other material could have been used for the same purpose.[16] More significantly, a blown cutting blank for large cameo glass vessels was not yet possible. Glassblowing was in its infancy[17] when the early cameo vessels were produced. Blown vessels were still small and simple.[18] A dipped overlay could not be created since crucibles large enough and furnaces hot enough were as yet unknown; as was the case with the required metal blowpipe and use of a pontil rod.[19]

Therefore, only an investigation of the manufacturing marks can solve the question of how cameo glass was made. The BM catalogue states: "Both the blue and opaque white glass of which the Portland Vase and the Auldjo Jug were made contain myriad bubbles."[20] This is true for other cameo glass as well. The bubbles are just one of several indications not previously taken into account. No glass cutter or engraver today would accept a cutting blank full of bubbles. After cutting or engraving, the glass surface would look like worm-eaten wood.[21] However, all well-preserved cameo glass has a perfectly smooth and generally almost bubble free surface. The figural features are softly rounded. The typical cutting flaws seen in much simpler figural intaglio engraving, which appeared about a century after the high relief cameo glass vessels, are absent. There are numerous additional indications that early cameo glass vessels were not cut at all. They seem to have been made instead in a hot process related to enamelling and to the manufacturing of relief-decorated pottery - a method proposed many years ago.[22] More open discussions about this topic would be desirable.

Diatreta glass

For many years, the manufacturing method of the miraculous diatreta or cage cups of Late Antiquity was a matter of debate. Still in the first half of the last century, the famous glass

13 Catalogue: Roberts *et al.* 2010; comments: Lierke 2011a and Lierke 2011b; Weiss 2012.

14 Rakow and Rakow 1982.

15 Northwood 1924.

16 Fluoric acid has been known only since the 18th century. www.fluoride-history.de/deutsch/fluor.htm. John Northwood sen. was a pioneer in its application for relief glass before he became involved with the Portland reproduction.

17 Israeli 1991, 46-55.

18 S. Fünfschilling 'Zur Frage der augusteischen geblasenen Gläser', in *Die römischen Gläser aus Augst und Kaiseraugst: Funde von 1981 bis 2010*, forthcoming.

19 For an excellent summary of the technological preconditions see: Weiss 2012.

20 Gudenrath 2010, 29.

21 Illustrated by the missing surface (here weathered) of an inserted fragment of the Dionysos-figure in Harden *et al.* 1987, no. 32, 71.

22 Lierke 1996 and 1997; Weiss, Mommsen, Simon, Lierke 1999, 67- 96; Lierke 2009, 61-72; Lierke 2011b with more literature.

engraver and teacher W. von Eiff considered it impossible that they could have been cut from a thick-walled blank. Yet the archaeologist Fritz Fremersdorf published a drawing, reflecting his opinion on how they were cut: from a thick-walled blank.[23] His drawing became the blue print for experiments by several artists.[24] They successfully used stress-free glass and modern tools. Their replicas are often more perfect than the originals and they even convinced sceptics. Again, we need to look closely at the manufacturing marks of Roman cage cups. Several cups feature thick round struts among thin, roughly square-cut struts.[25] Flattened bubbles are unknown in thick-walled glass, yet they can be seen within the inner beaker of several cage cups, while the expected cut-open bubbles are missing.[26] In existence are cage cups without any grinding marks on the inner beaker, except near the bases of the struts connecting the beaker with the cage. Likewise, the interior of the cage usually shows no trace of grinding although there are similar exceptions.[27] Several investigations strengthened my doubts concerning the theory of cutting a thick-walled blank. The use of a double-shell pressed blank, first proposed in 1995, saves material and agrees with the manufacturing marks.[28]

In a recent investigation, four roughly chronological groups of diatreta glass has been distinguished, based on the increased use of abrasive treatment.[29] Cutting a cage cup from a thick-walled blank would be the last step in such a sequence – indicating progress towards a more reliable stress-free cooling of the cutting blanks. T.E. Haevernick assumed that the fragmentary bucket from Termantia (Fig. 5) and the Situla of San Marco were cut from thick-walled blanks: “Here indeed one holds something in one’s hand which is suitable to be worked on. It is very different from the well-known Roman diatreta.”[30] Haevernick agreed with dating these vessels to Byzantine times. This dating may also apply to the fragments of a cage cup from Grenoble that broke during production.[31] The fragments were found on a mound above the Late Antique habitation layer.[32] Kappes (note 31) points out that the colourless inner beaker and the blue outer shell were fused together at the rim of the cage. A cage with a comparable solid upper rim is seen on the Termantia bucket and at the bottom of the Situla. It appears these objects were cut from a thick-walled blank. They are truly “very different from the well-known Roman diatreta”. Their production involved a great risk due to the critical cooling of a thick-walled blank. Most likely, stress from insufficient stress-free cooling or from the incompatibility of the clear and blue glass caused the Grenoble cage cup to break during manufacture. The fragments from Grenoble, the fragmentary cage cup from Termantia and the Situla of San Marco[33] seem to represent a revival of Roman cage cups from Byzantine times. Perhaps, the secret of the less risky Roman manufacturing technique had been lost.

One common manufacturing mark of ribbed bowls, cameo glass and cage cups

One salient manufacturing mark is in fact characteristic for the majority of ancient preblown glass vessels. It can appear on the inside,

23 Fremersdorf 1930. His main witness for the grinding theory was the Situla from San Marco (note 33).

24 Best known: Schäfer 1967; Scott 1991, and especially Welzel 1978.

25 Röder 1962/63; Gerick 2010, 133; Lierke 2013, 95; for the cage cup in Cologne see Wikipedia ‘Diatret’.

26 Gerick 2010, 121; Lierke 2009, 80; Lierke 2013, 95-97, pl. 21, 22a-c. Surface pitting in some examples should not be mistaken for cut-open bubbles.

27 No marks on beaker: Kisa 1908 II 621/2; Gerick 2010, 131/2 (only around struts); Budapest Fishdiatret, personal observation. No marks on the interior of the net: Lierke 2013, 95, Pl. 17e; Gerick 2010,133 (for 5 out of 6 examples); Weinberg and Stern 2009, Color ill. 18, fragment d, view 2.

28 Lierke 1995a; Lierke 1995b; R. Lierke, C. Steckner, B. Rütti in Lierke *et al.* 1999, 110-137; Lierke 2009, 79-86.

29 Lierke 2013, 89-102.

30 Haevernick 1971 (English translation R. L.).

31 Kappes 2011.

32 Colardelle 2008.

33 Volbach 1971, 10-11, no. 13, pl. X.

on the outside or on both: sharply engraved, not exactly parallel, horizontal rotary scratches with a beginning and an end, embedded in a smooth or even shiny surface. The scratches can be found on the inside of ribbed bowls (Fig. 6), on the inside of cameo glass – including small narrow necked bottles (!) – and less pronounced, on the inside of the late antique cage cups.[34] It has been investigated and previously explained that these scratches are not grinding marks.[35] Suffice to say that true grinding marks look different, as is occasionally visible on one vessel: for instance, on ribbed bowls with internal scratches and a ground rim. Vessels with distinctive rotary scratches – as on our examples – were not blown. Rather, the scratches were caused by the ancient mould or tool used in various manufacturing methods of hot glass, such as sagging, tooling or pressing on a turning wheel. These methods enabled the ancient artists to produce glass equivalents of highly treasured ancient vessels made in other materials, or even to create objects not comparable to anything else.

34 Ribbed bowl: Lazar 2004, 52, no. 14. Cameo example: Lierke *et al.* 1999, fig. 170; diatret dito fig. 290.

35 Lindig M.R. 'Untersuchungen der umlaufenden Spuren auf antikem Glas'. In Lierke *et al.* 1999, 15/16. In no period of history were glass vessels produced by 'turning on a lathe' (as has been concluded from the rotary marks), not even today.

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MANUFACTURERS' MARKS ON THE UNGUENT BOTTLES FROM THE ROMAN PROVINCE OF DALMATIA

A great amount of glass finds from the period of the Early Principate were found in the region of the Roman province of Dalmatia, particularly in cities and settlements along the coast. These products testify to the developed trade connections between the eastern Adriatic coast and other parts of the Empire. Intensive trade with glass products of Italic and Eastern Mediterranean provenance developed from the mid-1st century onwards, indicating that this region was an intersection of western and eastern influences. Alongside products of Italic workshops in the second half of the 2nd century, glassware from other glassmaking centers also appeared, primarily from the workshops in the Rhine region. In addition to imports, local glass production was confirmed in the province of Dalmatia. More than four hundred glass vessels marked with a workshop stamp were recorded among the numerous finds. Some of that material was published in a recent monograph *Roman Glass in Croatia – relief workshop stamps.*[1] A group of workshop stamps identified on unguent bottles with conically flattened bodies will be discussed in this paper. Their presence in the Roman province of Dalmatia provides an important source of information about the provenance and distribution of glass products of the western workshop circle. Their presence also reinforces previous insights into the intensive trade connections of the eastern Adriatic coast with other regions of the western provinces. This refers not only to imports of glass packages, but also to the distribution of precious liquid substances: from various cosmetic products to consumer goods. Although previous theoretic notions can serve as an introduction to these issues, some of the proposed theses may be modified due to new results based on modern archaeological research. In the province of Dalmatia, unguent bottles with workshop stamps were primarily recorded in the cities of Liburnia, Iader, Aenona, Asseria, Argyruntum and Senia (Fig. 1).

QOAA

The presence of unguent bottles of Italic provenance is best illustrated by the finds of

1 Fadić and Štefanac 2012.

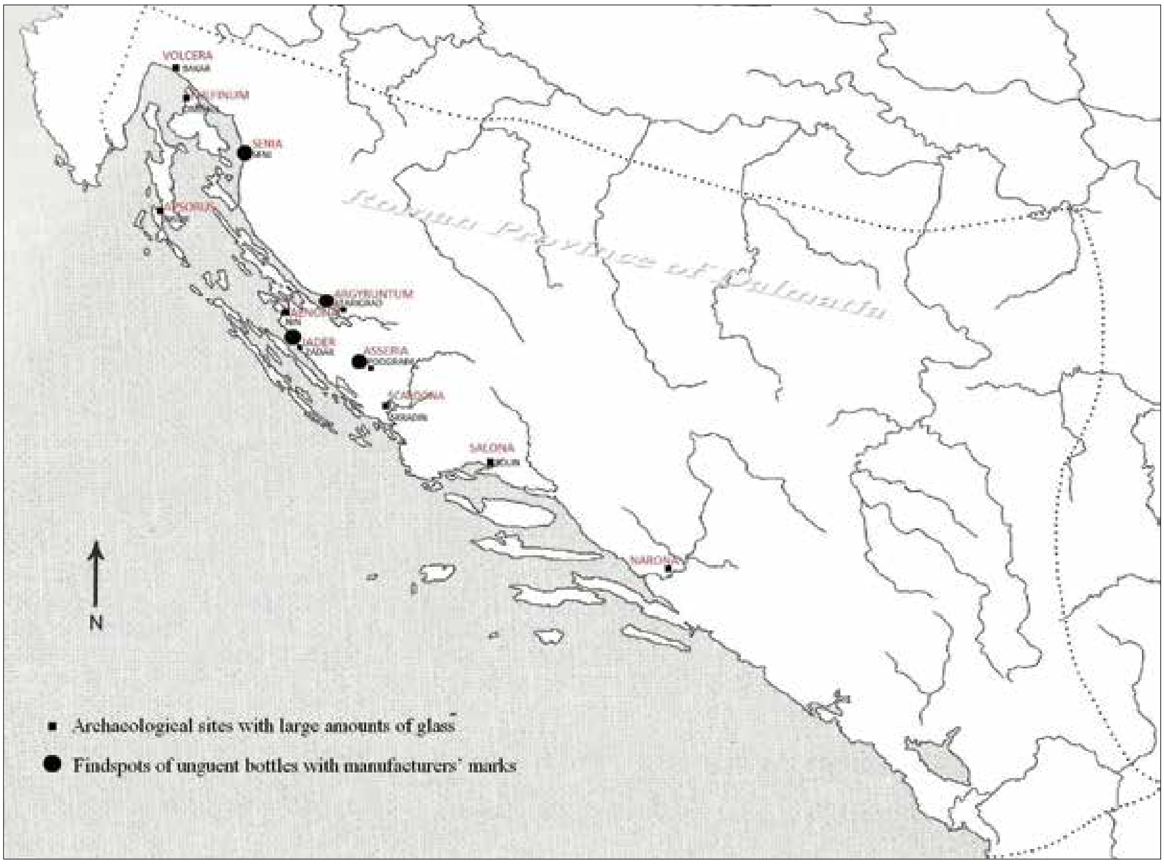


Fig. 1: Map of the Roman province of Dalmatia with the findings of glass unguent bottles with workshop stamps.

small bottles with workshop stamps. A stamp consisting of four circularly arranged letters QOAA is confirmed on six examples from the wider Zadar region (Cat. no. 1-6, Pl. 1). Although information about the exact location of discovery was not recorded, these finds definitely come from one of the ancient necropoles of Zadar, Nin, Asseria or Starigrad. The stamp was confirmed on a near-homogenous group of small bottles with conically flattened bodies and exceptionally long cylindrical necks (*Isings* 82 B2; D.T. 45). Their height varies from 12 to 14 cm and their capacity ranges from 40 to 60 ml. Small bottles with identical morphological characteristics were found at a great number of European sites.[2] They were used over a long period of time, from the end of the 1st to the mid-3rd century. The largest concentration of finds was recorded in the region of northern Italy, present-day Slovenia and Hungary. Most analogous finds were dated to the mid-2nd century.[3]

Small bottles with the stamp QOAA were also found in Italy, in addition to the province of Dalmatia.[4] Although the context is missing for the examples presented here, on the basis of a discovery in Aquileia, it is possible to date these examples to the 2nd century.

An interpretation of the QOAA stamp is not possible on the basis of present knowledge although the letters QOA may indicate *tria nomina*, i.e. the initials of the producer. It is possible that the last letter A marks the workshop center, in this case the city of Aquileia. Numerous finds of identical small bottles without the mark on

2 De Tommaso 1990, 68, form 45; Biaggio Simona 1991, 011.1.035; Ravagnan 1994, 102, no. 193.

3 Buora 2004, 28, 167-168, 170-171, no. 379-382, 388-392; Larese 2004, 83, pl. LXXXIII, 486; Mandruzzato and Marcante 2007, 20; Lazar 2003, 185, form 8.6.7; Barkóczi 1988, no. 208, 211, 213.

4 Mandruzzato and Marcante 2007, 52, 231.

the base show that Aquileia may have been the center of production.

QOP/AL.F

Stamps from large bottles with conically-flattened bodies (*Isings* 82A2) are important for a more precise determination of the distribution directions of glass products from northern Italy. A rare workshop stamp with initials QOP/AL.F was impressed (Fadić – Štefanac 2012, no. 284-286) on the examples from Zadar (Cat. no. 7, Pl. II, 7), Starigrad (Cat. no. 8, Pl. 2, 8) and Senj (Cat. no. 9, Pl. 2, 9) where letters are distributed in two rows. The upper row consists of the letters QOP while the letters ALF are below. The long hasta of the letter Q extends under the letters O and P. A distinction shaped as a little relief triangle is located between the letters L and F.

Glass products marked with the stamp QOP/AL.F have not been subjected to scientific analyses and discussions, because these initial marks were only recently introduced to the public. In 2007, the authors L. Mandruzzato and A. Marcante presented two unguent bottles from Aquileia in the monograph *Vetri Antichi del Museo Archeologico Nazionale di Aquileia*. However, a poor imprint at the base prevented the complete interpretation of the inscription. On the published examples, the last letter in the second row (letter F) is illegible.[5] In this context, it is important to take note of the example from Slovenj Gradec (*Colatio*) in Slovenia.[6] The stamp on this bottle has been interpreted as AT.F/OE; however, if the initials are observed in a mirror, a part of the mark QOP/AL.F is recognizable (only the long hasta is visible with regard to the letter Q). The form and dimensions of the vessel testify to the fact that this stamp is from the same producer as they fully correspond to the bottles from Zadar, Starigrad and Senj. When referring to rare analogies, it is important not to omit the example from Montebelluno (A. Maria in Colle) near Vicenza, which has been dated to the second half of the 1st century.[7] At the base of this bottle is a stamp that is only barely legible, but the letters Q and O are recognizable in the first row and the letter A in the second, indicating the possibility that these may be the initials of the same producer. A direct autopsy of the example may confirm some of the aforementioned hypotheses.

On the basis of these comparisons, it is evident that bottles marked with the initials QOP/AL.F were made in the workshops of northern Italy. Finds from Aquileia date this group to the second half of the 1st century.[8] On the other hand, examples from Zadar, Starigrad and Senj correspond to a somewhat later chronological range. The dating of our examples was performed on the basis of an example from Zadar found in a cremation grave from the first half of the 2nd century.

At present, research indicates a limited area of trading with regard to the aforementioned workshop, which supplied the markets of the Po Valley, a part of Slovenia and the eastern coast of the Adriatic. Vessels with various capacities that are marked with the stamp QOP/AL.F from Aquileia confirm the hypothesis that different kinds of content were traded.

Although on the basis of present knowledge the actual meaning of the stamp cannot be categorically ascertained, certain considerations should be noted. The first row of the letters QOP indicates *tria nomina*, i.e. the initials of the producer of the contents or the owner of the glass-making workshop Q(….) O(….) P(….). On the other hand, the first two letters AL in the second row designate the glassmaker with the last letter F, meaning FECIT. A similar situation was recorded with another workshop stamp analyzed in the following section.

Q.O.P.C.F.

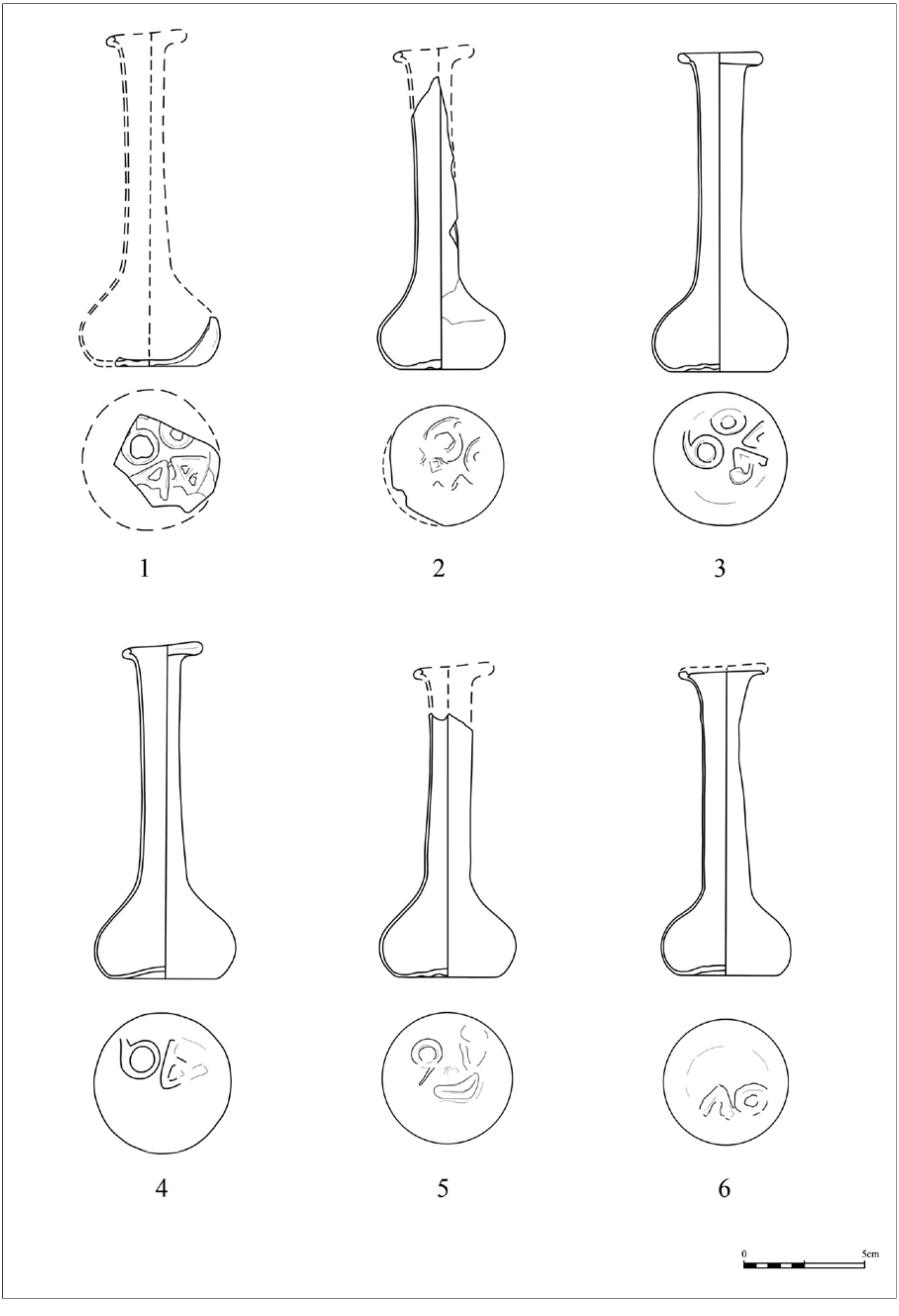
The workshop stamp Q.O.P.C.F. was confirmed on a large bottle with a conically flattened body of the form Isings 82 A2. The preserved documentation shows the example was found in the Benkovac region, but more precise circumstances surrounding the discovery are unknown (Cat. no. 10, Pl. 2, 10). The find was probably brought to the Regional Museum in

5 Mandruzzato and Marcante 2007, 51.

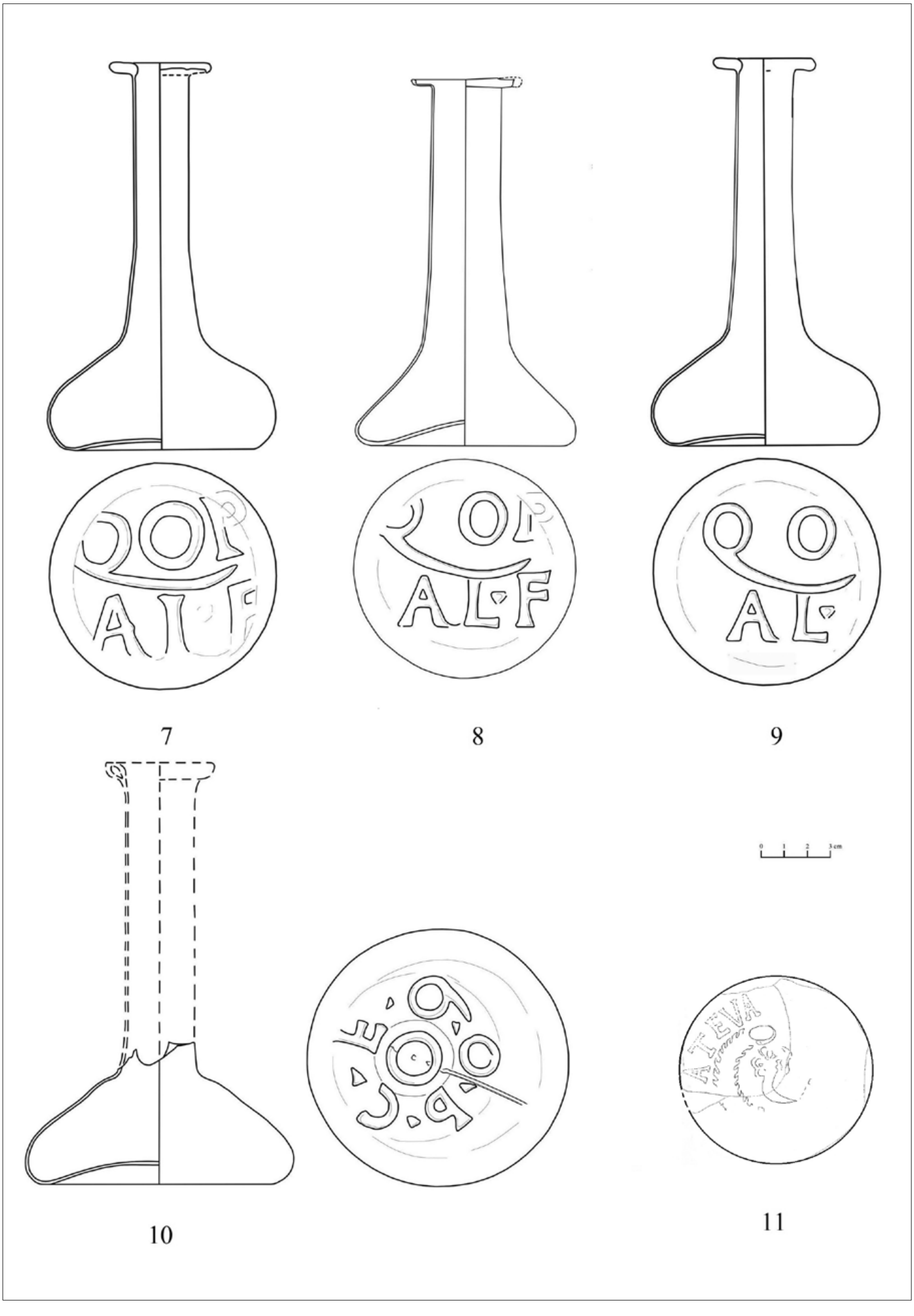
6 Strmčnik-Gulič 1981, 348-389, pl. 18:8.

7 Casagrande and Ceselin 2003, 112, no. 105.

8 Mandruzzato and Marcante 2007, 51.



Pl. 1: Unguent bottles with QOAA stamp from the broader Zadar region.



Pl. 2: Unguent bottles with QOP/AL.F, Q.O.P.C.F and PATEVAN stamps from Zadar (no. 7, 11), Starigrad (no. 8), Senj (no. 9) and Podgrađe (no. 10).

Benkovac from the necropolis in Asseria (a village of Podgrađe, 5 km east of the city of Benkovac). A relief stamp of the producer impressed as a mirror image at the base of the bottle is particularly interesting. The stamp consists of a circle in the middle and the letters Q.O.P.C.F encircling it. Letters are divided by small relief triangles, while between the letters O and P, a thin relief line ending with a small dot in the middle alongside a triangle can be identified.

Workshop stamp Q.O.P.C.F has not been the subject of scientific studies. Although glass products marked with this stamp do not appear in other papers, there is an example from Aquileia published with a mark OCP.[9] A matrix primarily used for marking large bottles with wide bases was probably used for marking the example from Aquileia. An example with a similar manner of impression was recorded on the Aquileian unguent bottles with the stamp QOP/AL.F.[10]

The meaning of the workshop stamp Q.O.P.C.F can be related to the marks QOP/AL.F. In the letters Q.O.P, *tria nomina* can be identified, i.e. the initials of the producer of the contents or of the owner of the glass workshop. The appearance of the letters confirms that stamps with the initials QOP/AL.F and Q.O.P.C.F can be observed in the same context. The question is: what is the exact meaning of the letter C located between the initials Q.O.P and F? It is possible that the letter before the letter F (fecit?) indicates the initial of the glassmaker, as on the stamp QOP/AL.F.

Finds with the stamp Q.O.P.C.F indicate that the trading area of the workshop was limited. Judging from the current state of research, examples with marks Q.O.P.C.F confirm the distribution of glass products from northern Italy to the eastern Adriatic coast in the first half of the 2nd century.

Patevan

Finally, it is worth noting an unpublished recent find of a large unguent bottle with a conically flattened body from Zadar (Cat. no. 11, Pl. 2, 11). It was found at the ancient necropolis in a grave from the second half of the 2nd century. At the base of the specimen is a stamp with the partially preserved inscription PATEVAN and a blurred central depiction framed with a wreath in the middle.

The workshop stamp PATEVAN belongs to a group of rare marks. Unguent bottles with this mark were only confirmed in France, alongside our example. An exact interpretation of the stamp has not been offered so far, but it is probably an abbreviation for PAT(rimoni) E(x) V(ectigal) AN(tonini).[11]

Catalog

Cat. no. 1 (Pl. 1, 1)
Unknown location of find (wider Zadar region)
Zadar, Museum of Ancient Glass, inv. no. A 13146. Small bottle with rounded conical body and a long neck, bluish-green glass (W = 5.4 cm). QOAA
Unpublished (drawing J.B.).

Cat. no. 2 (Pl. 1, 2)
Unknown location of find (wider Zadar region)
Zadar, Museum of Ancient Glass, inv. no. A 12823. Small bottle with rounded conical body and a long neck, bluish-green glass (H =12.1 cm; W = 5.4 cm). QOA[A]
Unpublished (drawing J.B.).

Cat. no. 3 (Pl. 1, 3)
Unknown location of find (wider Zadar region)
Zadar, Museum of Ancient Glass, inv. no. A 12635. Small bottle with rounded conical body and a long neck, bluish-green glass (H = 13.3 cm; W = 5.7 cm). QOAA
Unpublished (drawing J.B.).

Cat. no. 4 (Pl. 1, 4)
Unknown location of find (wider Zadar region)
Zadar, Museum of Ancient Glass, inv. no. A 12633. Small bottle with rounded conical body and a long neck, bluish-green glass (H = 13.8 cm; W = 5.9 cm). Q[OA]A
Unpublished (drawing J.B.).

9 Mandruzzato and Marcante 2007, 94, no. 233.
10 Mandruzzato and Marcante 2007, 51, fig. 1.
11 Foy and Nenna 2006, 141, F-UNG.026.

Cat. no. 5 (Pl. 1, 5)
Unknown location of find (wider Zadar region)
Zadar, Museum of Ancient Glass, inv. no. A 9976. Small bottle with rounded conical body and a long neck, bluish-green glass (H = 11.0 cm; W = 5.7 cm). Q[OAA]
Unpublished (drawing J.B.).

Cat. no. 6 (Pl. 1, 6)
Unknown location of find (Starigrad?)
Zadar, Museum of Ancient Glass, inv. no. A 4011. Small bottle with rounded conical body and a long neck, bluish-green glass (H = 12.5 cm; W = 5.4 cm). [Q]OA[A]
Unpublished (drawing J.B.).

Cat. no. 7 (Pl. 2, 7)
Zadar (*Iader*), ancient necropolis, archaeological excavations 2005, grave 34, first half of the 2nd century. Zadar, Museum of Ancient Glass, inv. no. A 9045. Bottle with rounded conical body and a long neck, bluish-green glass (H = 16.4 cm; W = 9.7 cm). QOP/AL.F
Fadić and Štefanac 2012, 136, no. 284, (drawing J.B.).

Cat. no. 8 (Pl. 2, 8)
Starigrad (*Argyruntum*)
Zadar, Museum of Ancient Glass, inv. no. A 4735. Bottle with conical body and a long neck, bluish-green glass (H = 14.5 cm; W = 9.2 cm) QOP/AL. F
Fadić and Štefanac 2012, 136, no. 285, (drawing J.B.).

Cat. no. 9 (Pl. 2, 9)
Senj (*Senia*)
Zagreb, Archaeological Museum in Zagreb, inv. no. R/8273. Bottle with rounded conical body and a long neck, bluish-green glass (H = 16.0 cm; W = 9.3 cm). QO[P] / AL.[F]
Fadić and Štefanac 2012, 136, no. 286, (drawing B.Š.).

Cat. no. 10 (Pl. 2, 10)
Podgrađe near Benkovac (*Asseria*)?
Benkovac, Heritage Museum in Benkovac, inv. br. ZMB-A-2521. Bottle with conical body and a long neck, bluish-green glass (preserved H = 6.1 cm; W = 11.5 cm). Q.O.P.C.F (circle or letter O at the center)
Fadić and Štefanac 2012, 136, no. 287, (drawing J.B.).

Cat. no. 11 (Pl. 2, 11)
Zadar (*Iader*), ancient necropolis, archaeological excavations 2007, grave 489, second half of the 2nd century.
Zadar, Museum of Ancient Glass, inv. no. A 9045. Bottle with conical body and a long neck, bluish-green glass (H = 18.5 cm; W = 8.7 cm)
[P]ATEVA[N] (wreath, indistinct depiction at the center)
Unpublished (drawing B.Š.).

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BULJEVIĆ Zrinka

THE SMALL GLASS BOAT FROM SALONA

A small glass boat (Fig. 2.1) was found among other items in stone urn 73 (Fig. 2.2) in grave 348 in Salona's Western Necropolis, Sector III, west of the city walls in the Houston test trench (Fig. 1).[1] This find is held in the Archaeological Museum in Split together with the remaining items from the Western Necropolis.[2] The boat is made of semi-transparent green glass, which has been moulded, cut, sanded and polished with smooth walls to form an oblong oval hull. The tip of the bowsprit is heart-shaped while the stern curves high above the keel (lng. 15.43 cm, wid. 4.96 cm, ht. of stern 4 cm).

The comprehensive grave unit presented at the conference held in Piran is published in the *Vjesnik za arheologiju i povijest dalmatinsku* 106, the bilingual annual journal of the Archaeological Museum in Split.[3]

Six similar finds were made in Italy: two (a semi-transparent green and a lost green example[4]) from Pompeii;[5] an opaque white example from Palombara Sabina,[6] an azure example from Aquileia,[7] a semi-transparent dark

1 The items were conserved by Ivana-Zrinka Bajić-Franković and sketched by Branko Penđer. The layout, based on superimposition of the field sketches by S. Žitnik (sheets 511 and 512, sketches 453 and 454) and drawn finds, was arranged by Zoran Podrug. The original sketches were made on 25 and 26 June 1987, at a scale of 1:10.

2 Maja Bonačić-Mandinić recalled that prior to washing the items from the urn, the tokens and dice were in the boat. The boat, dice, tokens, bone comb and bone pin head were displayed in the exhibition *Salona – From Underground to the Museum*, which was set up by the Archaeological Museum in Split in the gallery of the Zvonimir Culture Hall in Solin in September 1992. The exhibition was designed and arranged by Jagoda Mardešić.

3 Buljević 2013.

4 Haberey and Röder 1961, 135, c; Göttlicher 1978, 12, 84, no. 503.

5 Haberey and Röder 1961, 134, fig. 4.6; Göttlicher 1978, 12, 84, no. 501, pl. 40; Harden *et al.* 1987; *http://www.britishmuseum.org/research/search_the_collection_database/search_object_details.aspx?objectid=466289.*

6 Bordenache Battaglia 1983, 25-30.

7 Haberey and Röder 1961, 135, b, fig. 4.5; Painter 1968.

Fig. 1: Incineration grave 348 in Salona's Western Necropolis.

violet boat from S. Elena di Melma (Silea)[8] and one held in the Gorga Collection.[9] There is also a blue example from Germany: St. Aldegund (Landkreis Cochem-Zell) near Koblenz,[10] which is a realistic model of the rapid Roman vessel called the *celox*,[11] a merchant craft.[12]

All moulded glass models of Roman boats are similar as some may have been the product of the same mould (Santa Elena di Melma and Pompeii). After having been casted using a mould, they were then cut, sanded and polished and appear to have been made of coloured glass following assessment of the previously cited discoveries from Italy – including the lost example from Pompeii[13]- and St. Aldegund. The shortest is from Palombara Sabina, 11 cm, while the longest is from Pompeii, 22.4 cm. Only the Aquileia and the Salona boats lack the small applied feet. The small boat in the Gorga Collection is emerald green, translucent and shows one foot.[14] It should be noted that we have no knowledge of the lost Pompeii boat. They all have a raised stern and besides the Aquileia boat, a bow; it should be noted that the bow on the boat from S. Elena di Melma is damaged.

The contexts of the finds are known for some of the boats. The boat in Palombara Sabina was found in a marble urn of a twelve year-old girl named Laetilia Gemella. The model from Salona was found in a glass urn together with playing dice and counters; other finds suggest a grave

8 Calvi 1974-1975; Casagrande and Ceselin 2003; Larese 2004; Barovier Mentasti and Tirelli 2010, 52-53.

9 Bacchelli 1999; Larese 2004.

10 Haberey and Röder 1961, 132-136, fig. 2.1, pl. 31 and 32; Göttlicher 1978, 12, 84, no. 502, pl. 40.

11 Calvi 1974-1975, 482-484; Larese 2004.

12 Harden et al. 1987.

13 *http://www.britishmuseum.org/explore/highlights/highlight_objects/gr/c/cobalt-blue_glass_model_boat.aspx.*

14 Saguí 1996, 14, fig. 9a, b.

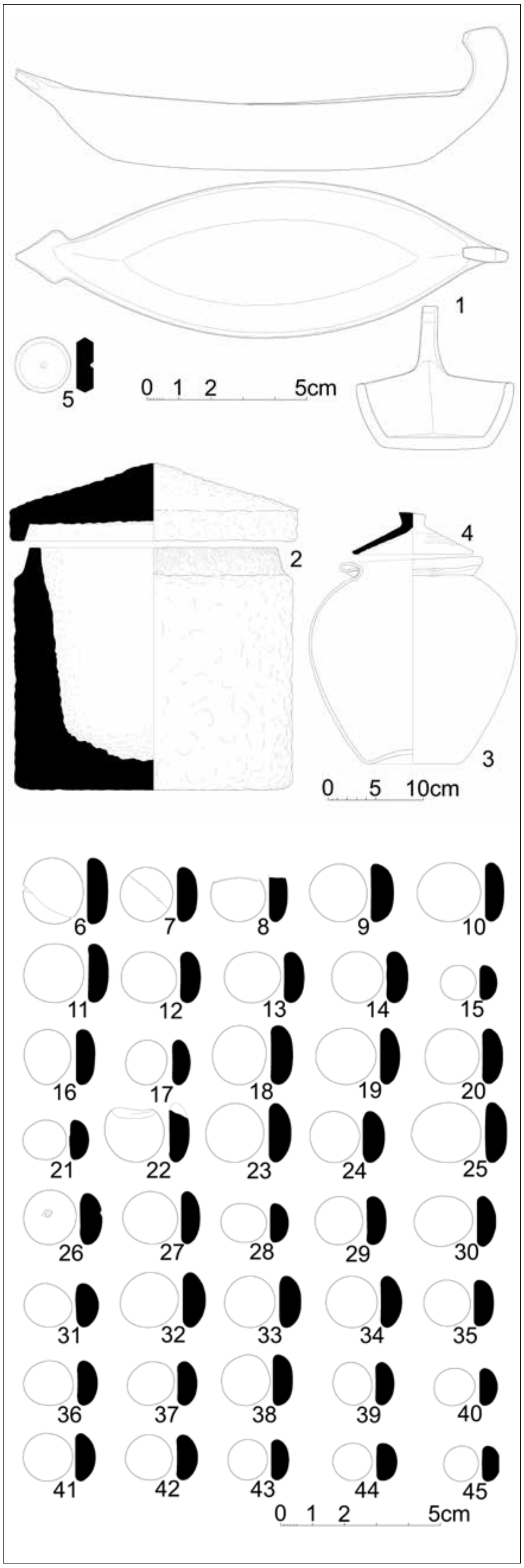

Fig. 2: Grave 348. 1-45.

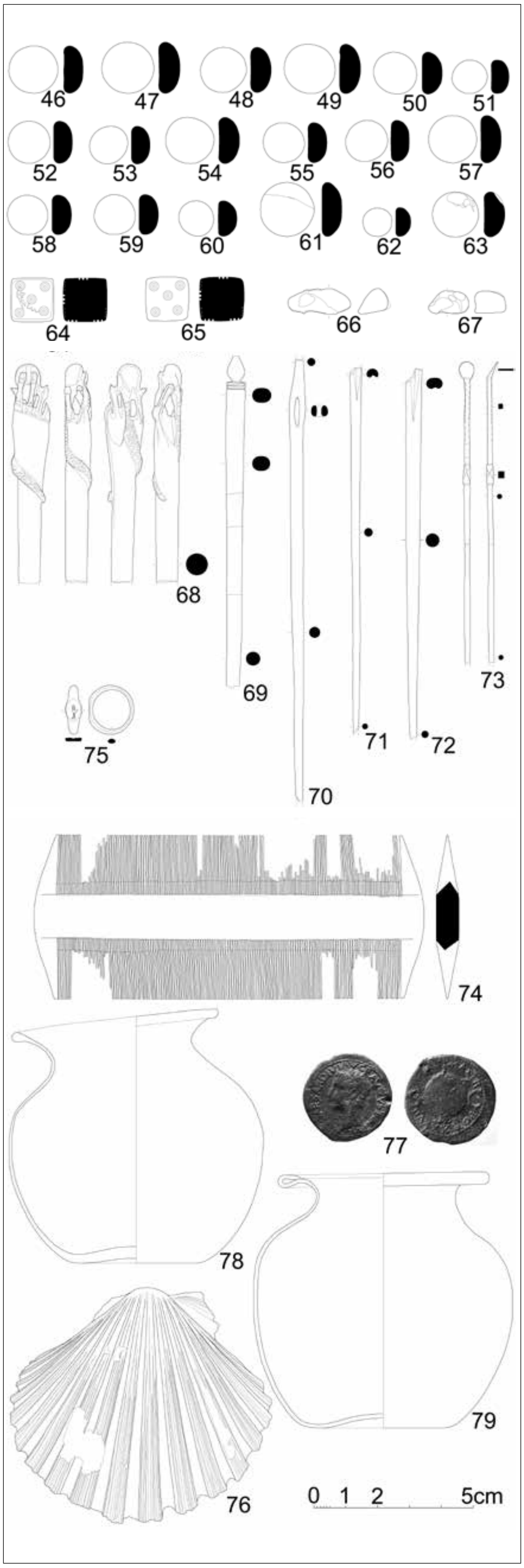

Fig. 3: Grave 348. 46-79.

belonging to that of a woman or child, the layers of which were dated by discovered coins. The example from Santa Elena di Melma was found in a glass urn together with a balsamarium, a ring and illegible coins. The example from St. Aldegund was found in a woman's grave and has been dated to the 4th century AD.

There are various hypotheses on their use. They are believed to have been an allusion to the occupation of the deceased and a symbol of his/her voyage in the afterlife; an allusion to the final voyage; a toy; a decorative container for toiletries; or a chamber pot. The latter three hypotheses are, among other factors, based on the fact that the known contexts for the discovered boats are from women's graves.[15]

In contrast to the analogous boat made of opaque purplish glass from Santa Elena di Melma, held by the Museo Civico Luigi Bailo in Treviso, and the example made of semi-transparent green glass from Pompeii in the British Museum, the Salona boat does not have a separately (with grooves and incisions) indicated edge or gunwale, nor a keel, nor applied feet. Therefore, it is believed that the examples from Treviso and Pompeii may have come from the same mould.[16] The difference in dimensions between these two boats is due to the absence of the tip of the prow on the model from S. Elena di Melma (which is damaged, hence its length of 20 cm), as opposed to the entire length of the Pompeii model, which is 22.4 cm. The example from Split is 15.43 cm long and so it is thought not to have been made using the same mould. The typological similarity of the boats with different dimensions from Palombara Sabina and St. Aldegund[17] should also be noted.

Glass boats are generally dated to the second quarter or middle of the 1st century AD[18] although in recent literature, the boat from S. Elena di Melma is accompanied by a reference to the 1st century AD.[19] They were probably the product of the same workshop and some may have come from the same mould.[20]

Other finds

The glass urn (Fig. 2.3)[21] in which the small boat was found belongs to a type made during the Tiberian and Claudian periods. If not a product of one of the Dalmatian workshops,[22] it was probably imported from (northern) Italy. The urn's ceramic lid (Fig. 2.4) can be dated to from the Tiberian era in the 1st century AD to the first third of the 2nd century AD.[23] From the remaining grave, items found in the Salona urn, bone hairpins (Fig. 3.68[24], 69[25]), cosmetic

15 Calvi 1974-1975, 483-484; Bordenache Battaglia 1983, 29; Harden *et al.* 1987; Whitehouse 1995, 133-135; Casagrande and Ceselin 2003, 36; Larese 2004.

16 Calvi 1974-1975, 479-480.

17 Bordenache Battaglia 1983, 28.

18 Calvi 1974-1975, 480; Bordenache Battaglia 1983, 27, 28-29; Harden *et al.* 1987; Whitehouse 1995, 133.

19 Casagrande and Ceselin 2003, 166, Fig. XII. 244; Larese 2004; Barovier Mentasti and Tirelli 2010, 52-53.

20 Calvi 1974-1975, 479-480; Bordenache Battaglia 1983, 28.

21 Lazar 2003, 166-168 7.2.3. and 7.2.4; Bonnet Borel 1997, 42, AV V 104, pl. 19; Roffia 1993, 170, 171, no. 376-379; Scatozza Höricht 1986, 68, 70, form 56, pl. XXII, XXXVIII; Welker 1985, 44, 45, pl. 13. 172-174; Czurda-Ruth 1979, 157; Goethert-Polaschek 1977, 240, forma 147a; Welker 1974, 121-123, pl. 17. 280-282; Calvi 1968, 88-92, type Aα, pl. F. 3; pl. 15. 2, 3; Isings 1957, 86/87, form 67a.

22 There are numerous Dalmatian examples: Buljević 2010, G1. 1, pl. 1. 1, fig. 1; G 6. 1, pl. 4. 1, fig. 16; G 7.1T. 5. 1, fig. 21; G. 8. 1, pl. 6. 1, fig. 22; G 9. 1, pl. 7. 1, fig. 29; G. 15. 34, pl. 13. 34, fig. 49; Lazar 2008, 76-77, pl. 13. 1, 2; Buljević 2003b, pl. II. 23, 24; Fadić 1998, 91, 92, no. 255, 256, 260; Ravagnan 1994, 205-209, no. 404-412; Damevski 1976, 64, pl. IV. 3.

23 Istenič 1999, 145. 8.3.14, fig. 133. PO 2/L 2; Istenič 2000, pl. 143. G 645. 3; Istenič and Schneider 2000, 341, fig. 5. 1, 2; Topić 2003, pl. 43. 182.

24 Dular 1979, 282, pl. 2. 10, T. 3. 6; Ruprechtsberger 1978, no. 344-346; Bíró 1994, 34, pl. XXXIV. 372-374; Petković 1995, 33, pl. XVI. 1-3, Type XIV; Ciarallo and De Carolis 1999, no. 136; Istenič 1999, fig. 68; Istenič 2000, Istenič 2000, 81-82, pl. 75, G 365. 2; pl. 146, G 649. 1; Ivčević 2002a, 335, no. 41; Buljević 2010, 98, G 5, pl. 3. 3, fig. 14.

25 Bíró 1994, 23-24, 125, pl. IX. 55: Nedved 1981, no. 1; Ivčević 2003, 120, no. 2, pl. I. 2.

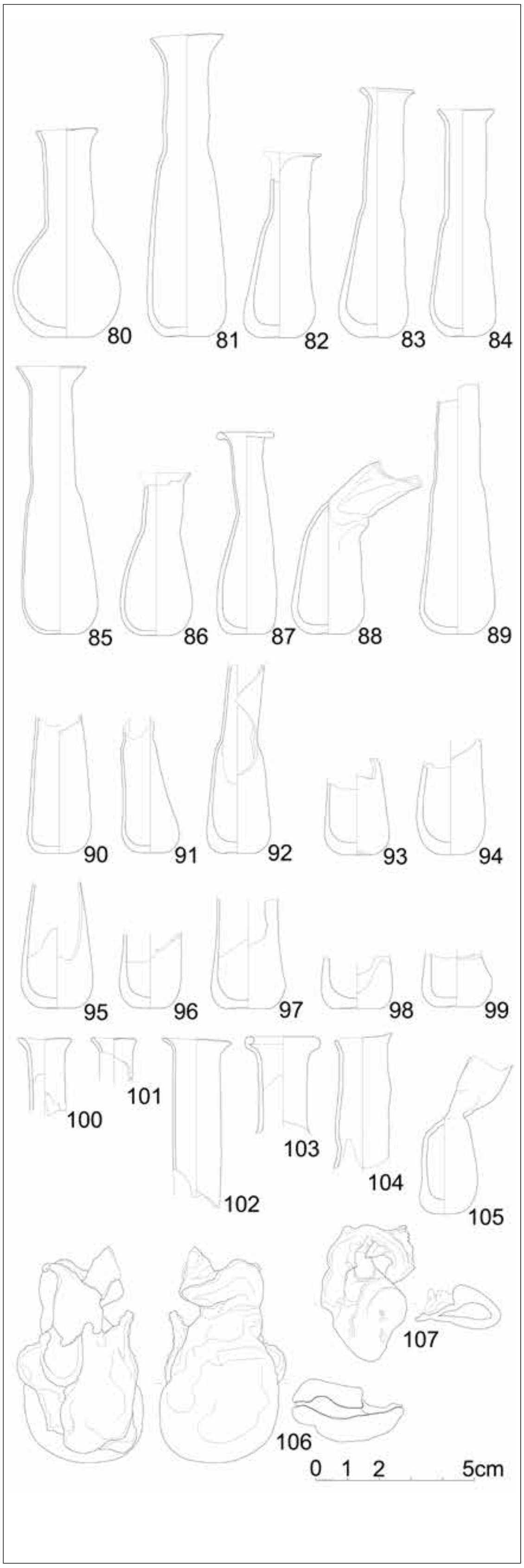

Fig. 4: Grave 348. 80-107.

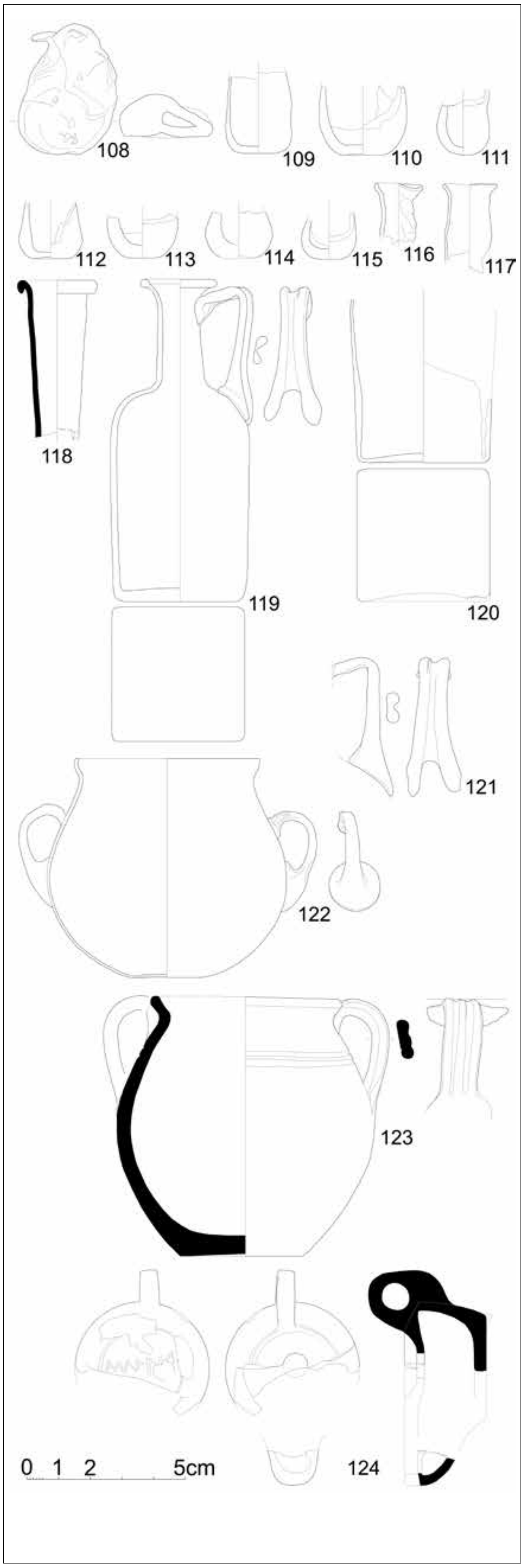

Fig. 5: Grave 348. 108-124.

spatulas (Fig. 3.71, 72) [26] and a comb (Fig. 3.74) [27] may be dated to the mid-1st century onward. The golden ring with the motif of an open fist on the bezel plate (Fig. 3.75) is typologically similar to the rings dated to the 1st century AD.[28] The remaining finds are not open to chronological interpretation.

The boat allegedly contained counters and dice.[29] Of the fifty-nine tokens, one is made of bone (Fig. 2.5)[30] while the rest are glass counters (Fig. 2.6-45 and Fig. 3.46-63). They were made of various materials, including glass, and were used for games as pieces for moving on playing boards.[31] Playing dice (Fig. 3.64 and 65) were used for gambling and in games involving counters that were moved over boards[32] such as mills or merrills; *tabula* or *ludus duodecim scripta*, a type of backgammon; and *ludus lantruculorum*, a type of chess or checkers.[33] Counters, together with dice, were found at the Zadar necropolises and have been dated to between the 1st and early 2nd centuries AD.[34]

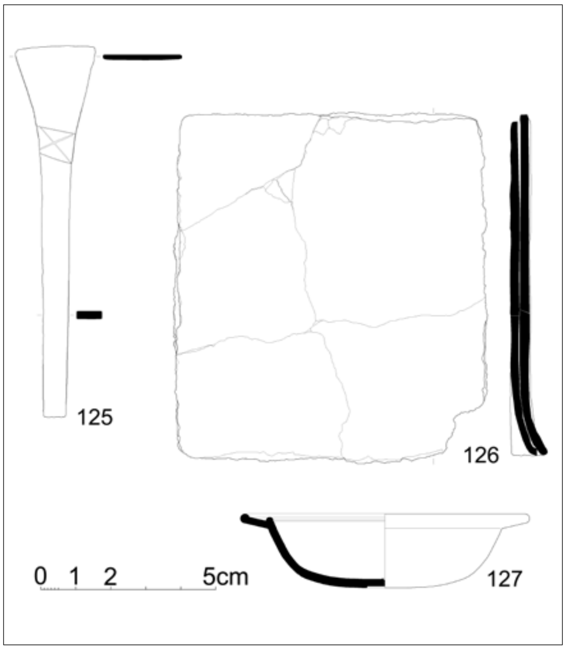

Fig. 6: Grave 348. 125-127.

The incineration layer, where an urn and one glass vessel were discovered (Fig. 3.78 or 79), also contained a bronze coin (Fig. 3.77) minted in the final years of Tiberius' reign,[35] which dates the grave to the time of his reign, or the period of his successors. Generally, the olla-form balsamaria (Fig. 3.78 and 79) were blown from glass in natural tones (Fig. 3.79) while they were more rarely made of coloured glass (Fig. 3.78). Their production began in the Claudian era and they were used well into the 4th century AD. They were common in the western Empire from the Flavian era to the end of the 2nd century AD.[36] A balsamarium with spheroid body (Fig. 4.80) belongs to a type dated to between the 1st and the beginning or first half of the 2nd century AD.[37] Thirty-six tubular

26 Istenič 1999, 80; Istenič 2000, pl. 91, G 455. 1; pl. 141. G 637. 1; pl. 167. G 747. 4; Bíró 1994, 42, 127, pl. LII. 452, 453, 455; Šaranović-Svetek 1981, 157, pl. V. 1-3; Dular 1979, 283, 284, pl. 1. 21-22, pl. 3.3; Vikić-Belanić 1948, 43, 44, fig. 6b; Dalmatian: Buljević 2010, 98-99, G 5, pl. 3. 4, fig. 15; 108, 111, G 8, pl. 6. 4, fig. 25; Ivčević 2003, 119, 120, no. 1, pl. I. 1; Ivčević 2002a, 333, fig. 15-21; Ivčević 1999, 113, 137-140, no. 148-170, fig. 25, 26.

27 Bíró 1994, 36-37, fig. 11; Buljević 2010, 143, 165, G 18. 164, 165, pl. 16, fig. 56; Ivčević 2002a, 333-334, no. 23.

28 Ivčević 2002b, 280, no. 6; D'Ambrosio and De Carolis 1997, no. 56-68, pl. VI, VII; no. 214-226, pl. XXII, XXIII. Such a silver ring is from an unknown Dalmatian site: Nedved 1981, no. 174.

29 See note 2.

30 Similar bone items were found at the Ptuj necropolis: Istenič 2000, 35, G 72, pl. 15.

31 Baldoni and Berti 1998, 73, note 3, no. 27, pl. VI. 4; Sternini 1999, no. 148-153, fig. 11; Marengo 2002, 36, fig. 1-5; Buljević 2003a, 336-338, no. 144-149, pl. 15. 2-7; Larese 2004, 44-45; Mandruzzato 2008, 34, 35, no. 108-117; Fadić 2008, 167, no. 49-57; Barovier Mentasti and Tirelli 2010, 158.

32 Varone 1994, no. 68, 69; Vomer Gojkovič 2008, 74-75, no. 1-4, fig. 1-4.

33 Varone 1994; Marengo 2002, 36, fig. 1-5; Vomer Gojkovič 2008, 74-76, no. 5-12, fig. 4-8.

34 Glusčević 1990, 112, note 8, G. 6, pl. V. 1-31.

35 RIC 58.

36 Lazar 2008, 82-83; Lazar 2003, 170, 8.2.1, 8.2.2; Buljević 2002, 399-400, 3i; Ciarallo and De Carolis 1999, no. 270; Ravagnan 1994, 53-59; Isings 1957, 88-89, form 68.

37 De Tommaso 1990, 46, group/type 12; Biaggio Simona 1991, 131, 133, note 33 and 34; Dalmatian: Buljević 2002, 396, 3g, pl. I. 30-33; Lazar 2003, 197, 8.6.13; Lazar 2008, 87, 90, pl. 19. 6.

balsamaria (Fig. 4.81-107 and Fig. 5.108-117), make up the majority of the glass items. These are the most numerous of all balsamaria and a standard accessory in the entire Roman world during the time of the early Empire.[38] These are balsamaria on which the body is longer or has the same length as the neck. Those with bodies having a higher volume in comparison to the necks have been dated from the late Augustan and Tiberian eras to the beginning of the 2nd century AD.[39] The later tendency to extend the neck, thereby limiting the body's volume, is well known. Therefore, balsamaria on which the body is longer than the neck are the earliest tubular balsamaria. These were followed by balsamaria with necks and bodies of virtually equal length, which appeared around the year AD 50,[40] rather than with bodies shorter than the necks. The neck of a ceramic balsamarium (Fig. 5.118) belonged to the type of balsamaria with rounded bodies and flat bases, which were used from the 1st century BC to the end of the 1st century AD.[41] Production of square glass phials (Fig. 5.119-121) began in the early 1st century AD. They were an enduring and widespread form used for storage and transportation, and were common from the latter half of the 1st century to the 2nd century AD.[42] The small glass bowl with handles (Fig. 5.122) could be dated to the 1st century AD, beginning with the Tiberian/Claudian era.[43] The metal mirror (Fig. 6.126) is dated to the 1st century AD.[44]

Other finds from the grave are not open to chronological interpretation.

Given the finds of coins, olla-form balsamaria and tubular balsamaria with equal body and neck lengths, we maintain that the layer - like the grave - should be dated to the Tiberian-Claudian era at the earliest. With regard to the presence of the remaining 1st-century finds, the grave can be dated to no later than the 1st century AD.

Given the analogous example and the contexts of the finds, it can be concluded that the Salona boat is an Italic product of the second quarter or mid- 1st century AD and possibly served as a container for dice and counters.

38 Isings 1957, 24, form 8; De Tommaso 1990, 78, 81-85, group/type 60, 67, 70, 71, 72; Fadić 1998, 80, no. 4, 10, 11, 12, 14, 21-23; Buljević 2002, 401-403: I: $3k_3 – 3k_6$; 202-204: II: pl. III-VI; Buljević 2003a, no. 37-47, pl. 5. 8-15, T. 6. 1-3; Buljević 2004, 196-197, no. 41.

39 Biaggio Simona 1991, 140-144, pl. 19-21, fig. 6; Platz-Horster 1979, 27-31, fig. 1 and 2; Buljević 2002, $3k_3$.

40 Biaggio Simona 1991, 141-142, fig. 64, 65, pl. 19, 20 and 21, fig. 6; Buljević 2002, $3k_4$.

41 Anderson-Stojanović 1987, 110-114, form 2; Dalmatian: Mardešić 2002; Gluščević 1990, 120-123, G 8, pl. XII. 24, 25, pl. XIII and pl. XIV. 26, note 59.

42 Czurda-Ruth 1979, 135; Charlesworth 1966; Isings 1957, 63-67, form 50.

43 Rossi and Chiaravalle 1998, 30, pl. II. 4; Isings 1957, 27-30, form 12 (variant for analogous examples with small handles are not known).

44 Goethert-Polaschek 1983; Deimel 1987, 78-80, pl. 58. 1, 2, pl. 59. 1, 3-5, pl. 60, 3, 4.

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Abbreviations

RIC = C.H.V. Sutherland, R.A.G. Carson, The Roman Imperial Coinage, volume I, revised edition, from 31 BC to AD 69, London 1984.

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GLASS WORKING SITES IN HISPANIA: WHAT WE KNOW

This study is the outcome of collaborative work between Spanish and Portuguese researchers, conducted in order to put Iberian roman glass back at the centre of European glass studies, by bringing together all glass working sites found so far in the Iberian Peninsula. Besides doing the state of the matter exercise, we have actively looked for new unpublished sites and reviewed the ones that have already been published. This updating exercise has been carried out according to the most recent scientific criteria and directly on site, whenever possible. The outcome of this work is presented here for the first time in the form of a map and a catalogue. The aim is that it may serve as a starting point for future studies and may be regularly reviewed and updated.

Criteria

The selection of sites was based on a short list of glass working examples that are: melted glass, tools, crucibles (also known as pots), row glass, glass slag, glass waste, moulds and furnaces. However, not all examples are equally reliable, which is why it is highly recommended to consider different examples and not refer to one alone. Melted glass, tools and opaque row glass are less reliable, because melted glass can be originate from incineration piles; glass working tools are not very distinct from other tools and opaque row glass can be associated with mosaic making. The other criteria are more reliable if correctly identified. Row glass came usually in the form of small lumps with flint-like fractures. Crucibles, as much as moulds, can be recognized by the internal glassy or burned surfaces, which are usually rough and irregular, unlike glazed pottery. Glass slag refers to the unclean and shapeless glass that dribbles from the crucibles or the fusing tanks. Under the common name of ‘glass waste,’ there is a wide range of glass working by-products: from simple glass drops, trails and rods - sometimes twisted or showing tooling marks - to the more distinctive moils - that is the glass from around the end of the blowing iron - or even the wasters, the distorted and discarded vessels. Finally, the furnaces and the workshop structure can be easily recognized archaeologically as long as there is evidence of other glass production, such as glass slag impregnating the furnace. No textual or epigraphic reference to secondary glass production has yet been found in Portugal or Spain.

The glass working sites

The current survey includes a total of 32 sites and 7 uncertain sites that are not shown here, but we believe that many more are waiting to be excavated or simply identified and published. The first impression is that secondary glass production in Hispania appears to be as prolific and relevant as in any other roman province. France alone counted one hundred workshops in a 2010 survey.[1] It is expected that virtually all the important towns in Hispania featured one or more workshops that specialised in what would not be much different from pottery or metalwork. For instance, in *Bracara Augusta* and *Augusta Emerita*, the existence of at least three glass workshops has been revealed in both cases. In the 4th and 5th century this industry developed even further in some secondary towns, often along the main trading routes, both terrestrial and maritime.

A close look at Figure 1 shows that the sites seem to be concentrated in four main regions, corresponding to the area of influence of the provincial capitals of Hispania. This fact alone suggests that these towns acted as doorways for glass production in Hispania, from where it spread to neighbouring cities and thus, it is highly probable that these regions remained regional glass production centres. We have *Tarraco* and the Ebro valley; *Chartago Nova* and the littoral of the Chartaginensis province; *Emerita Augusta* and the north-eastern part of the Lusitanian province; *Bracara Augusta* and the western part of the Callaecia province. We also notice the almost complete absence of sites in the Iberian southwest, which corresponds to the south-western part of Lusitania and the entire Betica province. We are convinced

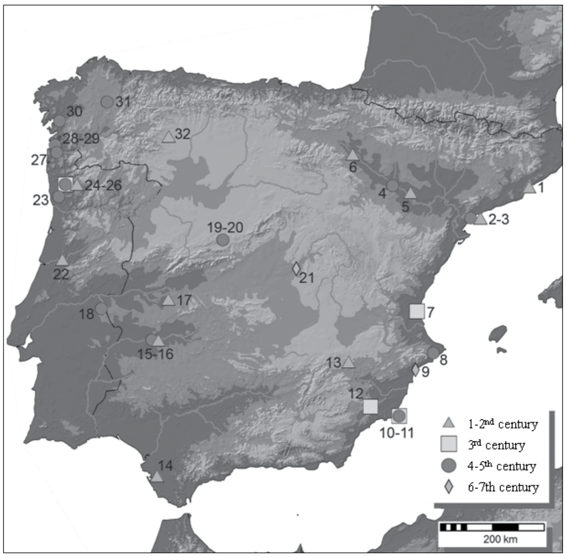

Fig. 1: Glass working sites in Hispania (the numbers refer to the catalogue).

that this is due to a lack of research and information and not exactly to the absence of glass production.

As a general rule, we can assume that each glass working site corresponds to a workshop and in some cases, more than one. We can also assume that all of them are secondary workshops, producing glass objects and vessels from row glass or cullet and not from basic raw materials. There is still no sufficient evidence of primary production in the Hispania roman provinces in spite of the well known quote from Pliny[2] referring to the use of local sand. This does not mean that primary production did not take place in Hispania, but rather that it is yet to be identified and in any case, it must had been residual and geographically limited. Recent archaeometric studies carried out in the northwest of Hispania have revealed the massive presence of Eastern Mediterranean glass[3] as it occurs across the Western Roman Empire.

Catalogue

1. Iluro

Torre Llauder (Mataró, Barcelona, ES)

Several news items on glass working sites have been recorded in this ancient Laietan town

1 Foy 2010, 31.

2 Plin. *Nat. Hist.* 36.66, 194.

3 Cruz 2009, 37 ff.

and its surroundings,[4] among which stands out Torre Llauder, where four square furnaces have been documented. Inside theses furnaces were found a great amount of glass slag and melted glass along with glass vessels and flat glass.[5] According to Jennifer Price,[6] the workshop would have been operating during the 2nd century.

2. Tarraco
"el Pasaje Cobos" (Tarragona, ES)
A dump dated around AD 25-50 has revealed, among many other finds, two distorted cylindrical glass fragments that Jennifer Price[7] identified as two possible pontil rings or moils.

3. Tarraco
"el basurero de Vila-Roma" (Tarragona, ES)
This dump has revealed at least three fragments of moils,[8] suggesting the existence of a glass workshop operating in the first half of the 5th century[9] and integrated in an artisan quarter in the area of the former Provincial Forum.

4. Caesaraugusta
Roman theatre and Gavín-Sepulcro Street (Zaragoza, ES)
Glass waste, glass slag and row glass were found on these two sites in association with fragments of glass vessels, mostly from local production, which prove that glass working was still in place by the end of the second half of the 5th century.[10]

5. Celsa
"Casa de los delfines" (Velilla del Ebro, Zaragoza, ES)
Excavations on the so-called "House of the dolphins", in the former colony of Celsa, permitted the recovery of waste related to glass working in layers dated around AD 54/60.[11] It is mainly composed of lumps of row glass, both opaque and translucent, used either to produce small objects or for blown glass vessels.

6. Pradejón-Calahorra
"el alfar de La Maja" (La Rioja, ES)
This roman pottery provides numerous examples of glass blowing, such as glass waste and cullet, together with a furnace and different sorts of metal tools.[12] Among these tools, are a blowing iron, tweezers and an iron object in the shape of a rectangular box. This furnace would have been running during the second half of 1st century.[13]

7. Valentia
Sabater Street 9 (Valencia, ES)
Part of a building hosting a round glass furnace has been located in the historic centre of Valencia.[14] Along with these constructions were found all sorts of glass waste, such as lid-like moils (Pl. 4), row glass and window glass for recycling. According to Albiach and Soriano,[15] the finds from the overthrow layers point to the first quarter of the 4th century.

8. Villa El Albir
(Alfaz del Pi, Alicante, ES)
A great amount of glass waste from blown vessels was documented among the baths of this roman villa. Among the homogeneous yellowish green glass, there were lumps of row glass, semi-fused glass, glass drops and a great number of trails. The presence of this glass and other related material indicates that a small glass workshop had occupied the old bath facilities around the first half of the 5th century.[16]

4 Juncosa and Clariana (1984, 42 ff) refers to the existence of glass furnaces in a nearby roman villa as Figuera Major, Cirera and even Can Rafart, in association with partially melted glass and fragments of crucibles.
5 Ribas Bertrán 1972, 130 ff, figs. 8 and 9.
6 Price 1981, 398 ff.
7 Price 1981, 402 and 619 ff.
8 Benet and Subias 1989, 343, 9.71-9.72.
9 Idem, 346. A glass furnace has also been recorded in the Paleochristian necropolis (Price 1981, 402).
10 Ortiz 2001, 407, fig. 127.
11 Paz 1998, 529 ff, fig. 259.
12 González and Garrido 2002, 22 ff, figs. 1, 25-27.
13 Idem 32.
14 Albiach and Soriano 1989, 726, figs. 1 and 2.
15 Idem 729.
16 Sánchez de Prado 2009, 168 ff, fig. 10, 7-9.

Plate 1: A 4th century glass furnace from the CTT workshop, Braga (No. 26).

Plate 2: Lumps of yellowish brown row glass from Colector Colón, Vigo (No. 28).

9. Alicante
El Barrio de Benalúa (Alicante, ES)
The excavation of two archaeological dumps in this urban district has provided ceramic and glass materials in abundance so as to corroborate the existence of a nearby artisan area. Among scores of fragments of glass vessels for recycling, it was possible to document an important amount of debris related to the activity of glass blowing.[17] The recovered vessels confirm the advanced date of the 6th century.

10. Carthago Nova
Honda Street 17 (Cartagena, Murcia, ES)
The remains of a round furnace,[18] along with abundant glass slag, were identified in room II of a house converted into a glass workshop in the 3rd century. The abandon layers, where a large amount of glass slag and glass waste[19] was found, dated from around the end of the 4th century to the 5th century.

11. Carthago Nova
Cerro del Molinete (Cartagena, Murcia, ES)
The excavations carried out on the west slope of the hill of Molinete allowed the documentation of an important artisan such as a glass workshop dated to between the 3rd and the 5th century, that featured part of a fire chamber of a furnace, the remains of a working bench, fragments of crucibles and a dump.[20]

12. Lorca
Eugenio Úbeda Street 12-14 (Murcia, ES)
At this location, structures linked to domestic and artisan activities were identified in two distinct sectors, along with evidence of glass working in late roman layers.[21] In the west sector was located a raft, filled in the second half of the 3rd century, with waste from artisan activities such as pottery and glass making. Among the waste, there was cullet and glass waste, like trails, glass slag, lumps of row glass and moils.[22]

13. Villa Hellín
Albacete, ES
The excavation of this roman villa brought to light the structures of two furnaces, one large and one small. The small one has a round plan with a funnel shape entryway, shows some glass slag inside and is supposed to have been used for glass making.[23] It is a patrician villa with an artisan area, which had been functioning since the end of the 1st century AD and reached its peak during the 3rd century.

14. Los Barrios
Venta del Carmen (Cádiz, ES)
The pottery of Venta del Carmen would have housed a glass workshop producing mainly

17 Idem 178 ff, fig. 11, 5-8.
18 Fernández Matallana 2009, foil 3.
19 Idem 147, fig. 4 and foil 4.
20 Egea *et al.* 2006, 36.
21 Martínez and Ponce 1999, 324.
22 Sánchez de Prado 2004, fig. 9.
23 Abad, Gutiérrez, Sanz 1998, 93 ff.

Plate 3: Glass waste from Maximinos, Braga (No. 24).

unguentaria. A significant amount of failed vessels were recovered on a waste dump. This workshop could have already been working around the year 80 of our era.[24]

15. Augusta Emerita
The National Museum of Roman Arte site (Mérida, Badajoz, ES)
During excavations carried out in 1970, two deep bowls were recovered on a dump area, with vitreous remains on its inner surface, interpreted as moulds and related to the so-called "workshop number 2". The layer in which they were found was dated to the Julio-Claudian era onwards and the workshop is supposed to have persisted until the 4th century.[25]

16. Augusta Emerita
Cerro San Albín (Mérida, Badajoz, ES)
Nearby this hill[26] were located 34 glass pieces that were revealed to be glass waste known as "moils",[27] together with what was left from some iron tools, like 5 blowing irons, tweezers and shears. These finds demonstrate the presence of a glass workshop located outside the city walls in an artisan area, along with potteries. The context has been dated by a set of coins from the 4th century.[28]

17. Augustobriga
Talavera la Vieja, Cáceres, ES
An artisan area, attached to the city wall, was identified during an archaeological survey on the site. Two ceramic moulds were then found: one was a decorated terra sigillata mould and the other was the base of a square glass bottle with a mark, composed by four concentric circles in low relief under a thin layer of glaze. The associated material was dated to around the second half of the 1st century AD and the beginning of the 2nd century.[29]

18. Ammaia
South Gate Aramenha, Marvão, PT
The excavations carried out in the south gate sector revealed substantial evidence of glass working such glass slag, lumps of row glass, moils, and different sorts of glass waste with tooling marks. These examples are mainly concentrated inside the east tower, which leads to the supposition that this tower may have been used as a glass workshop - at least by the end of the 4th century or the beginning of the 5th century, according to the date of the associated glass vessels.[30]

19. Ávila
San Vicente Park (Ávila, ES)
Two furnaces were identified during archaeological excavations; one dedicated to pottery and the other to glass. The glass furnace preserved the base of the combustion chamber and was associated with glass waste related finds. The materials recovered in the abandon layers points to a chronology originating from the 4th-5th century and may extend to the 6th century.[31]

20. Ávila
Padres Paules convent (Ávila, ES)
The excavations in this ancient convent enabled the identification of a glass furnace with an oval

24 Fuentes 1998, 268 ff.
25 Caldera de Castro 1983, 69.
26 Idem, 66 ff.
27 Price 1981, pl. 6-9.
28 According to Jennifer Price (2004, 21), the characteristics of the glass points to the end of the 4th century or the beginning of the 5th century.
29 Aguilar-Tablada and Sánchez de Prado 2006, 182 ff, figs. 3 and 4.
30 Unpublished data collected by Mario da Cruz. Ongoing study.
31 Martínez *et al.* 2004, 427, figs. 1-3.

plan and vaulted section. Associated with the find were several deposits of ashes, glass slag and misshapen glass vessels. The furnace would have been running between the 2nd century and the second half of the 4th century, when the place was renovated.[32]

21. Recópolis
Zorita de los Canes, Guadalajara, ES
The excavations in this Visigoth new town enabled archaeologists to locate the remains of a furnace used for glass production that would have been running between the end of the 4th century and the beginning of the 7th century.33 The furnace preserved the combustion chamber, of circular plan, coated with tiles with glazed surfaces. A great volume of glass slag and small fragments of crucibles were found nearby.[34]

22. Conimbriga
Condeixa-a-Velha, Coimbra, PT
The existence of local glass production was first raised after the discovery of glass slag, row glass and refractory clay with glass runoff[35] - although residual and scattered - in contexts dating back to the end of the 1st century AD. More recently, while checking these finds, we realized that there was no evidence of moils or other related glass blowing waste. Instead, there was a large amount of glass beads, some of them misshapen or unfinished, which leads us to propose the existence of a glass workshop that specialized in the production of small glass adornments. The type of beads and its colours, mostly dark blue, as much as its context points to a chronology originating from the first half of the 1st century or earlier.

23. Castellum Madiae
Alvarelhos, Trofa, PT
A semi-circular structure, interpreted as a glass furnace, was identified in the so-called "domus

Plate 4: Lid-like moils from Sabater Street, Valencia (No. 7).

of the handicraft complex"[36] with a chronology that originates from the beginning of the 4th century to the mid 5th century. The associated evidence for glass production consists mainly of glass slag that impregnated the floor and the furnace stone elements.[37]

24. Bracara Augusta
Maximinos – Casa do poço (Braga, PT)
The first evidence of local glass production from Braga was identified in the so-called "Well house"[38] and included all sorts of glass waste (Pl. 3), such as moils and lumps of row glass, as well as small fragments of crucibles with adherent rough glass. A furnace and bricks covered with glass have also been reported. The associated ceramic materials, dating back to the 1st century, indicate that this could have been the first glass workshop in town.[39]

25. Bracara Augusta
Fujacal (Braga, PT)
The area of the former "farmer of Fujacal" and the adjacent street of São Geraldo have revealed all sorts of glass working evidence, ranging from row glass to glass waste and even bricks covered

32 Marcos Herrán 2006.
33 Castro and Gómez 2008, 123.
34 Idem, 118 ff, figs. 2 and 5.
35 Alarcão 1964, 56; Alarcão and Alarcão 1965, 16; Alarcão 1994, 15 and 83.
36 Moreira 2009, 402, pl. LVI.
37 Idem, 403.
38 Sousa and Oliveira 1982.
39 Cruz 2009, 236.

with glass,[40] mostly found in contexts associated with the construction of the late roman wall by the end of the 3rd century to the beginning of the 4th century. We can assume that production was already running during the 3rd century and there is strong evidence that it was not interrupted by the construction of the wall, but carried on until the end of the 5th century to the first half of the 6th century according to the dating of some discarded vessels.41 The dispersion of this evidence suggests the existence of more than one workshop in the area.

26. Bracara Augusta
CTT (Braga, PT)
The best preserved glass workshop ever found in Braga was excavated in 2008 in the block of the former post office. Besides a great amount of cullet and all sorts of glass waste,[42] there was an almost complete building with two round furnaces (Pl. 1) corresponding to two different phases of the workshop. It was built extramurally on a former burial ground around the first half of the 4th century and abandoned in the second half of the 5th century.[43]

27. Tude
Tui, Pontevedra, ES
A combustion structure, interpreted as a glass furnace, was documented on the street Loureiro and was associated with numerous glass waste, such as moils, trails, glass slag, row glass and also clay with dribbled glass. The proposed chronology for the site originates from around the 4th to the 6th century; however, the few glass vessels identified points rather to the second half of the 5th to the 6th century.[44]

28. Vicus Helleni
Colector Colón (Vigo, Pontevedra, ES)
The first evidence of a local glass production came to light during the opening of a storm sewer on street Colón and consisted of a waste pit filled with lumps of raw glass (Pl. 2) and waste glass, such as moils and failed glass vessels, suggesting that the workshop was dismantled during the first half of the 5th century.[45]

29. Vicus Helleni
Rosalia de Castro Avenue (Vigo, Pontevedra, ES)
Evidence of a new glass production site was found in a sector known as "O areal". Along with crushed glass (cullet), glass slag, glass waste and lumps of row glass were also found.[46] A small and round combustion structure, possibly a furnace, was discovered in "parcela 4" (plot 4). The associated glass vessels point to the second half of the 5th century to the first half of the 6th century.

30. Aquis Celenis
Caldas de Reis, Pontevedra, ES)
Recent archaeological excavations on street Ferreiro of this ancient thermal town revealed a small but informative amount of glass waste, as well as glass drops, lumps of row glass and a moil. The site is supposed to have a chronology originating from the first half of the 5th century to the first half of the 6th century.[47]

31. Lucus Agusti
Lugo, ES
The existence of a local glass workshop was first proposed following the discovery of two combustion structures, interpreted as possible glass furnaces.[48] Recent surveys allowed the identification of glass waste, for example row glass with impressions of the crucibles, in three different areas probably corresponding to a single glass workshop whose materials were dispersed. The use of crucibles and the colour of the glass suggest that the workshop was operating during the 4th century or later.[49]

40 Idem, 186 ff, 236.
41 Idem, 188 ff, fig.s 24.2.2.3a, no. 3 and 7.
42 Idem 217 ff and 237; Cruz 2011, 25.
43 A recent revision of the data also led to the revision of the previously proposed chronology for the first furnace as being Early Empire (Cruz 2011, 25).
44 Vilaseco 2003; Cruz 2009, 250.
45 Cruz 2009, 244 ff.
46 Idem, 246 ff.
47 Idem, 252.
48 Xusto Rodríguez 2001, 123.
49 Cruz 2009, 242.

32. Asturica Augusta
Antiguo Hospicio (Astorga, León, ES)
The existence of local glass production has already been suggested by the catalogue of the local museum,[50] although additional accurate data concerning the chronology and origin is absent. More recently, our survey has detected some glass waste on the site of the "Former Hospice," bearing strong evidence of a nearby workshop[51] that would have been running from the second half of the 1st century to the 3rd century. Moreover, the discovery of a lump of row glass with the impressions of a crucible on street Garcia Prieto may suggest the existence of a second workshop in town.[52]

50 Amare Tafalla 2002, fig. 20.

51 Cruz 2009, 238-241.

52 Idem, fig. 5.1.2a-5.

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THE SECONDARY GLASS WORKSHOP IN THE CIVIL TOWN OF BRIGETIO

In 2006, the Klapka György Museum in Komárom and the Institute of Archaeological Sciences at Eötvös Loránd University carried out an excavation together in the less researched area of the civil town of Brigetio, under no. 13 Komárom/Szőny Vásártér. The conductors were Á. Gelencsér and E. Számadó. During the excavation of an area measuring 153 m², a striphouse of living quarters constructed in different time periods and a glass workshop related to one of these periods, were discovered.

Brigetio (Komárom/Szőny) is located on the right bank of the river Danube, opposite the estuary of the river Vág.[1] Clarifying the location of the civil town is problematic since the modern settlement of Szőny completely overlaps the ancient site. The center of the civil town could have been present-day Vásártér, where excavations have been carried out under Professor L. Borhy's leadership since 1992.[2] No permanent buildings were constructed in modern-day Vásártér, since it is still used as a market place today. Therefore, the remains of the city were able to survive. The pottery workshop and the military fortress of the *legio I Adiutrix*, which was adjacent to the *canabae* on its east side, were located to the east of the civil settlement. The two sections of the town were separated by cemeteries and by the amphitheater (Fig. 1).[3]

The construction periods of the striphouse

The building discovered under no. 13 Komárom/Szőny in Vásártér had five construction periods, of which the first one can be dated back to the end of the 1st century AD. The last period was in the middle of the 3rd century AD. The building must have had the shape of a typical striphouse in the 2nd period. Later in this second period, it formed a trade house, which was well known in other cities in Pannonia and in the northern provinces. The living area was located in the first part of the building, whilst on the east side and in the backyard, a glass workshop operated for a short time during the 3rd construc-

1 Barkóczi 1951, 5.

2 Borhy 2005, 75; Borhy 2004, 231.

3 Barkóczi 1951, 6-10; Borhy 2009, 67.

tion period (Fig. 2). During the Severan age, the glass workshop was shut down and the building extended by adding underfloor heating and fresco decoration. The building was demolished in the middle of the 3rd century AD, which was followed by the 5th period, signifying a slight attempt at establishment.

Finds related to glass workshops in Pannonia

In those parts of Pannonia that are located in present-day Hungary, only one glass workshop was uncovered apart from Brigetio, but unfortunately this has still not been published. During 1973, a glass workshop was uncovered in Intercisa, 30 metres southwest from the camp. Five kilns and about 200 kg of batch were revealed. This workshop must have been used until the around 260 AD. After the *cohors I Aurelia Antoniniana milliaria Hemesenorum,* a Syrian archer troop, was moved to Intercisa, several eastern civilians came and settled down here.[4] They were likely to have introduced the trend of a new style of beaker with applied trails, the so-called snake-thread glass in Pannonia. Eastern masters could have been working in Brigetio and in Aquincum as well.[5] Apart from the two towns mentioned above we have only, some indirect proof of glass making in other towns. For example both a stamped clay tablet, wich was used to make mould-blown bottles and a glass fragment with the positive image of the same stamp were found in Aquincum.[6]

The glass workshop in Brigetio

The partial remains of two kilns were found in the workshop at no. 13 Komárom/Szőny in Vásártér (Pl. 1.1). One of them had a rectangular shape with an apsis on one side and was divided into two separate parts. The other kiln was circular (Fig. 2). The kilns could only be identified with the help of the ground plans and nothing is known about their upper parts. No tegulae were found in the walls of the kilns, except for one fragment in the rectangular kiln. The walls of the kilns consisted of burnt red clay. Their diameters are approximately 60 cm and the distance between the two kilns is 30 cm. A black, charred layer was found next to the circular example and must have been the ash of the wood used for heating the kiln. The fire hole of this circular kiln faced the rectangular shaped kiln.

There are two possible analogies for the reconstruction of the rectangular kiln. The first presumes that it could have been an annealing kiln since it was similar to the rectangular version with a semi-circular apse found in Hambacher Woods near Cologne. According to F. Seibel, the kiln found in Germany was an annealing oven with a fire place within the rounded part, which was built slightly lower.[7] Another cooling unit found in Kaiseraugst has a similar placement. A. Fisher accepted F. Seibel's theory, so the rectangular kilns with a semi-circular fire place were identified as annealing units.[8] The kiln found in Poetovio had a similar shape as well.[9]

The other option is that this rectangular kiln with two separate parts could have been connected to the circular example and may have operated like the kiln reconstructed by M. Taylor and D. Hill. The circular kiln is the melting furnace while the connected rectangular example is the lehr.[10] The small distance between the two units provides some evidence to support this theory, although we do not know anything about the construction of these furnaces.

Thus, it can be concluded that the circular kiln must have been the melting furnace, while the rectangular example was the annealing furnace while they might have been connected to each other. A big piece of raw material was found in the circular kiln, which means that it was a melting furnace, but other finds were not uncovered.

In the courtyard of the striphouse, four big rubbish pits were found consisting of the following: cylindrical *moiles*, spoiled pieces, raw materials in chunks, additives used for coloring, almost the whole amount of the spoiled glass

4 Visy 1974, 316.
5 Barkóczi 1988, 32.
6 Barkóczi 1988, 29.
7 Seibel 1998, 142-144.
8 Fischer 2009, 80.
9 Korošec 2004, 67-69.
10 Taylor and Hill 2008, 249-270.

Fig. 1: Ground plan of Brigetio. Made by D. Bartus.

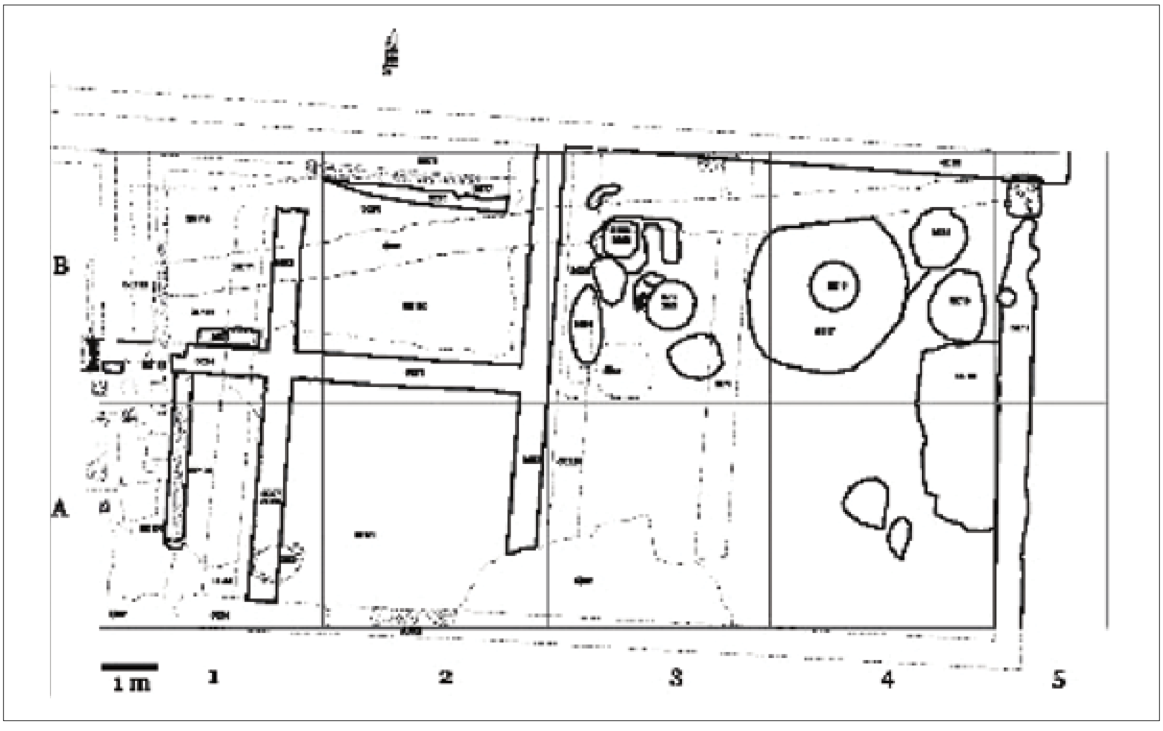

Fig. 2: Ground plan of the striphouse and the glass workshop. Made by Á. Gelencsér.

beads, glass rods, glass trails and glass drops bearing tool marks. Therefore, the waste from the glass making procedure must have been put into these pits (Pl. 1.2). It is not known if the pits were either temporarily used for keeping waste material, which could have been recycled, or if they were used as final dumps. One pit located near the circular furnace includes almost the whole amount of the spoiled glass beads and may have been the final production of the workshop.

A post hole with glass chunks in the courtyard was found, which might have been part of a lightweight construction to protect the work-

Plate 1: 1 - The remains of the two furnaces, photo Á. Gelencsér; 2 - The waste of glass making process; 3 - The chunks of raw materials; 4 - The fragment of a marvered block; 5 - The roughly curved stone tool; 6 - The bronze tool with a hook, all photos D. Bartus.

shop and was supposed to be a roof. The well in the middle of the courtyard was also used during the operation of the workshop, although it had been placed there in an earlier construction period. Fragments of 8 glass vessels and 5 pieces of melted glass were also revealed in the inner ring of the well.

In the rubbish pits, a huge amount of raw materials (20-30 kg) was found.[11] The colours of the pieces of raw material are quite similar: due to the colouring, they vary from translucent dark green to opaque dark blue or blackish. It is important to mention that the colour of the pieces includes transition, as they did not melt homogenously; others are translucent; and some opaque. These raw materials were deliberately smashed into splinters with sharp fractural surfaces during the melting process so as to make the portioning easier (Pl. 1.3). Most glass beads seem to be made of this material. The composition of one piece of raw material has also been analyzed.

Furthermore, during the production of the glass beads, pieces of glass drops, some melted glass and some glass trails were found (Pl. 1.2). Colourless or naturally coloured, curved and cylindrical *moiles* with sharp edges, which are the waste products of the iron blowing process, were found among the finds.[12] These finds provide evidence that not only glass beads but also glass vessels were produced. Most glass drops and glass trails found in the pits have tool marks, probably caused by different pincers, which were triangular, rounded or ended in a hook (Pl. 2.1). Among the finds, there is a glass disc cut into two pieces (Pl. 2.3). Moreover, three different tools were found in the pits: a bronze tool, a marvered block and a roughly-carved disc, of which the last two are made of metamorphic chalkstone.

The depression of the bronze tool can be seen on many fragments (Pl. 1.6). It has a hook on its end, which indicates the tool might have been used in the decorating process. After having rolled the different coloured trails on the beads, the beads were then pulled with this tool before being rolled on the marvered block (Pl. 2.2). By using this method a so-called bird feather pattern was made. A fragment of a stone slab also has a burnt splash in the middle of its flat surface. This marvered block was used for modelling and decorating the beads and vessels, and also for cooling their surfaces (Pl. 1.4). The thin glass trails and flecks were pressed into the beads while they were being rolled on this slab. A roughly curved tool is also worth mentioning (Pl. 1.5). This object with a 5 cm diameter and thickness of 1.5 cm was found together with the marvered block and bore a thin glass layer on its upper part. Concentric circles can be seen on its surface, which could have been a result of turning the tool round and round while it was touching the glass object. The glass layer confirms that the tool must have been used for glass making. It might have been used as a base-form of the cylindrical, mould-blown vessels or to form simple blown vessels. No analogy of the disc has yet been found.

Glass beads

One hundred and twenty-one partly fragmentary and partly complete beads were uncovered in the pits, of which 107 pieces can be identified by their forms. There are altogether only 8 complete beads; the others are faulty or defected. Most pieces are deformed and traces of sharp fractures and cuts can be seen on them. Spherical, cylindrical, biconical shapes are represented among the glass beads (Pl. 2.6).[13] Most of the beads are multicoloured and made with opaque glass (69,42%). Only a few translucent, green fragments were found (33 pieces). They are mostly decorated with only 10 glass beads without any decoration – 8 of them are opaque. Among the colours are the following: 63 dark blue, 15 dark green, 12 glass green, 3 colourless, 2 white and light blue, 1-1 sea blue and grass green. The colours used on the decoration are always opaque; there is a white decoration on 56 beads, yellow on 27 pieces, red and turquoise blue on 3-4 pieces or a combination of these.

11 Fórizs *et al.*, 2012. Related to the chemical composition of raw materials.

12 Price, Cool 1991, 26.

13 Dévai, Gelencsér, 2012. Regarding a longer article including a catalogue of the beads.

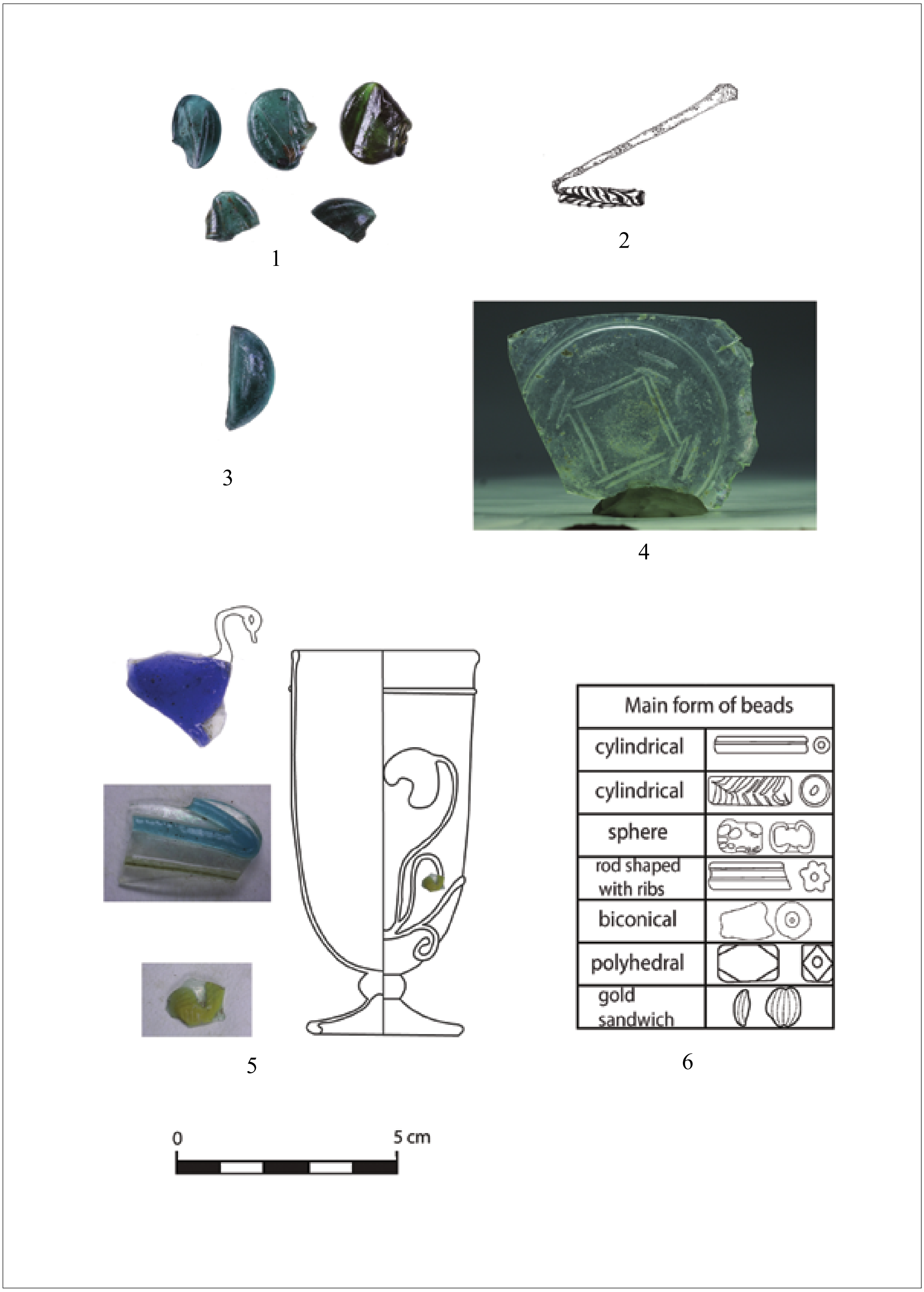

Plate 2: 1 - Glass drops with toolmarks; 2 - Decoration method with a bronze tool (drawing K. Dévai); 3 - The cutted glass disc; 4 - The base of a bowl with facett-cut decoration; 5 - Fragments of cylindrical beakers with flower and bird decoration, all photo D. Bartus; 6 - The main forms of glass beads.

Considering the shape of the beads, there are 40 pieces of small and big cylindrical examples (Pl. 3.1). The cylindrical glass beads occurred in Pannonia between the 1st century AD and the beginning of the 5th century AD. They are usually opaque, black and decorated with yellow, white, blue, or green applied trails. We only know of two opaque, white beads with turquoise blue decoration, which is very rare, although similar ones appear in Pannonia.[14] The white feather pattern on opaque, cylindrical, black beads is typical along the river Danube and the Rhine,[15] and appears frequently in our workshop. To achieve this decoration the tool with a hook on its end mentioned above was used. The second frequent shape is spherical (Pl. 3.7). Altogether we have 37 pieces; apart from 1-2 translucent pieces they are opaque and mostly decorated with glass trails or with multicoloured flecks. The 7 long rod shaped beads with 6 or 7 ribs on their surface are worth noting (Pl. 3.5). Their cross-sections have the shape of a petal. These beads were made of translucent, naturally coloured material or were opaque, dark blue. This type of bead did not occur on any other sites in Pannonia. One possibility is that they were unfinished products since they were not cut into smaller pieces. The small glass beads with 4-6 petals were used by the Sarmatians and are also known from the Gepids' grave.[16] Based on these facts, the glass beads could have been produced for the Sarmatians in Brigetio. Another assumption is that the long rod shaped beads with ribs were finished products as they are analogous with specimens from the West part of Poland, where they are well known in Wielbark and Przeworsk culture.[17] This long type of bead only existed for a short period of time, from the end of the 2nd century to the first decades of the 3rd century. The fact that the production of this type in Brigetio, together with their brief overall occurrence, confirms that the workshop only operated for a short period in the first decades of the 3rd century. This long bead also existed in the area of Chernyakhov culture.[18] Among the collection are also 12 biconical, big sized glass beads (Pl. 3.2), whose decoration is similar to the cylindrical specimens. Only one polyhedral bead with a square section and diamond shape facets was found in isolation and so it cannot be unequivocally identified as the part of the workshop (Pl. 3.3). Made of translucent dark blue, this type of bead occurred in the Barbaricum from the 2nd century AD before spreading all over the Empire during the 3rd century AD.[19] In addition, there is a unique, so-called gold sandwich bead with a thin gold film between the two layers of translucent glass (Pl. 3.4).

Fragments of glass vessels

The several fragments of glass vessels are not direct proof of their production since vessels were systematically collected and recycled in Roman times. Therefore, the fragments found in the rubbish pits might not have been products of the workshop, but instead may have been cullet. However, some curved fragments also originate from the blow-pipe (moiles), which strengthens the evidence for the production of glass vessels in this workshop. Some cylindrical beakers with flower and bird ornaments, of which one type is of Syrian origin,[20] were also uncovered (Pl. 2.5). They vary in colour: from colourless trails to opaque yellow, white and blue. The same white and yellow can also be seen on the beads' decoration. Other white and yellow pieces were also discovered and are judged to be coloring additives. The same colouring additives and colours dominate the decoration of both the beads and the beakers with Syrian origin, which provides proof of the production of this type in the workshop. The annealing furnace also supplies additional proof of the manufacture of vessels, which was not needed to make glass beads. There is a bot-

14 Swift 2000, 98.

15 Swift 2000, 112.

16 It was a find from the Gepids assemblage, Hajdúnánás-Fürj-halom-dűlő, Hungary. I am very grateful to Zs. Rácz for this unpublished data.

17 Tempelmann-Maczyńska 1985, 39.

18 Likhter 1998, 193, fig. 2.

19 Swift 2000,102; Riha 1990, 90-91; Bartus 2003, 25-26.

20 Barag 1967, 63-65; Barkóczi 1981, 35-62; Stern 2001, 138-139.

tom of a colourless bowl of extremely good quality with an applied base ring. The base includes some facet-cutting: a square of double lines standing on one of its angles, with an oval shape in the middle of the square and some surrounding ovals (Pl. 2.4).[21] The fragment originates from the period after the workshop was shut down.

Fragments of window glass

Several fragments of windowpanes were found in the rubbish pits (Pl. 3.6). They were not made of blown glass, but were made of casted glass, which was poured into a wooden frame scattered with sand and thus produced a pane where one side is harsh and becomes progressively thicker by its edges. They were produced due to local demand.

Conclusions

Our glass workshop operated within the limits of the civil town in a short period of time. Both glass beads and vessels were produced in two furnaces, which could have been a circular melting furnace with an attached lehr. However, there is insufficient evidence to support this theory. The fragments of colourless cylindrical beakers with flower and bird patterns, those with a chequer design and the fragments of vessels with oval facets prove that production was active in the first half of the 3rd century. It is worth noting that some other little workshops must have existed in the Hungarian part of Pannonia including Intercisa, Aquincum and possibly Arrabona.

Plate 3: 1 - Cylindrical beads; 2 - Biconical beads; 3 - Polyhedral bead; 4 - Gold-glass bead; 5 - Rod formed ribbed beads; 6 - Fragment of a window pane; 7 - Spherical beads, all photos D. Bartus.

21 Barkóczi 1986, 166-189; Stern 2001, 137. Bowls with facet-cutting were classified by L. Barkóczi from Pannonia and these could have also been manufactured in a Pannonian workshop.

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LE VERRE DÉCOUVERT DANS LES THERMES ROMAINS D'ERÉTRIE (EUBÉE, GRÈCE)

Avant-propos

Le verre présenté dans cet article est issu de fouilles récentes qui se sont déroulées de 2009 à 2011 à Erétrie sur l'île d'Eubée, sous l'égide de l'Ecole suisse d'archéologie en Grèce. Les recherches sur le terrain se sont poursuivies durant les années 2012 et 2013, mais la verrerie mise au jour durant ces deux dernières campagnes de fouille n'a pas pu être prise en compte dans cette étude. Cet article a donc pour but de présenter les premières constatations établies lors de l'étude de ce nouveau matériel.

Découverte d'un complexe thermal

Le chantier archéologique pris en considération se situe dans la parcelle E/600 SW – selon le quadrillage de la ville – et a été baptisé "Terrain Sandoz".[1] Il se trouve dans une zone particulièrement riche en vestiges d'époque romaine, avec un quartier artisanal et le temple du Sébasteion au Nord (E/600 NW) et un quartier d'habitations et de probables boutiques à l'Est (O.T. 740).[2]

Le bâtiment principal mis au jour est un vaste complexe thermal dont l'entrée donne sur un des axes routiers principaux traversant la ville du Nord au Sud, de l'acropole au port de la cité. On accédait à l'établissement thermal par l'Est, en débouchant dans un vaste vestibule à atrium (Fig. 1: V) bordé au Sud par deux pièces à peine dégagées dont la fonction n'est pas établie. A leur sujet, on ne peut en effet pas dire si elles appartenaient aux thermes ou s'il s'agissait de locaux indépendants, par exemple. Les pièces qui composent les thermes proprement dits sont caractéristiques de ce type d'établissements : le vestiaire – ou apodyterium – tout d'abord (Fig. 1: A),

1 Pour les rapports de fouille, voir Theurillat *et al.* 2010; Theurillat *et al.* 2011 et Theurillat *et al.* 2012.

2 Le verre retrouvé dans les quartiers bordant ce nouveau chantier archéologique a fait l'objet de plusieurs publications: Demierre Prikhodkine 2005a; Demierre Prikhodkine 2005b; Demierre Prikhodkine 2009 et Demierre Prikhodkine 2012.

pavé d'une mosaïque à galets noirs et blancs, bordé par des banquettes en marbre; il possède une porte au Sud, qui permet l'accès à un local dont la fonction n'est pas définie. Ensuite, on accède aux pièces d'eau : le frigidarium, avec une piscine froide rectangulaire et un espace pour les bains par affusion (labrum), le tepidarium et enfin le caldarium aménagé sur hypocauste[3] (Fig. 1 : F, T, C). L'itinéraire de sortie empruntait probablement le même parcours.

En l'état actuel des connaissances, les thermes semblent avoir été construits en une seule phase, que les archéologues situent aujourd'hui au milieu du IIe siècle de notre ère. Une réfection du frigidarium et du tepidarium a pu être observée, sans qu'elle puisse être datée précisément.

L'abandon des thermes peut être placé avec assurance dans la deuxième moitié du IIIe siècle grâce à la découverte dans l'impluvium du vestibule d'un trésor monétaire de 201 antoniniens, dont le plus tardif date de 254 après J.-C. Les couches de destruction qui scellent le bâtiment ont livré une céramique abondante attribuable à la deuxième moitié du IIIe siècle et au début du IVe siècle.[4]

Au Nord des thermes, trois fours à chaux ont été fouillés et deux autres repérés. Ils sont à mettre en relation avec la construction de l'établissement thermal et probablement avec d'autres activités artisanales nécessitant l'usage de chaux.[5]

Le verre une fois encore à l'honneur

La quantité de verre retrouvée dans ce nouveau quartier est importante, puisqu'en ont été extraits plus de 2000 fragments.[6] 607 formes, représentant un peu moins du tiers des trouvailles, ont pu être prises en compte dans l'étude typologique. On relèvera toutefois un fait déjà observable dans le Quartier du Sébasteion, à savoir que cette verrerie était majoritairement (58%) localisée dans le grand four à chaux au Nord des thermes et dans une moindre mesure dans l'impluvium du vestibule de l'établissement thermal (28%). Les récipients restants furent retrouvés dans les petits fours de l'Ouest, l'aire de chauffe du caldarium et la région au Nord du vestibule, à l'extérieur des thermes. Hormis le vestibule, les pièces intérieures du complexe thermal ne contiennent que très peu d'attestations de verre, constatation qui a également été faite pour le reste du mobilier archéologique.

L'analyse du verre s'est concentrée principalement sur les trouvailles faites dans les thermes et dans le four à chaux le plus imposant.

Verrerie localisée dans les thermes

Le verre est globalement mal conservé et le corpus établi présente un nombre important de lèvres et de bases de types non déterminés. Toutefois, les formes retrouvées sont variées – en majorité déjà rencontrées sur les autres chantiers archéologiques d'Erétrie – et, contre toute attente, la vaisselle de table est prépondérante avec une majorité de gobelets, de plats et de coupes, puis de cruches et de bouteilles, en regard des récipients de toilette.

Le verre retrouvé à l'intérieur des thermes était principalement situé dans l'impluvium du vestibule. On y retrouve des bouteilles à section carrée ou cylindrique de type Isings 50 et 51,[7] notamment un fragment de bouteille présentant un début de côte sur la panse, qui pourrait être soit une variante du type Isings

3 Les fouilles 2012 se sont particulièrement concentrées sur le dégagement des pièces tiède et chaude. Il paraît très probable qu'il y ait également une pièce intermédiaire de transit (laconicum) entre le tepidarium et le caldarium.

4 Sauf mention contraire, toutes les datations se comprennent après J.-C.

5 On citera notamment son utilisation dans l'épuration des eaux et des canalisations, dans l'assainissement de l'air ou comme détergent textile, par exemple.

6 A titre comparatif, on retrouve grosso modo le même nombre de fragments dans tout le Quartier du Sébasteion situé au Nord des thermes: voir Demierre Prikhodkine 2005a et Demierre Prikhodkine 2005b.

7 Isings 1957, 63-67, no. 50 et 67-69, no. 51.

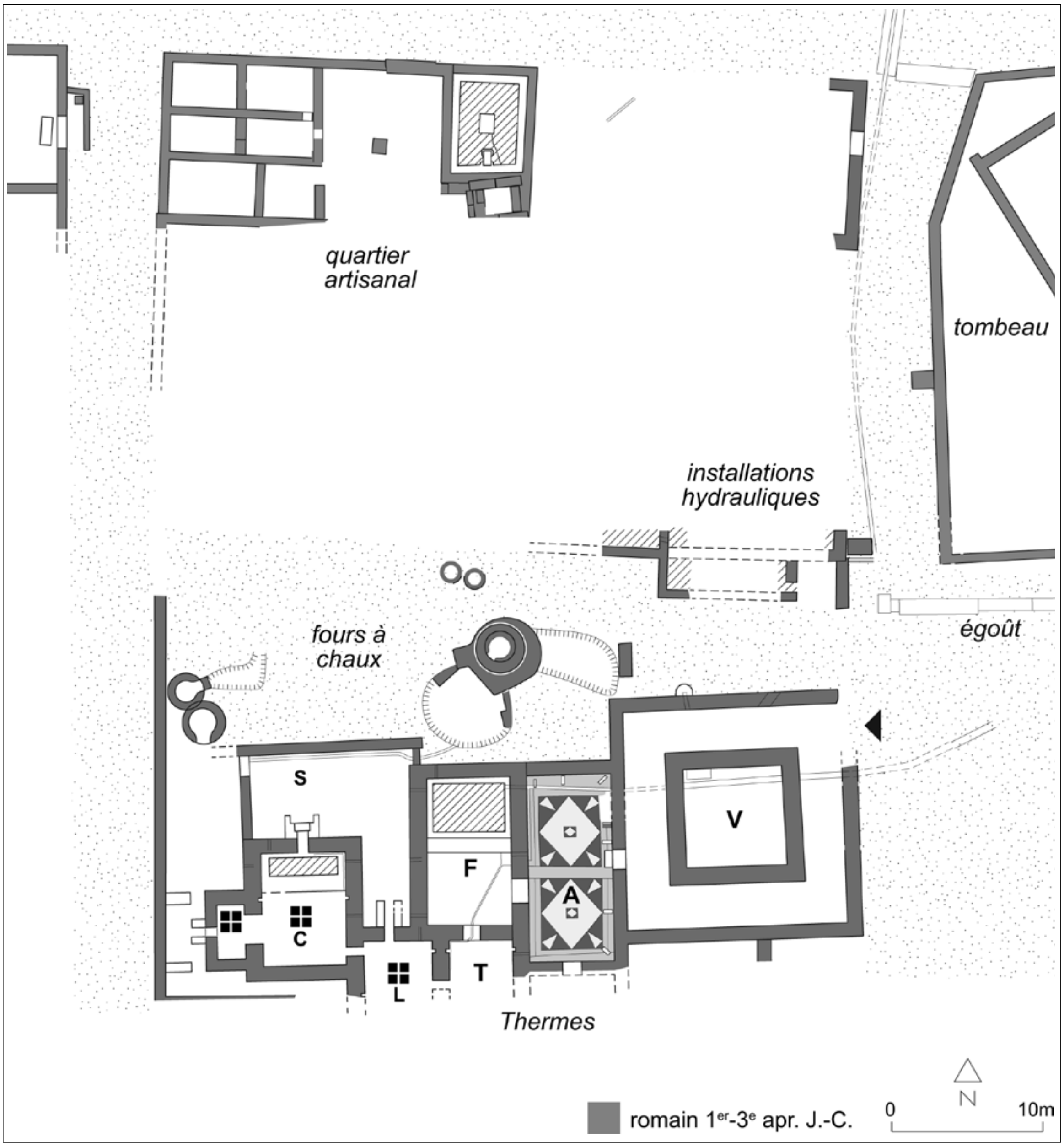

Fig. 1 : Plan du Quartier des thermes (ESAG).

51[8] (Ier au IIIe siècle), soit une variante du type Isings 98[9] (1ère moitié du IIIe siècle), caractérisée par des dépressions en lieu et place de côtes (Fig. 2a).

Parmi les récipients servant à boire, les gobelets sont majoritaires. Les fragments les plus fréquents sont des lèvres simples arrondies, dans le prolongement de la panse ou évasée, de type AR 77, datées du Ier au début du IIIe siècle, ou de type AR 98.1B et AR 98.1C / Isings 85b, datées du milieu du IIe à la fin du IIIe siècle, voire du début du IVe siècle. Plusieurs fragments de panses de gobelet avec décor de points en relief façonnés par pincement du verre ont également été mis au jour dans le vestibule.[10] Cette forme,

8 Isings 1957, 67-69, no. 51.

9 Isings 1957, 118, no. 98.

10 Rütti 1991, 70, no. AR 60.3, pl. 62; Isings 1957, 116, no. 96b2; Davidson Weinberg and Goldstein 1988, 59, no. 161, pl. 4-22; Alarcaõ and Etienne 1976, 189 et 191, no. 193, pl. XLI ; Whitehouse 2001, 134-135, nos. 1113-1115.

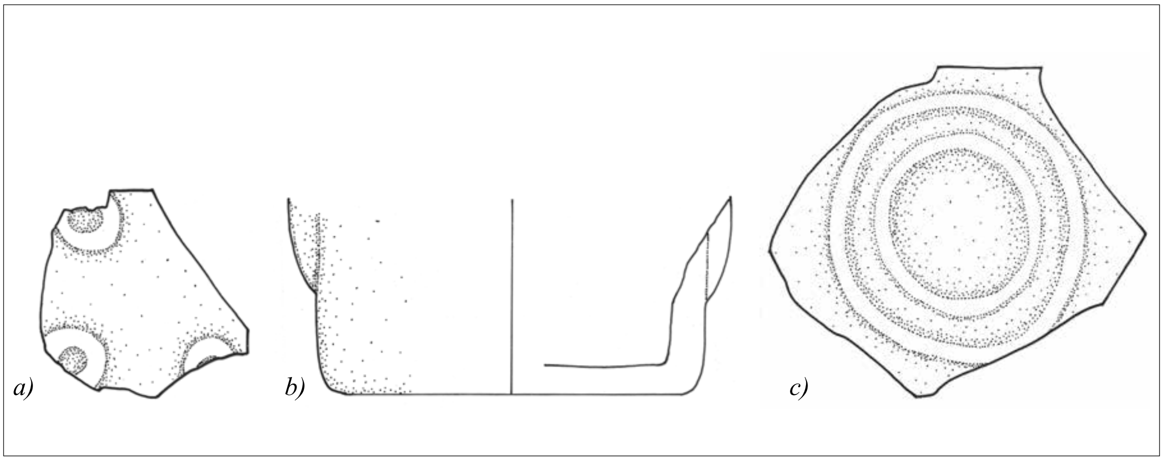

Fig. 2 : Bouteilles. a) cylindrique, bleu-vert. b) section carrée, vert pâle. c) hexagonale, vert.

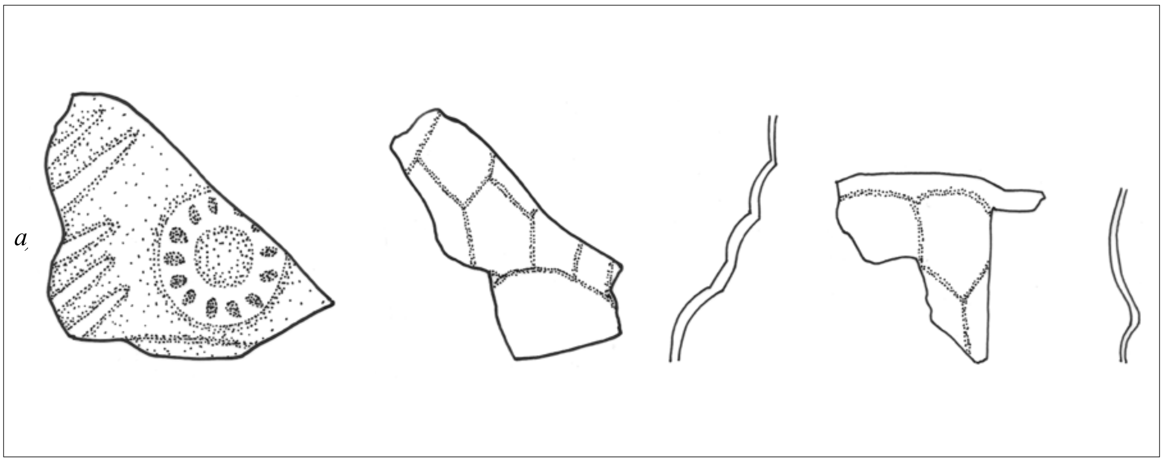

Fig. 3 : Gobelets. a) incolore. b) blanc opaque.

datée entre le IIe et le IVe siècle, avait été retrouvée pour la première fois à Erétrie dans le Quartier de la Maison aux mosaïques.[11]

En matière de récipients servant à contenir des aliments, on retrouve quelques attestations de coupes moulées côtelées de type Isings 3a-b[12] datées du Ier siècle avant J.-C. au Ier siècle après J.-C. Les autres coupes, toutes soufflées, sont majoritairement des formes appartenant aux types Isings 87 / AR 79[13] et Isings 115 / AR 109.1-2,[14] caractérisées pour les premières par une panse légèrement évasée et une lèvre repliée vers l'extérieur, et pour les secondes par une lèvre repliée vers l'extérieur pour former un rebord tubulaire.

Une coupe encore inconnue à Erétrie (Fig. 5), présente une lèvre arrondie dans le prolongement de la panse, une paroi convexe, puis concave, sans que l'on sache sur quel pied elle reposait. Ses caractéristiques permettent de la rattacher à la coupe Isings 24[15] datée du Ier siècle.

Les récipients de toilette, qui, jusqu'à aujourd'hui, étaient très peu représentés à Erétrie, sont nombreux et variés sur ce nouveau chantier archéologique. Toutefois, malgré leur diversité, ils se retrouvent en moindre quantité à l'intérieur du complexe thermal.

Les balsamaires sont les récipients de toilette les plus fréquents dans le vestibule : on retrouve en majorité des fonds caractéristiques

11 Demierre Prikhodkine 2012, 153, fig. 3e.
12 Isings 1957, 18-20, no. 3a-b.
13 Isings 1957, 104, no. 87; Rütti 1991, 84, no. AR 79, pl. 74.
14 Isings 1957, 143, no. 115; Rütti 1991, 104-106, no. AR 109.1-2, pl. 90-92.
15 Isings 1957, 39, no. 24.

formant des panses coniques (Fig. 6a, d) ou bulbeuses (Fig. 6e) - datés du IIe siècle[16] – ou des formes plus étroites à fond plat. Leur diamètre varie entre 1.3 cm et 8 cm. On relève également quelques attestations de petits flacons, dont une embouchure droite avec un long col cylindrique (Fig. 6h).

En dernier lieu, on note passablement de fragments de verre à vitre de couleur naturelle bleu-vert ou vert, mats sur une face et brillants sur l'autre, dont la majorité se trouvent dans le vestibule et, dans une moindre mesure, dans le vestiaire.

Verrerie localisée dans le four à chaux

Le plus grand des 5 fours à chaux mis au jour contenait, à l'instar du four du Quartier du Sébasteion,[17] la majorité des trouvailles de verre. Celles-ci se répartissent à l'intérieur même du four, ainsi qu'à l'emplacement de l'aire de chauffe.

Etant donné que c'est à cet endroit que l'on a retrouvé la majorité du verre, c'est aussi là qu'il y a le plus grand choix de formes et de types. Les gobelets sont la forme nettement prédominante, suivie par les balsamaires, puis par les bouteilles à section carrée. L'essentiel des formes rencontrées est déjà connu à Erétrie.

Parmi les gobelets, les formes les plus fréquentes identifiées sont les mêmes que celles que l'on retrouve dans le vestibule des thermes (voir plus haut). La plupart de ces contenants sont des formes simples et lisses, sans décor apparent, outre quelques lignes en relief ou incisées ou petites côtes fines incisées. On relève quelques rares décors dans la catégorie des gobelets : un fragment incolore avec une roue et des feuilles de palme (Fig. 3a) appartient à un type populaire de gobelets portant généralement une inscription exhortant le buveur à saisir la victoire ou à prendre du plaisir.[18] Ce type de dé-

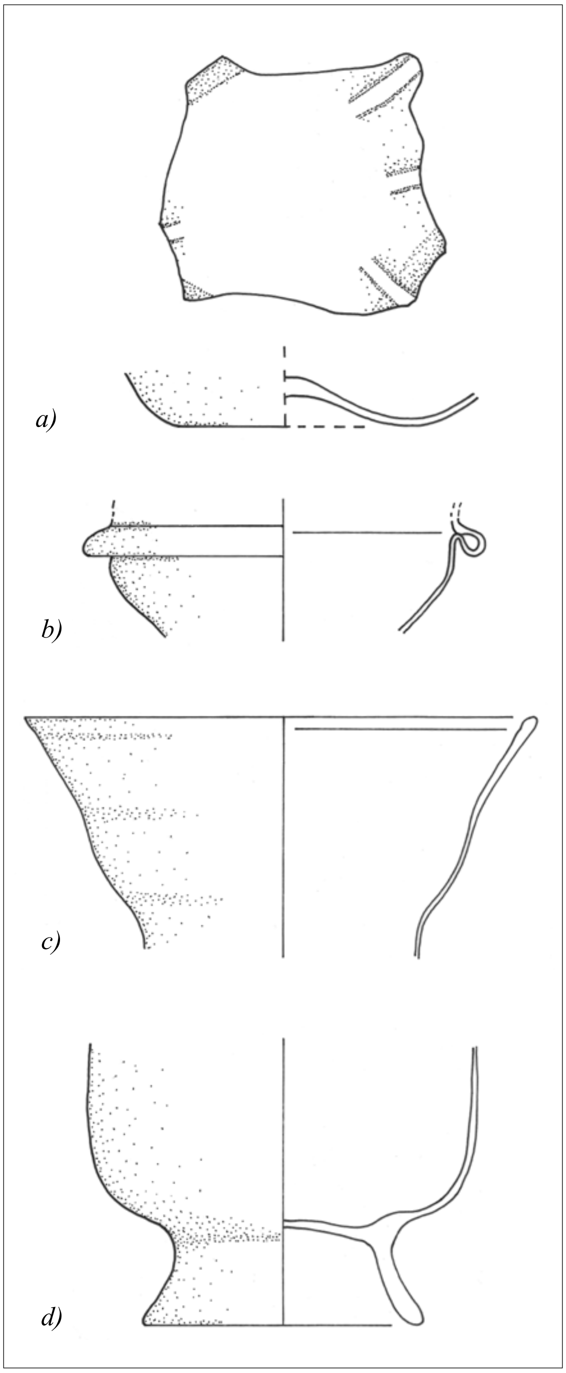

Fig. 4 : Coupelles et bols. a) coupelle, bleu-vert. b) coupelle, bleu-vert. c) bol, vert-jaune pâle. d) bol, incolore à tendance verte.

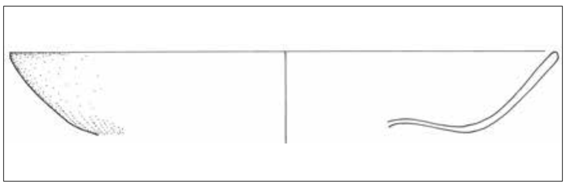

Fig. 5 : Coupe, incolore.

16 Panses coniques: Arveiller-Dulong and Nenna 2005, 238, no. 704, pl. 51; panses bulbeuses: Arveiller-Dulong and Nenna 2005, 233, no. 685, pl. 50.

17 Voir Demierre Prikhodkine 2005a et b.

18 Arveiller-Dulong and Nenna 2005, 194, no. 536, pl. 38 (2e moitié Ier siècle); Stern 1995, 98-99 et 274, nos. 2-3.

cor avait pu être observé dans le Quartier des amphores panathénaïques sur un petit fragment n'excédant guère 2 cm de côté.[19] Cette nouvelle trouvaille atteste de manière certaine la présence de ce type de gobelets à Erétrie. Un autre décor à facettes (Fig. 3b), inédit à Erétrie, est présent sur une panse qui appartient vraisemblablement à un gobelet de type Isings 21 / AR 45.1-2,[20] daté de l'époque flavienne à celle d'Hadrien.

Le contenu du four à chaux a révélé une riche variété de récipients de toilette. Outre des récipients semblables à ceux issus du vestibule des thermes, on retrouve une série de balsamaires sous la forme de longs cols fins aux bords évasés à horizontaux, arrondis, formés ou non par pliage (Fig. 6f-g), puis de bases aux formes coniques ou bulbeuses (Fig. 6b-c), datées du milieu du I^er^ siècle au IV^e^ siècle.[21] Plusieurs petits flacons à col long et panse bombée ou ovoïde (Fig. 6i-j) ont été mis au jour, ainsi qu'un flacon à col court (Fig. 6k) et panse vraisemblablement piriforme. Trois fragments d'aryballes à anses delphiniformes, sur les quatre retrouvés, faisaient partie du contenu du four à chaux, le dernier ayant été mis au jour au niveau du caldarium des thermes. Il s'agit dans tous les cas d'aryballes de type Isings 61 / AR 151.1-2,[22] datées du I^er^ au III^e^ siècle.

La plupart des bouteilles retrouvées dans le four sont des bases non décorées, à section carrée ou cylindrique, dont les formes sont déjà connues à Erétrie. Parmi les bases décorées, on retrouve des cercles concentriques en relief, un fragment de roue à rayons et des petits cercles placés aux quatre angles de la bouteille (Fig. 2b), décor inédit à Erétrie. On note également la présence de fragments d'une bouteille hexagonale, sous la forme d'une base avec décor de cercles concentriques (Fig. 2c) et de fragments de panse.

Le four contenait aussi des attestations de récipients servant à contenir des aliments, toutefois en moindre quantité. A côté des formes déjà connues à Erétrie, on relève, parmi les formes moulées, un fragment de fond de coupe à décor côtelé (Fig. 4a). Parmi les formes soufflées, une petite coupe se caractérise par une panse bombée et un décor tubulaire formé par le pliage de la paroi, le reste du récipient (notamment la lèvre et le pied) n'étant pas conservé (Fig. 4b). Dans la catégorie des bols, deux nouvelles formes se distinguent : une lèvre de bol arrondie formant une embouchure large et conique (Fig. 4c), puis une base sur pied haut, avec une panse vraisemblablement cylindrique (Fig. 4d). L'état de conservation de ces deux récipients ne nous a pas permis de les rattacher à un type précis.

Les verre est-il «in situ» dans les thermes?

La localisation du verre de ce chantier, amassé principalement dans le four à chaux au Nord de thermes et dans le vestibule, génère la question suivante : le verre est-il in situ ou provient-il d'un autre contexte aux alentours, encore indéterminé?

Tout comme pour le verre, l'essentiel de la céramique à l'intérieur des thermes est concentrée dans le vestibule.[23] Le matériel peut être divisé en deux grands ensembles provenant en premier lieu du remblai de construction et en second lieu des couches de destruction. Le mobilier céramique issu de ces dernières comprend de nombreuses amphores, de la vaisselle de table, mais aussi de nombreuses céramiques de cuisine. L'analyse du verre du vestibule montre que l'on retrouve en premier lieu de la vaisselle de table (gobelets, coupes, plats et bouteilles) et que les récipients de toilette sont certes bien représentés en comparaison des autres chantiers archéologiques d'Erétrie, mais de manière toutefois moins marquée que

19 Demierre Prikhodkine 2009, 107, fig. 6a-b.

20 Isings 1957, 37-38, no. 21; Rütti 1991, 59, no. AR 45.1-2, pl. 52. Ce décor peut également se trouver sur d'autres récipients, comme sur un plat du musée de Corning: Whitehouse 1997, 234-235, nos. 297-299.

21 Isings 1957, 97, no. 82A1; Rütti 1991, 121, no. AR 140, pl. 102-103.

22 Isings 1957, 78-81, no. 61; Rütti 1991, 127-128, no. AR 151.1-2, pl. 108.

23 Les informations concernant l'étude céramologique ont été obtenues auprès de Guy Ackermann qui a dirigé une partie des travaux sur le terrain lors de la fouille de ce quartier.

la vaisselle de table. La datation du verre de ces couches de destruction se situe pour l'essentiel entre le milieu du IIe siècle et la fin du IIIe siècle, soit en adéquation avec la datation actuelle des thermes.

Bien qu'il soit difficile d'être catégorique sur la question de la provenance du verre, la présence de récipients de table dans les thermes ou aux alentours n'est pas étonnante. Contrairement à notre vision moderne aseptisée des bains thermaux, on y mangeait et on y buvait dans l'Antiquité, comme en témoignent plusieurs sources antiques, dont Sénèque et Martial notamment.[24] La vaisselle de table n'est donc pas étrangère aux thermes. Quant aux récipients de cuisine en céramique, il faut peut-être supposer la présence d'échoppes où l'on pouvait se restaurer. Des pièces au Sud du vestibule n'ont pas été fouillées et pourraient apporter des éléments de réponse à ce sujet.

Que penser du verre situé dans le four à chaux?

Pour l'ensemble du mobilier retrouvé dans le four à chaux, outre la vaisselle de table, nous relevons une forte présence de récipients de toilette, avoisinant les 20% de la vaisselle retrouvée. Cette proportion est particulièrement importante en regard des autres secteurs de la ville antique d'Erétrie, où les récipients de toilette sont quasi-inexistants. Peut-on pourtant, sans risque, attribuer ce verre aux thermes situés à proximité? Il reste difficile d'y répondre avec certitude, mais c'est ce que laisserait supposer la présence d'autant de récipients de toilette dans son antre. Selon l'étude céramologique, le four contient du tout-venant qui semble prélevé d'un peu partout. Les archéologues supposent que les habitants du quartier ont dû utiliser ces structures en creux, abandonnées après l'édification des thermes, pour y jeter leurs déchets. Le four aurait eu cette fonction de dépotoir au moins jusqu'à la fin du IIe siècle au plus tard d'après la céramique.

Le résultat de l'étude du verre des thermes romains d'Erétrie laisse plusieurs questions en suspens : une fois encore, les récipients sont re-

24 Sénèque, *Lettres à Lucilius*, 56 ; Martial, *Epigrammes*, XII, 19.

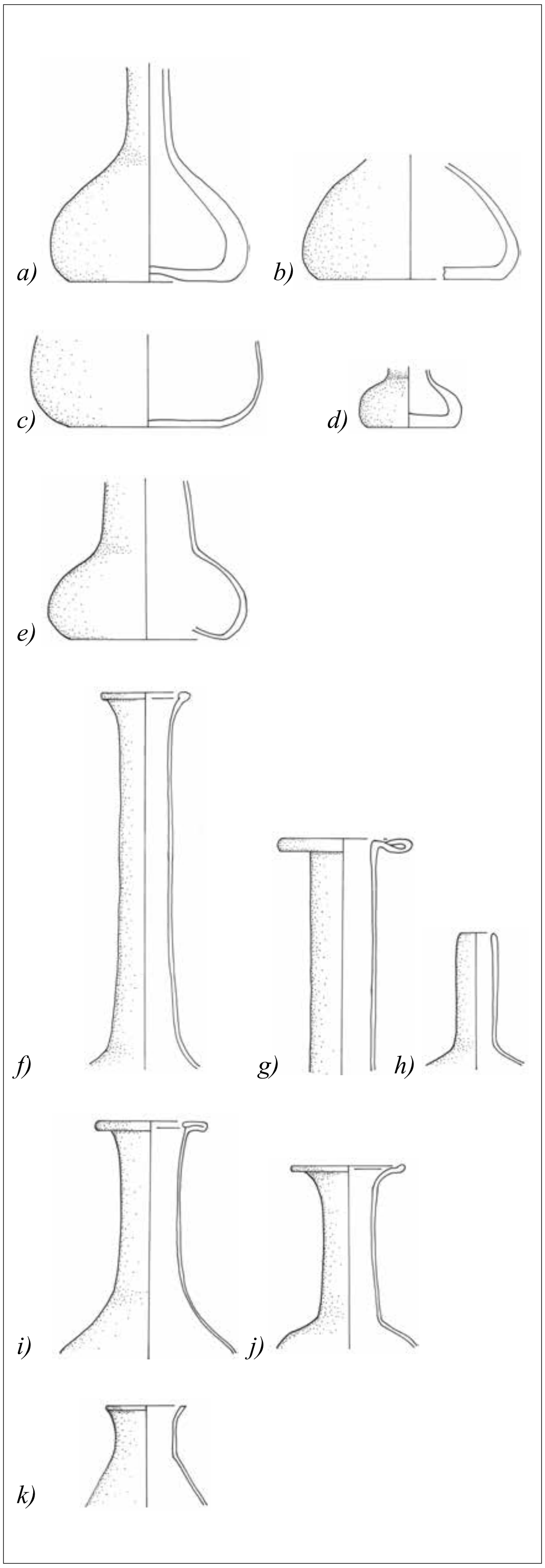

Fig. 6 : Récipients de toilette. a-e) balsamaires, bleu-vert. f) balsamaire, incolore à tendance verte. g) balsamaire, bleu-vert. h-k) flacons, bleu-vert.

trouvés en majorité dans un dépotoir (le four à chaux), tout comme cela avait été le cas dans le Quartier du Sébasteion au Nord[25] et, dans une moindre mesure, dans le Quartier des amphores panathénaïques à l'Est.[26] Rappelons que dans ce dernier cas, le verre avait été retrouvé en grande quantité dans un hypogée. Une explication fiable est difficile à proposer : les habitants utilisaient-ils toute structure en creux comme dépotoir dès son abandon ou faut-il y voir un grand nettoyage du quartier qui a eu lieu après l'abandon des thermes et qui serait en lien avec une possible réoccupation partielle des anciens habitats? Un tel nettoyage est avéré dans le Quartier du Sébasteion; il est moins évident dans les autres quartiers. L'étude de la période romaine tardive à Erétrie, amorcée par l'analyse de la céramique et par l'étude des vestiges paléochrétiens,[27] permettra peut-être de mieux appréhender l'évolution de ce secteur de la ville antique d'Erétrie. Le verre vient ajouter sa pierre à l'édifice et apporte de nouvelles données indispensables à la compréhension de ce secteur de la ville à l'époque romaine.

25 Voir Demierre Prikhodkine 2005a, 98 et Demierre Prikhodkine 2005b, 67.
26 Voir Demierre Prikhodkine 2009, 108.
27 L'auteure de cet article est en charge de l'étude des vestiges paléochrétiens et plus largement «tardifs» mis au jour à Erétrie.

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A FOREIGN FAMILY'S TOMB? RECONSIDERING THE GLASS FINDS FROM GEVA–ABU SHUSHA

An outstanding group of finds was exposed in a burial cave on the southern part of the Valley of Jezreel, near kibbutz Mishmar Ha-Emek, in the north of Israel (Map). The cave, with a central space and seven burial niches around it, has an entrance through a wide corridor with a built vaulted ceiling.[1] It is situated not far from the site of Abu Shusha (Tel Shosh, in Hebrew), identified as the town Gaba (Geva) mentioned in various ancient sources, the oldest being the lists of Thutmoses III of Egypt. A weight with the Greek name GABH was found nearby, as were many coins carrying the town's name. The coins are dated to an era starting in the year 61 BC, which is probably the date of the settlement's establishment.

The burial gifts found in the cave include pottery and glass vessels, metal utensils and containers, bone and metal implements. No bones of the interred survived. The cave had been robbed not long after the burial took place and most of the burial gifts were found in the central room, having been discarded by the robbers. Among the finds was a large group of glass vessels of special importance for its size, diversity and accurate chronological context. It included 54 glass vessels (two thirds of which were intact or restored) and a few glass beads and whorls.

The vessels represent three techniques and include a core-formed *amphoriskos*, six mold-blown vessels, and mostly free-blown bowls, beakers and bottles.

The large core-formed *amphoriskos*, missing its knob-base and one of the handles, is probably an heirloom (Fig. 1). The vessel of translucent olive-green glass with trail decoration in yellow and white belongs to a late Hellenistic subtype, possibly produced on the Phoenician coast and diffused in the Eastern Mediterranean from the

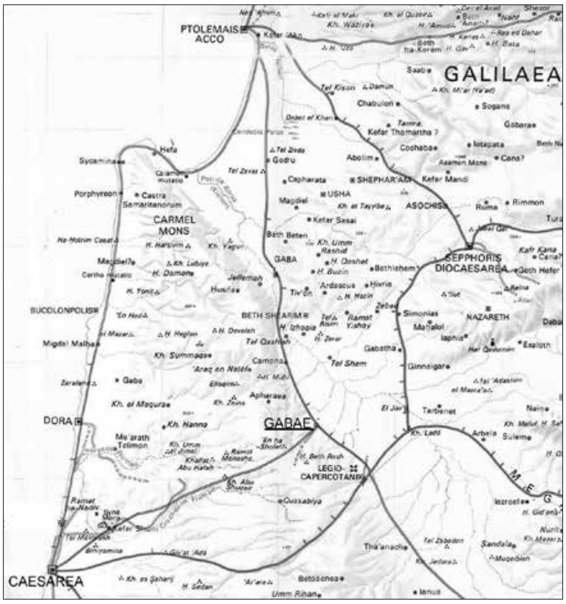
1 A partial report of the burial cave and its finds was published in Hebrew only (Siegelmann 1988). Apart from a few of the objects which were included in an Israel Museum exhibition at the Metropolitan Museum (Israeli 1986, 255–256 cat. nos. 135-140; 142-145), most of the group is on display in the Israel Museum.

1st century BC to the beginning of the 1st century AD.[2] The practice of keeping core-formed bottles, plausibly because of their high cost before offering them in the family tomb, is also known from the Second Temple period tomb at Ramat Rachel, Jerusalem, where a core-formed bottle was discovered alongside early blown glass.[3]

The mold-blown decorated vessels are outstanding in the group by their number and their state of preservation. Generally classified as Sidonian, they are dated to the 1st century AD. These mold-blown containers from Geva-Abu Shusha are rarely found in excavations and imply comparative wealth.

One of the most interesting and possibly the earliest form is a pyxis decorated with vegetal and geometrical motifs. Regrettably it has been preserved in very small (restored) fragments and without its lid (Fig. 2a). Parallel examples from museum and private collections are identical in size and decoration while they are mostly of white opaque glass, which possibly attest to a single workshop. Random finds from securely datable contexts include two lidded boxes from tombs in Athens dated to the early 1st century AD,[4] another from a late 1st century AD necropolis in Aquileia[5] and an intact light blue opaque pyxis from Grave 36 in the Krenides Eastern cemetery at Phillipi, Macedonia, dated to the first half of the 1st century AD.[6]

Two small hexagonal bottles from Geva feature an identical decoration of amphorae, fruit-filled vases and jugs framed within columns supporting a pointed arch (Fig. 2b). They were possibly blown into the same mold, but were finished by hand and have slightly different heights and rim forms. The distinctive architectural design featuring a high quality mold, as well as the opaque white glass, attribute these pieces to an early generation of



Map of northern Israel.

a type with a wide geographical range, dated by M. Stern not later than the third quarter of the 1st century AD.[7] Tombs at Tyre, Abila in Jordan and Tel Nebi Mend (Qedesh) in Syria should also be noted.[8] Two small body fragments from Neronian and later contexts at Knossos[9] are a rare non-funerary find. Additionally, a recent publication includes a bottle from a cemetery of Acanthus in Macedonia,[10] found with coins from the reign of Vespasian.

A welcome addition were two bottles (not yet published), which were revealed in a 1st century AD tomb at Ashkelon on the Mediterranean coast of Israel.[11] They are made of blue opaque and yellowish translucent glass while the design of arches framing rounded objects is less distinct than on the bottles from Geva-Abu Shusha. The decoration of the two bottles from Ashkelon is slightly different to those from Geva, indicating that they were made in different molds, probably manufactured in different workshops, and may originate to a slightly later period.[12]

2 For discussion of local finds see Jackson-Tal 2004, 13-16, 26.

3 Stekelis 1934-1935, 38-39, fig. 7, no.1.

4 Weinberg 1992, 123-124, nos. 94, 95.

5 Mandruzzato and Marcante 2007, no. 362, see therein further reference to a tomb in Slovenia.

6 Nikolaidou-Patera and Amoiridou 2010, 397-398, no. 480.

7 Stern 1995, 115-118.

8 Fuller 1987, 149-150, fig. 120, see further references therein.

9 Price 2002, 124-125, fig. 2, nos. 5, 6.

10 Trakosopoulou 2002, 85, fig. 13.

11 For a preliminary excavation report (glass not mentioned) see, Wallah 2000, 120.

12 Stern 1995, 115.

Fig. 1: Core-formed amphoriskos.

Fig. 2: Mold-blown vessels.

Although hexagonal bottles with birds are well-known from collections, the blue bottle from Geva-Abu Shusha is a rare specimen of the type revealed in an archaeological context (Fig. 2c). Its body is decorated with gabled façades, each frame carrying a different bird standing on an unidentifiable object in high relief. Stern places this type early on in the Sidonian series, dating it to before the mid-1st century AD,[13] while Barag places it later, sometime between the Flavian and Hadrianic periods.[14] A rare published parallel is a white bottle from the Krenides Eastern cemetery in Philippi, Macedonia from the first half of the 1st century AD.[15]

Vessels of these "Sidonian" series are extremely rare in Syro-Palestinian sites: a couple of small body fragments of hardly diagnostic types come from 1st century contexts at Gamla.[16] Surprisingly, they are missing from urban contexts in Jordan, Syria and even Lebanon.[17] Worth noting is the discovery in Jerusalem of larger and higher quality mold-blown glass vessels, like the Ennion jug, good wishes beakers and almond-beakers.[18]

Two small brown date-bottles, possibly blown in the same mold, were also found at Geva-Abu Shusha (Fig. 2d). This type seems to display different patterns of distribution having also been found in settled sites like Gamla,[19] Masada[20] and Beirut,[21] although mostly in tombs. Generally dated from the mid-1st to the 2nd century AD, these bottles have a wide geographical and chronological range.[22]

The numerous free-blown vessels recovered from the site comprise various types, including two plates, four small bowls or cups, nine beakers, two juglets, an *amphoriskos* and thirty unguent bottles. They demonstrate the general glass repertoire prevalent in Western Galilee and Southern Phoenicia in the late 1st to early 2nd century AD. Almost all the vessels are made of light blue, light green or colorless glass.

13 Stern 1995, 143-144.
14 Barag 1985, 102, no. 148.
15 Nikolaidou-Patera and Amoiridou 2010, 398 no. 481.
16 Jackson-Tal 2009, 158.
17 Jennings 2002, 131-132.
18 Israeli 2011.
19 Jackson-Tal 2009, 158.
20 Y. Max, pers. comm.
21 Jennings 2002, 127.
22 Stern 1985, 92-93.

Simple decorative techniques, such as wheel-abraded lines and ribbing, are characteristic of this group, which is similar to many other contemporary glass assemblages from Israel.

Only two bottles show a somewhat luxurious style. One is a small pear-shaped, beautifully proportioned opaque white flask with two delicate blue handles. The other is a pear-shaped bottle of an amazing blue hue with a typical constriction on the upper body (Fig. 3).

Several small bowls/cups were found, of which those with deep rounded shapes and cut-off rims (Fig. 4a) do not often occur in Israel, possibly originating from Cyprus[23] or Anatolia. The latter includes an exact parallel with the same very thick walls decorated with a deep groove mid-body.[24] Cylindrical bowls with a high collar-shaped mouth wider than the body (Fig. 4b, c) are quite common in Western Galilee.[25] Other parallels from the region include the Early Roman Tomb 54 at Pella.[26]

A characteristic feature of the period, especially observable in the group from Geva-Abu Shusha, is the striking resemblance of shapes between glass and pottery of tableware and small containers, which provides a beautiful picture of mutual influence between the two materials. Like their pottery counterparts, the two glass plates found in the cave have flat bottoms and vertical sides (Fig. 5). Yet the unique quality of the blowing technique enabled the glass maker to fold out the vessel's sides and create a double wall. An additional eight-shaped fold forms a broad ring-base. Comparable specimens from the Levant stem from the Early Roman tombs at Akhziv, north of Akko,[27] and especially from Pella.[28]

The large number of glass beakers found in the tomb is impressive. They feature common cylindrical-conical forms with thin unworked or

Fig. 3: Remarkable blown bottles.

rounded rims, some with linear-cut decoration. Remarkable are the ones with deeply concave (Fig. 4d) or carinated (Fig. 4e) sides, which are quite unusual in local contexts and possibly came from Cyprus or Asia Minor. A tall cylindrical beaker with ribbed decoration visible on both sides (Fig. 4f) has no parallel in excavation reports. A very similar beaker, in the British Museum collections, is said to have come from Beit Jibrin.29 The beaker with a double-fold on the wall (Fig. 4g) is also rare. Small fragments, possibly of this type, were found at Masada in contexts dated to no later than 73 CE.[30]

Numerous small and medium plain glass perfume bottles were scattered all over the burial cave, side by side with similar clay unguent bottles (Fig. 6). Their rounded or piriform bodies, mainly with a short constricted neck, are so similar that they might easily be confused with one another. A very similar repertoire of bottle forms and an impressive number of them per grave is known from the 1st century AD cemetery near Akko.[31] Elongated bottles with a constriction on the junction between the neck and the piriform body are common finds of the Second Temple period in Judea, in domestic as well as funerary contexts.[32] Two plain juglets

23 Vessberg 1952, 119-121, pl. 3, nos. 9-19.
24 Lightfoot 1990, 8, 9, figs. 1-2.
25 Stern and Gorin-Rosen 1997, 7*-8*, fig. 2, no. 13; Abu 'Uqsa 2000, 9*, fig. 15, no. 1.
26 Smith and McNicoll 1992, 130, pls. 87, nos. 13-15; 90, f-h.
27 Abu 'Uqsa 2000, 9*, fig. 15, no. 2.
28 Smith and McNicoll 1992, 130, pls. 87, nos. 8–11; 90 a-d.
29 Barag 1985, 103, pl. 17, no. 153.
30 Y. Max, pers. comm.
31 Fortuna 1965, figs. 2, 4, 12, 14, 15.
32 Israeli 2010, 226, nos. 30-37.

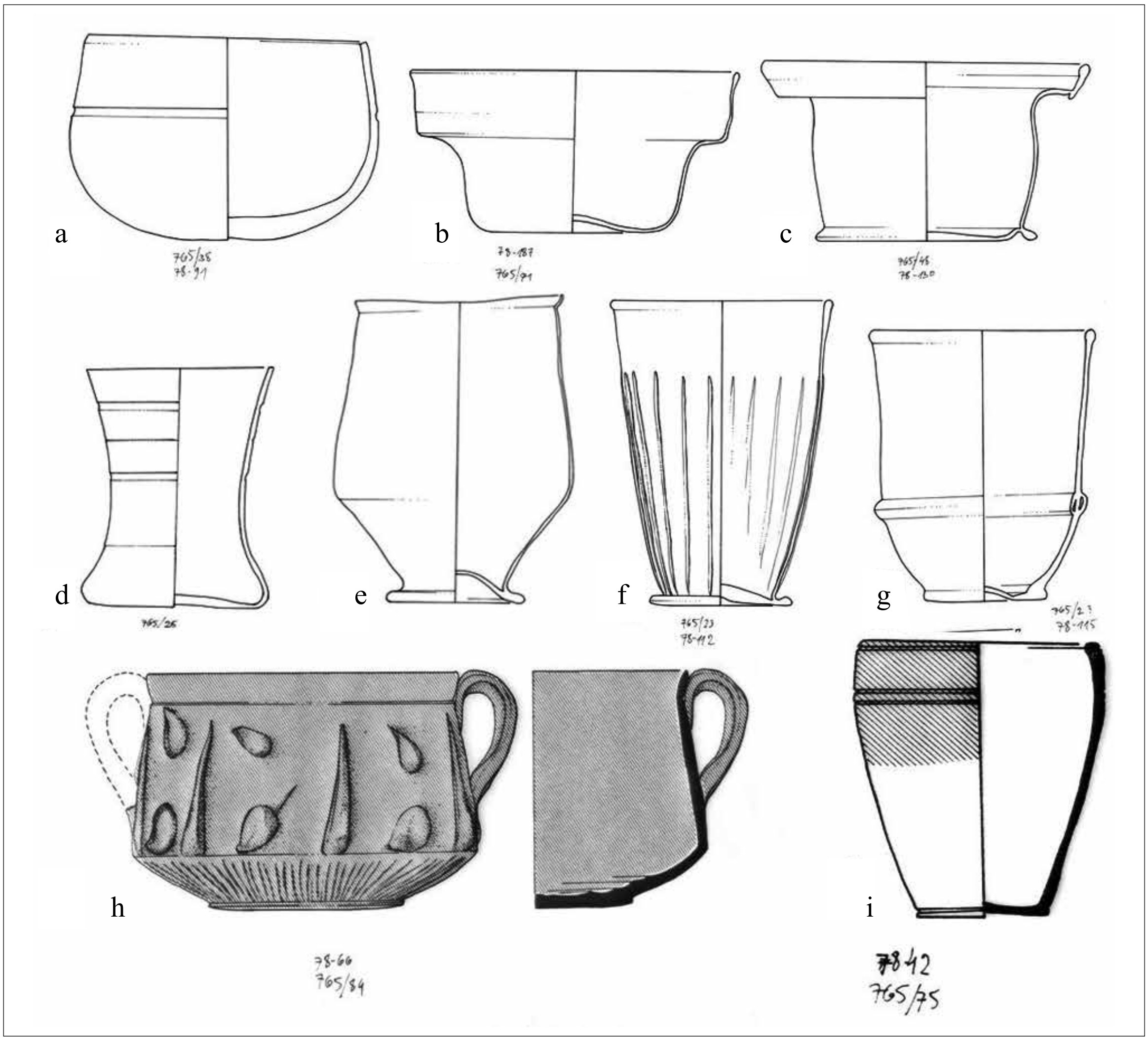


Fig. 4: Glass and pottery bowls and beakers.

found in the tomb (not illustrated) could also be assigned to cosmetic ware of the 1st century AD. One is greenish with a tall pear-shaped body and a short constricted neck[33] while the other, pale bluish, has a cut-out fold at the shoulder.[34] Both types are widespread in the West, occasionally occurring in Greece[35] and in a 1st century AD tomb near Akko.[36] In addition to the beautiful glass vases, the finds in the cave consist of many pottery vessels. Among them are Eastern Sigillata small bowls and dishes, some Thin-wall vessels and a Barbotine cup, side by side with typical local cooking utensils and unguent bottles. In addition, metal bowls, working tools and metal dress accessories, such as a bronze fibula of the *aucissa* type (celtic in origin) were found. Of particular interest are bone spindles with the whorl still sitting on the long spindle, which may have been used for spinning flax which was grown in the area.

As stated above, the mutual influence of shapes between pottery and glass is especially evident in the group from Geva-Abu Shusha, like the pair of glass dishes and their counterpart Eastern Sigillata examples (Fig. 5).

The pottery Barbotine cup (Fig. 4h) found in the cave can be considered a fine example of relief decoration parallel to the glass mold blown bottles. A few more vessels with Barbotine decoration, probably not locally

33 Isings 1957, form 52c.

34 Isings 1957, form 53.

35 Carington Smith 1982, pl. 36 g.

36 Y. Gorin-Rosen, pers. comm.

made, were found in the vicinity of the site.[37] A Thin wall pottery beaker is another rare find in the assemblage, and was possibly imported from north Italy (Fig. 4i). It brings to mind the attractive 'Aco' beaker found years ago near Ashkelon and exhibited in the Rockefeller Museum in Jerusalem.[38]

Eastern Sigillata and Thin wall ware are found on various sites of the late Second Temple period in Israel, but it is not clear where they were produced. Many excavations in the Eastern Mediterranean revealed that alongside imported high quality wares, local imitations of shapes and techniques were produced, integrating influences of imported wares into local styles.

Although no coins were found in the cave, considering the fact that the Eastern Sigillata is usually dated from the 1st century BC to the 1st century AD, and the blown glass from Geva-Abu Shusha cannot be dated to much earlier than the middle of the 1st century AD, we propose to date the whole assemblage to that time or not much later.

The character of the outstanding funerary gifts reflects vast commercial and cultural relations. It should be stressed that tableware like those found in the cave were not common funerary gifts in Second Temple Judea. Furthermore, the location of Geva-Abu Shusha, situated on a border zone between Judea and Phoenicia, should be taken into consideration. When considered altogether, these facts seem to point to a foreign identity of the interred. The people buried in the cave near Abu-Shusha could be Phoenicians, but the fact that many of the coins found in the cave's vicinity bear the figure of the Phrygian god, Men, may preferably indicate people of Phrygian origin.

Consequently, the report of Flavius Josephus comes to mind: "Galilee…. is enveloped by Phoenicia and Syria. Its western frontiers are the outlying territory of Ptolemais (*Acre*) and Carmel, a mountain once belonging to Galilee, and now to Tyre. Adjacent to Carmel is Gaba, the "city of Cavalry", so called from the cavalry who, on their discharge by King Herod settled in this town" Jewish War III: 35-40.

Fig. 5: Glass and Eastern Sigillata plates.

Fig. 6: Glass and pottery bottles.

A disagreement exists between scholars about the exact whereabouts of "Gaba Hippeon" – Gaba of the cavalry – mentioned by Josephus.[39] However, the funerary gifts from the burial cave and the finds in its vicinity seem to confirm the identification of Geva-Abu Shusha as Gaba Hippeon and relate the cave's interred to the descendants of Herod's Phrygian cavalry men.

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37 Siegelmann 1990, fig. 3, nos. 1, 2, 4.

38 Illiffe 1936, 21, fig. 2.

39 Siegelmann 1984.

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SENTIA SECUNDA AND SARAPODORA

The role of women in ancient glass production is controversial. The sole undisputed artisan is a nameless woman who made glass beads ca 300 (Agathangelos 66).[1] Two case studies illustrate the problems encountered in interpreting the evidence.

Sentia Secunda

Sentia Secunda was active in Aquileia in the first half of the 2nd century. Her name is known from the base-marks of four huge rectangular bottles.[2] There is no reason to assume that her role differed from that of male producers whose names appear on base-marks. Some ten or eleven female names are known from base-marks.[3] Sentia Secunda is no longer an anomaly requiring special consideration. The problem concerns what the base-marks on the underside of glass storage containers refer to: do they refer to the vessel's production (i.e. to the mould-maker, the glassblower or the workshop proprietor) or to the contents (the producer or the type of contents)? Luigi Taborelli (2006) argued that theoretically all these interpretations are possible. In my opinion, the question is not what is possible, but how the evidence fits the context of the period.

Sentia Secunda used two different base-marks: SENTIA SECUNDA//FACIT AQUILEIAE and SENTIA SE//CUNDA FA//CIT AQ[uileiae] VITR. Both base-marks include *facit* and the name of her hometown; the three-line inscription adds *vitr*, an abbreviation of *vitrum* 'glass', *vitra* 'glasses' or *vitrearia*, the feminine form of glassblower.[4] It has been suggested that *vitr* refers to a substance made from

1 Lafontaine 1973, 232, cf. Stern 2013, 86. All dates are AD. On the problems with identifying Neikais as a woman's name: see Stern 1997.

2 *CSMVA* 2, AUS 68, 69; SI 67. A fourth base-mark from Romania was presented by Sz.-P. Pánczél at AIHV 19 in Piran.

3 *CSMVA* 3, 297-397, indices. Additional female names in Mainardis 2003.

4 According to ancient lexicographers, *vitr(e) arius* was the equivalent of Greek *huelourgos* 'glass-worker', a compound that had no separate female form.

a herb with the linguistic root *vitr*.[5] I have argued elsewhere that this hypothesis is improbable, because the earliest mention of a herb called *vitriaria* dates from the 5th century.[6] The dark blue pigment called *vitrum* with which ancient Britons painted their faces (Caesar, *De bello gallico* V.14), was not a vegetal dye extracted from woad, but rather a mineral-based pigment made from crushed glass.[7] Roman painters often used pigments made from crushed glass.[8] If one assumes that *vitr* referred to the contents, Sentia Secunda must have produced glass-based pigments for which she commissioned containers from one or more anonymous glassblowers (two different base-marks). In view of the bottles' enormous capacity of six to seven litres, one would expect the buyers to have been professional artisans. However, the two women, in whose adjacent graves complete bottles were found, had rich grave gifts that indicated a high social standing.[9] Not one of the other grave gifts suggests that the deceased were painters or engaged in any kind of profession.

We have no archaeological evidence for prismatic glass bottles being sold that were filled with a specific content, which is what one would expect if the base-marks referred to the contents. In the ruins of a shop at Herculaneum, destroyed by the eruption of Mount Vesuvius in 79, excavators discovered a series of glass vessels ready for sale, one of which was an empty square bottle.[10] Moreover, the location of the base-mark on the underside of a full, heavy container, seems an illogical place for a reference to the contents, especially if the glass bottle was packed in a basket or box for the journey. It is far more probable that the contents were indicated by labels attached at a later stage, as recorded by Petronius, *Satyricon* 34. If the contents were indicated by labels, it seems logical to assume that the producers of the contents likewise used labels.[11]

The addition of *facit* in Sentia Secunda's base-marks recalls the traditional Greek manufacturer's signature *epoiesen* or *epoiei* 'made it', which identified the artisan who made the object marked with his or her name.[12] The use of the present indicative *facit* 'makes (it/me)' instead of the more common past indicative *fecit* (frequently abbreviated as *fec, f*) can also be seen on the rectangular base slab of a glassblower's mould from Salona, Dalmatia.[13] The Greek formula was well-known in northern Italy and Dalmatia, whether stamped onto the handles of cups[14] or integrated into the decoration of mould-blown tableware.[15] Fulvia Mainardis (2003) argues that the signatures on tableware cannot be compared to those on the base-marks of glass storage containers, because the latter were produced serially. However, signed tableware was also produced in a series. No tradition of signing glass during production existed prior to the introduction of glassblowing under Augustus. It was a short-lived practice that went out of fashion in the Flavian period and was almost exclusively confined to signatures on glass containers.

The assumption that the production of storage bottles was a large-scale enterprise comparable to the pottery industry resulted in the assertion that the names on the base-marks represent firm owners.[16] However, the exigencies of the craft make it unrealistic to assume any form of large-scale glass industry in antiquity. The Roman glassblowers' furnace was small and provided room for just one glassblower at a time.[17]

5 Taborelli, Menella 1999, 25.

6 Stern 2004, 116-117.

7 Pyatt *et al.* 1991.

8 Knauer 1993, 28-34.

9 *CSMVA* 2, AUS 68, 69. Cf. Karnitsch 1952, 437-446, graves 99a and 99c.

10 De Franciscis 1963; Scatozza Höricht 1991, 77.

11 Sternini 1993, 93; Mainardis 2003, 10. Cf. the representation of a label attached to a glass unguentarium on a Roman mosaic floor: Taborelli 1992, 326-27, fig. 1.

12 Cf. the Greek base-mark *Magnos epoiei*: Lehrer-Jacobson 1992, 40.

13 *CSMVA* 3, CRO-M 1.

14 Del Vecchio 2004, 32.

15 De Bellis 2010; Buljević 2012.

16 Kiechle 1974, 63; Mainardis 2003, 111. Cf. Taborelli, Menella 1999, 24, who interpret *facere* as *faciendum curare* 'to cause something to be made'.

17 Stern 1999, 454-456; Lazar 2005.

If the signatures represented large-scale entrepreneurs rather than artisans, one would expect that the thousands of preserved base-marks would show far less variety and that many would feature the name of one particularly successful individual. With over twenty base-marks including her name, the woman Claudia Italia is one of the most prolific producers of glass containers currently recognized. Even C. Salvius Gratus, the most productive signer of all, can barely compete with Ennion's output of signed tableware. The available evidence suggests that most ancient glassblowers were independent entrepreneurs.[18] The large number of base-marks showing names in the nominative and the relatively small number of base-marks with the name of one specific individual[19] conforms to a scenario where relatively small glassblower-entrepreneurs were actively involved in the production process.

The addition of *vitr* to Sentia Secunda's three-line base-marks is unique, whether it is short for *vitrearia* or for what she produced. As argued above, *vitr* does not refer to the bottles' contents, but to the vessels or their producer.[20] It can be short for *vitrum*, the bottle itself; *vitra*, glass bottles in general; or *vitrearia*, glassblower. *Vitrum* seems the least likely option, because it is redundant following the artists' signature *facit*. The placement of *vitr* following the verb favours the interpretation *vitra* as the grammatical object of *facit* rather than *vitrearia*, as a predicate of Sentia Secunda.[21] While this is true in normal Latin prose, it seems of minor importance in the context of a base-mark, where considerations of space and format are more compelling. However the base-marks are read, the meaning remains the same: Sentia Secunda produced vessel glass. Nevertheless, it is worth considering what other wording her base-marks could have used to unambiguously state that she was an independent glassblower-entrepreneur.

18 Stern 1999, 459-460.

19 CSMVA 3, indices.

20 So already Harden 1969, 49, note 25.

21 Taborelli, Menella 1999, 24; Mainardis 2003, 108-109.

Sarapodora

Sarapodora's name appears in a mid-3rd century Greek papyrus from Egypt, preserving a contract between three *huelourgoi* 'glassworkers' and the local town council.[22] The glassworkers agreed to complete the glazing of windows on three bath buildings, as well as the windows of other public buildings, for a salary of six drachmai and six obols per [square] cubit instead of the eight drachmai they were receiving at the time:

To the most excellent council, represented by Aurelios Theon,

alias Demetrios, the current chairman, from Aurelios Horos

and his son Aurelios Mareinos from the city of Koptos, and

Sarapodora, alias Didyme, citizeness, – glassworkers.

We agree to make the windowpanes of three bath buildings…etc.

The woman's name is Sarapodora, alias Didyme. She does not mention her hometown. Instead, she calls herself a citizeness, presumably of Panopolis, since the glassworkers were contracted to work on buildings in Panopolis.[23]

When I presented this papyrus in 2010 at a symposium in London, I considered that the question of women blowing glass in antiquity had finally been answered, because the text provided incontrovertible evidence of a woman working with glass at a hot furnace.[24] However, this proved not to be the case. The papyrologist Klaas Worp argues that the three glassworkers formed "some form of family business" and that Sarapodora "did the administration" while her partners "were doing the actual work of producing glass in a (hot!) oven." In his view, Sarapodora was probably "the wife of Horos

22 Frisk 1929, 16-18, customarily cited as *PGot* 7; on the date of the papyrus: Skeat 1964, xxxii-xxxiii.

23 Skeat 1964, xxxii-xxxiii.

24 Stern 2013, 85-86.

and the mother of Marinus." He maintains that Sarapodora called herself a citizeness, because she "did not (wish to) belong to the Panopolitan rank and file". Based on her supposed "special claim for status", Worp concludes that it is unlikely that Sarapodora actively worked as a "labourer / producer of glass" or even as "an artist / glassblower who applied some form of decoration".[25]

My first and foremost objection to this scenario is that there is nothing in the papyrus text to support this theory. Sarapodora's statement that she is a citizeness identifies her as a Panopolitan, similar to the way the two men are identified as being from Koptos. The fact that she was a citizen may have been an advantage in relation to a business contract with the town council of Panopolis. There is no indication of a relationship between the three glassworkers other than perhaps a business enterprise for a specified period of time. Contracts for ad hoc business associations are known for Roman potters[26] and early medieval glassblowers.[27]

Worp cites no parallel for a woman doing business administration. Equally unsubstantiated is his suggestion that "Sarapodora herself probably was the immediate author of the offer". It is far more probable that the papyrus was written by a scribe. The erroneous spelling *noumenaria,* instead of *lumenaria* for 'windowpanes' (line 5), is not the kind of error one expects a person to make who is accustomed to writing the word for window-glass. In my opinion, the wording of the papyrus indicates that Sarapodora acted on a par with her male colleagues from Koptos. Apparently, this was nothing unusual and invited no comment in the contract.

The glassworkers specify their price per cubit. This suggests they produced flat windowpanes measuring approximately 50 x 50 cm.[28] Whether the panes were cast or blown by the cylinder process, the production of window-glass was probably the most dangerous and physically exacting of all ancient glass-working techniques.[29]

Worp's remark concerning the "(hot!) oven" where Sarapadora's partners worked - but which was out of the question for a woman - brings to mind Kiechle's verdict regarding Sentia Secunda: "one can hardly imagine this business woman herself worked at a hot furnace".30 However, there is no physical reason why women should not have been able to blow glass at a hot furnace.

Abundant evidence exists for the association of women and hot furnaces in antiquity. The evidence comes from a field of science currently known under the anachronistic name of alchemy. Ancient alchemists were scientists who performed practical experiments to test philosophical theories regarding the substance of material matter. Very little is known about them, because they are not mentioned by ancient Greek and Roman authors. Heat played a major role in the transformation and transmutation of substances. Alchemists invented specialized vessels, often made of glass which allowed them to monitor the processes taking place. It is not known whether they actually blew the vessels themselves, but many of their recipes required the use of *kaminia huelopsika* "small glassblowers' furnaces" e.g. Zosimus 11.[31]

Zosimus of Panopolis is the earliest alchemist who can be dated with near certainty. He lived around 300 or, at the latest, around the mid-4th century.[32] Zosimus frequently cites the names of predecessors. At least two were women: Maria the Jewess and Isis. Maria the Jewess (1st century) was the most famous alchemist of all time. Zosimus regarded himself as her 'pupil' and cites her treatise: *Peri kaminôn kai organôn* 'On furnaces and apparatuses'. According to Zosimus, Maria designed a

25 Worp 2011, 86-87.
26 Cockle 1981, citing documentary papyri from Egypt.
27 Stern 1999, 460 citing documents from the Cairo Geniza.
28 Foy 2005, 23; Stern 2007, 385-88.
29 Stern 2013, 85-86.
30 Kiechle 1974, 63.
31 Cf. Berthelot 1963, 246.
32 Halleux 1983, xi.

burner called *kerotakis* for sulphur,[33] but her most famous invention was a kind of alchemical still called *tribikos*.[34] Another device she constructed and described is still known today under her name in many languages, but not in English: the water bath called *balneum Mariae* or *bain Marie*.

Conclusions

Evaluating the evidence for female glassblowers in antiquity is not an easy task given that until recently, glassblowing in the western world was an exclusively male occupation. In my opinion, the evidence from antiquity is straightforward and unambiguous. Female artisans were active in all fields of glass-working: from bead-making to blowing vessels, as well as manufacturing window-glass. Women invented new types of furnace and heating devices while they were at the forefront of scientific research into the chemistry of glass.

33 Beretta 2004, 27-28.
34 Beretta 2004, figs, 4, 5 opposite p. 19.

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PRECIOUS GLASS FROM PIEDMONT: THE CASE OF THE PYXIS OF FORUM VIBII – CABURRUM

The *municipium* of *Forum Vibii* was established on the plain located near the town of Cavour (Turin district), probably on the initiative of C. *Vibius Pansa*, who was consul in 43 BC in the territory belonging to the *Caburriates* Ligurian tribe. The area came under progressive Roman control of access routes to the western Alpine passes (Fig. 1).

In 1835, in a field located across the road from Cavour and stretching to Villafranca Piemonte, a sarcophagus was accidentally found "covered with stone and lead sheets." The sarcophagus contained a glass pyxis, two tablespoons, a spatula and a bronze ass of Geta (210-212 AD). The objects were purchased by the theologian Giovanni Maria Vignolo, parish vicar, who sold the glass to the Turin Civic Museum, which thereafter transferred it to the Museo di Antichità. The other objects are no longer detectable. The discovery area corresponds to a necropolis from imperial times, intercepted in 1984 during work on a sewer, and in all probability related to a main road leading out from *Forum Vibii / Caburrum* to the north-east, towards *Augusta Taurinorum*. The dating of the burial to the 3rd century contrasts with the antiquity of the glass vessel, which must have been preserved for a long time by its owners, if not collected as a precious object.
(F.B.)

The object is a pyxis with a lid, made from opaque, dark-violet glass (Fig. 2) and has the following dimensions: total height, including the lid: 21.5 cm; diameter of rim: 9 cm; max. body diameter: 13.5 cm; foot diameter: 8 cm; lid diameter 7.5 cm. The circumstances of the find (discovered in a 3rd century AD burial, but the stylistic characteristics make this typical for the period from the end of the 1st century BC - early 1st century AD) and the very few comparisons necessitated in-depth analysis in order to clarify aspects of production technique, origin and composition. With regard to the first question, the particular workmanship of the vessel - a closed shape that has grooves and engraved decoration, which makes it similar to vessels made of "noble" materials (metal or stone), as

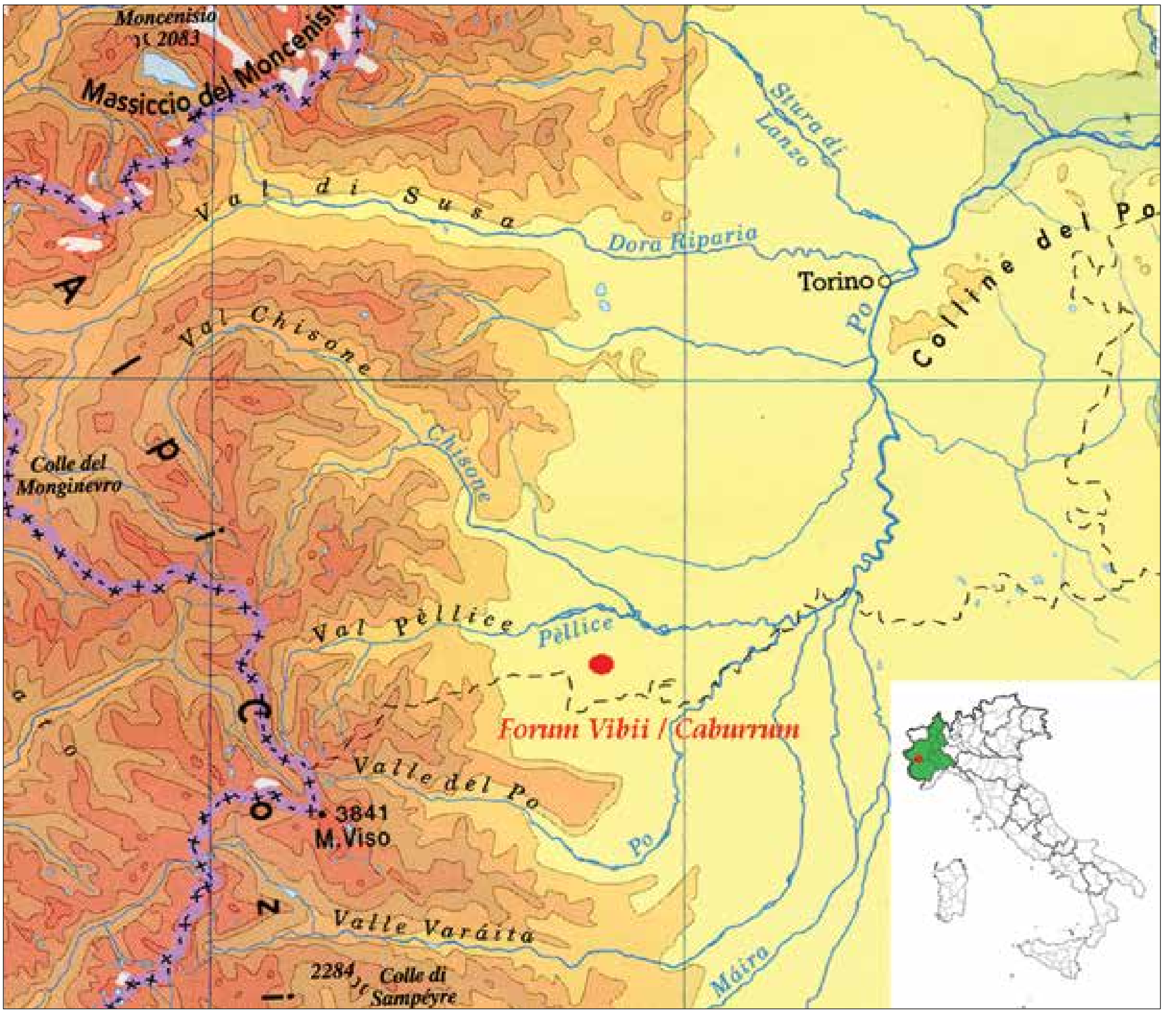

Fig. 1: Plan of Piedmont with the municipium of Forum Vibii.

well as the dark-violet colour (there are rare examples of bowls i.e. in Adria or Todi)[1] - recalls the words of Pliny, who asserted how glass imitates obsidian (Plin., NH, XXXVI, 136 – 138). It is clear that vessels of this bill, due to the accuracy of the workmanship and the imitation of luxury products, required great technical expertise and the use of non-conventional manufacturing techniques. The analysis of the details (inner and outer rim, foot, lid) supports the plausibility of Pliny's claim relating to the use of the lathe for the glass (Plin., NH, XXXVI, 193: *aliud torno teritur*).

The almost total absence of air bubbles, the presence of thin concentric circles/scratches both on the inside and outside, the "*striae*" visible on the neck of the vessel (Figs. 3a-c), and the central protruding knob in place of a central cavity (probably from clamping the metal or wooden blank in the lathe; Fig. 3d) all make it plausible to transform glass (or rather the semi-finished product) into a viscous state without actually reaching the melting point, perhaps with the aid of one or more moulds for the more complex parts, and with clamps for the creation of ribs and depressions (Fig. 3e).[2] Furthermore, the treatment of the particularly smooth outer surface and the inner part of the neck of the vessel (attainable with instruments), as well as the alternation of smooth surfaces with the rough surfaces on the lid confirm a subsequent grinding and polishing (Fig. 3f). The pyxis of Cavour is

1 Bonomi 1996; Giorgi and Manconi 2012, 91-95.

2 Lierke 2011, 91-99.

Fig. 2: The pyxis of Forum Vibii – Caburrum.

an uncommon example within the ancient Mediterranean region. To date, the only direct comparison is a pyxis (without a lid, and bearing a foot with triangular section and light molding) from a monumental tomb in the necropolis of Garipler at *Caesarea*, Cappadocia (Fig. 4).[3] The sample is slightly smaller than that of Cavour (total height: 14.8 cm, diameter of rim: 8.3 cm, max. body diameter: 13.4 cm, foot diameter 7.5 cm) and can be dated to the Augustan times, from a princely tomb. The similarity between the two pieces, the shape of similar examples in "noble" stone or silver, the slight differences and the lack of comparisons all suggest that it is a unique manufacture and therefore, was not a serial reproduction. Equally interesting is the choice of colour - dark-violet – which has few comparisons, especially among non-blown vessels, and were mostly derived from Hellenistic and Eastern Europe. Examples include a cup made of wine-coloured glass, from Via Orvietana in Todi, manufactured in a mould and dated to the early 2nd century BC. Another cup was formed in a mould and originates from the Casa dell'Ara Massima of Pompei. Additionally, there is another moulded cup with inlay cloisonné, which also comes from Pompei. Both examples have been dated to the first half of the 1st century AD.[4] The characteristic dark-violet colour, present due to the addition of manganese, makes the pyxis similar to obsidian. At the same time, this element separates it from other examples (basically worked with the blowing technique), which are made of black-olive coloured glass due to the addition of iron, and which thus imitate the production of metal or fine pottery. For example, it is significant to compare these specimens with a glass sample from Köln (Becher Glas 499, Römisch-Germanisches Museum),[5] dated to the 2nd century AD, and which apparently echoes the production of silver or of so-called "terra nigra", which are common in the Rhine area (Fig. 5).
(E.P.)

Energy Dispersive X-ray Fluorescence (EDXRF) analysis was carried out with a EDXRF Thermo NITON XL3T GOLDD with an Ag target, tension variable between 6-50 kV, a maximum amperage of 100 µA and a Si Drift detector (SDD) of 25 mm^2 in terms of area. The geometry used is 30°/30°, with a working distance of 1 mm, a diameter focal point of 3 mm and a time analysis of 240''. All analyses were carried out in situ by means of portable instrumentation. The obtained spectra were then

3 Eskioğlu 1989, 189-224.

4 Giorgi and Manconi 2012, 91-95; Cima and Tomei 2012, 112-126.

5 Fremersdorf 1958, pl. 51; La Baume 1964, pl. 88; La Baume 1975, pl. 53,3. The becher (total height 10.5 cm, diameter of rim: 8.6 cm, diameter of foot: 3.4 cm) was found in the grave of a child in Köln, in Severinskloster 12, along with a rich set of glass. The set consisted of three transparent glass bottles that were blown in a mould and have ribbon handles e.g. glass ampoule (no. inv. 497, 500, 501, 502). I thank Ms Fridericke Naumann-Steckner, the director of Römisch-Germanisches Museum Köln, for her willingness to carry out XRF analysis.

Fig. 3: Details of the pyxis.

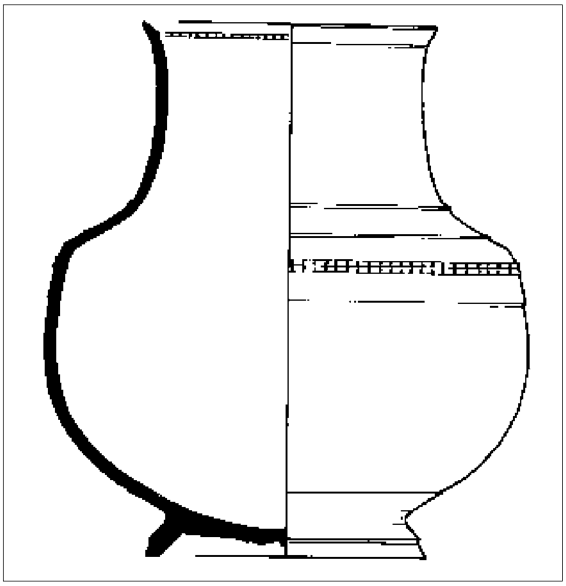

Fig. 4: The pyxis of the necropolis of Garipler.

Fig. 5: The glass no. 499 from Köln.

processed with commercial software WinAxil, which is derived from academic software IAEA. Quantitative data were obtained using WinFund software by means of the Partial Least Square approach[6] and a set of appropriate Certified Reference Materials (CRM).

The data analysis (Fig. 6) immediately shows that there is a substantial difference between the chemical composition of the pyxis and the glass from Köln. Firstly, there is a difference in the chromophores used: in one case manganese (pyxis), and in the other iron (glass from Köln), which is especially evident during illumination from the inside to the outside; in the first case, exhibiting a tendency towards a violet colour and in the second, yellow-green.

Another difference in the pyxis is the absence of opacifiers, such as calcium antimonite ($Ca_2Sb_2O_7$), which is instead, present in the glass of Köln.

The matrix indicates a composition with a reduced potassium content, characteristic of sodium glass. As reported in the bibliography,[7]

6 Jenkins, Gould, Gedcke 1995; Van Grieken and Markowicz 2002.

7 Uboldi and Verità 2003, 641-648.

	SrO	PbO	Fe_2O_3	MnO	TiO_2	CaO	K_2O	Sb2O3	Al_2O_3	SiO_2	tot
koeln499-01	0.04	0.036	11.21	0.32	0.095	6.86	1.88	0.19	2.21	55.2	78.0
koeln499-02	0.04	0.032	11.20	0.32	0.091	6.96	1.01	0.2	1.48	61.5	82.8
koeln499-03 bottom	0.04	0.030	9.51	0.27	0.080	6.11	1.09	0.26	2.34	56.2	76.2
pyxis high 01	0.07	-	0.32	2.66	0.042	7.70	0.80	-	1.90	61.6	75.1
pyxis high 03	0.06	-	0.30	1.83	0.043	7.35	0.84	-	1.51	65.3	77.2
pyxis low 01	0.06	-	0.32	1.99	0.045	7.50	0.86	-	1.87	65.7	78.3
pyxis low 03	0.06	-	0.30	1.90	0.045	7.38	0.82	-	1.72	64.6	76.8
pyxis middle 01	0.06	-	0.29	1.93	0.042	7.42	0.80	-	1.39	68.8	80.7
pyxis middle 02	0.06	-	0.29	2.27	0.042	7.81	0.81	-	1.89	67.8	81.0
pyxis middle 03	0.06	-	0.34	1.93	0.042	7.58	0.81	-	1.73	67.6	80.1
pyxis top 01	0.08	0.148	0.94	4.06	0.073	6.11	1.49	0.07	2.44	66.7	82.1
pyxis top 03	0.08	0.137	1.01	3.77	0.081	5.67	1.36	0.06	1.40	61.7	75.3

Fig. 6: The data analysis.

Roman sodium glass was characterized by a total content of K_2O and MgO, less than 1.5% with $K_2O = 0.75 \pm 0.24$ and $MgO = 0.6 \pm 0.3$ wt%. The glass obtained with plant ash coastal is instead characterized by a content of K_2O and MgO greater than 2.5 wt%. The content of K_2O in the pyxis varies between 0.80 and 1.49 wt%, thus supporting the hypothesis of sodium glass in natron. The content of aluminum and calcium is indicative of ancient glass,[8] and reach values up to 7.81 wt% for calcium, thus showing a dispersion of aluminum towards smaller values (maximum value of around 2.44 wt%).

A final examination of the pyxis demonstrates how the lid has a composition slightly different from the body. In this case, it can be considered that different vitreus masses or another processing method were used, which led to increased cationic concentrations in the final object.
(A.A.)

8 Cluster reported in Seccaroni and Moioli 2002.

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A STUDY ON THE ROMAN ENGRAVED GLASS BOWL WITH A DIONYSIAC MOTIF IN THE MIDDLE EASTERN CULTURE CENTER IN JAPAN

Introduction

The purpose of this paper is to re-examine the fragmented Roman engraved glass bowl in the Middle Eastern Culture Center in Japan (hereinafter the MECCJ piece).[1] The MECCJ piece was published in 1976 by its former owner Mr Ishiguro; the piece is described in Mr and Mrs Ishiguro's collection catalogue, as a "Bowl with engraved athlete (fragmented)" dated to the 3rd to 4th century and purchased in Cairo, Egypt in 1970.[2]

However, my research on the MECCJ piece revealed that its motif is not athletic but Dionysiac.[3] In recent years, new findings of Roman engraved glass have been reported and some of them also bear a Dionysiac motif. In addition, several sub-classifications of Roman engraved glass by the technique of engraving or by chronology have been proposed. Therefore, the MECCJ piece should be reconsidered in this new context.

Description of the MECCJ piece

The fragments of glass are joined to form almost half of the original shape of the bowl (Fig. 1). The extant parts of the rim and the central base make it possible to reconstruct its original shape and size (see Fig. 4): a shallow bowl with everted rim, convex walls, flat bottom (Isings form 116), 4.8 cm in height, 20 cm in diameter, and with a thickness of 0.25 cm (towards the top edge - rim) ~0.38 cm (towards the bottom). The glass is colourless with yellow-greenish tinge. Both the inner and outer surfaces of the bowl are weathered and on the exterior surface there are remains of brown weathering or dirt.

The wheel-cuts and freehand engravings that were made on the outer surface were meant to be seen from the inner surface. Five horizontal grooves were made by wheel-cutting; a pair of narrow thin grooves under the rim, a thicker

1 Unfortunately, the Middle Eastern Culture Center in Japan has been closed since March 2013 and at this moment there are no plans to reopen it.
2 Ishiguro 1976; Mikazuki 1976, no. 202.
3 Shindo 2005, 30, 56-57, no. 60 (only in Japanese).

groove on the body and another pair of thin grooves to define the zone of the bottom. The latter two grooves correspond to the frame of the central medallion on the bottom (about 10 cm in diameter).

The central medallion shows, although the extreme right-hand side of the image is lacking, a young naked man with a profiled head and three-quarters body striding towards the right swinging his arms (see Figs. 1, 3, as seen from the inside). He has a helmet-like hairstyle with a curled forelock and a wisp on the nape. He is stepping forward with his left leg and raising his left arm in a forward movement, while his right leg and his right arm bend backwards. This movement seems natural at first glance; however, if we consider how we actually walk, it is an unnatural pose but it makes his sculptured torso stand out. He is holding a *pedum* (shepherd's crook)-like object in his right hand and also two festoon-like objects are floating downwards from his clenched hand. The end of his left hand is lacking, so we cannot know whether he was holding another object or not. There is a dot in front of the toe of his left leg.

Wheel-cutting (facet cutting) and freehand engraving (scratching) were used to create the figure (see Fig. 2); the face, head, neck, chest muscle, abdominal muscle, arms, hands, legs, toes are indicated by shallow engraved facets. Details such as the eyebrow, eye, nose, mouth, hairline, muscle fingers, and genitals were then engraved on the facets with 'parenthetic' short and curved scratched lines. 'Roundel'-type lines were also scratched on his right thigh, knees, calf and heel.

The central medallion is surrounded by a band of vegetal ornament (see Figs. 3 and 5). Although only one fourth of the whole decoration remains, we can assume that the original decoration was a scroll of alternating vine leaves and bunches of grapes hanging from long, curved stalks. From every dividing point of the stalks, or along the stalks, sprout little cirrus.

The same combination of wheel-cutting and freehand engraving was used for the band of grapevine decoration; long and curved stalks were wheel-cut, ten grains (from the top arranged 4-3-2-1) of the grape cluster were facet-cut and then roundel lines were scratched inside each facet; the five lobes of the grape leaf were facet-cut and then five straight lines were engraved freehand to show the veins of each of the five leaf lobes, and finally a zigzag indentation around the leaf was scratched freehand.

Parallels in colour, shape and size

The combination of colour, shape and size of the MECCJ piece is comparable to several pieces that belong to the so-called 'contour grooves group' (hereinafter the 'CG group'), dated to the second half of the 2nd century or late 2nd to early 3rd century. The CG group is a sub-classification of Roman engraved glass that was proposed by E. Marianne Stern in 2001 after its most salient feature (their figures are outlined by wheel-cutting and then the details are engraved freehand).[4] She also calls them 'fish-bowls' because the fish figure always appears on them. The widespread find places indicate that "they were made in one of the countries bordering the Mediterranean" and some scholars have further associated them with Alexandria, Egypt.[5] Similar pieces include:

- Parallel 1: a shallow bowl said to be from Egypt, Ernesto Wolf Collection, colourless, Isings form 116, 4.7–4.0 cm in height and 18.8 cm in diameter;[6]
- Parallel 2: a shallow bowl from Buccari, Croatia, Zagreb Archaeological Museum, colourless with greenish ting, Isings form 116, 4.6 cm in height and 18.7 cm in diameter;[7]
- Parallel 3: a shallow bowl from Cologne, Germany, Römisch-Germanisches Museum, colourless, Isings form 116, 4.0 cm in height and 17 cm in diameter.[8]

The Parallel 3 also bears a vine grape motif on one part of its surrounding band. However, differences between the 'CG group' of Isings form 116 and the MECCJ piece are also evident; 1) the figures on the central medallion of the 'CG group' are all profiled busts often with a pointed hat and

4 Stern 2001, 136–137, 156-158, no. 56.
5 Lazar 2010, 147-158.
6 Stern 2001, 156-158, no. 56.
7 Lazar 2010, 153, figs. 4-5.
8 Fremersdorf 1967, 154-155, fig. 35, pl. 20.

appear rather motionless, while the figure of the MECCJ piece is full size and with movement;[9] 2) the frame of the central medallion of the 'CG group' consists of concentric double-line circles including short radial wheel-cut grooves, while the frame of the MECCJ piece consists of simple concentric double-line circles; 3) the wheel-cut lines are used in the 'CG group' to outline the figures, while these lines are used in the MECCJ piece to define the body itself and 4) the MECCJ piece bears no fish or marine figure.

Parallels in the combination of colour, shape and size can be also observed among the 'non-CG group', particularly the one from Ventimiglia. In the case of this piece, we can find similarities with the MECCJ piece also in terms of engraving.

- Parallel 4: a shallow bowl with a marine motif in the Civico Museo Archeologico, the 'Girolamo Rossi', colourless, 4.5 cm in height, 19.8 cm in diameter, dated to the first half of the 3rd century.[10]

F. Paolucci classified it as belonging to the 'Lynceus group', which dates to the 3rd to 4th century. This group was associated by F. Fremersdorf with a Rhineland workshop based on a concentration of finds in Cologne, while by D. B. Harden linked it with an Alexandrian workshop based on findings from Karanis, Egypt.[11]

Parallels in iconography and engraving technique

Figure

There are similarities in both the iconography and the engraving technique used for the figure of the MECCJ piece with the following three examples. They were classified by M.-D. Nenna in 2003 as "group with vegetal and historic decoration" (hereinafter the 'VH group'), an earliest examples of figure-engraved Roman glass, dated to the late 1st to the early 2nd century, which can probably be associated with Egyptian (Alexandrian) production.[12]

- Parallel 5: A lying naked young man (satyr) on a fragmented bowl from Begram, Afghanistan, 26.5 cm in diameter, Musée Guimet.[13]
- Parallel 6: A pair of naked *amorini/putti* at the center of a blue large plate from Albenga, Italy,

Fig. 1: The MECCJ piece (photograph of the interior).

Fig. 2: The MECCJ piece (photograph of the exterior).

9 Full body figures can be also observed on the 'CG group' such as the young naked man sitting on front of the *pharos* on the bottle from Ptuj, Slovenia, however, this time also, the wheel cut lines are to outline the figure (see Lazar 2010, 147-149).

10 Paolucci 1997, 127-129, 229-231. Paolucci cited another two fragmented pieces from Larciano which should be from the same *atelier*.

11 Harden 1987, 182, note 12.

12 Nenna 2003, 359-375.

13 Hamelin 1952, 11-25; Nenna 2003, 360.

41.2 cm in diameter, Soprintendenza archeologica della Liguria.[14]

- Parallel 7: A naked man carving the Greek letter zeta (corresponds the number 7) on a Nilometer on a cup, 9.9cm in diameter, British Museum (Harden dated to the early 3rd century).[15]

P. Nicholson, when publishing the fragmented piece from Berenike in 1996/1997, indicated that its style is much closer to Parallel 7.

- Parallel 8: A Bacchant bust on a fragmented bowl or large cup from Berenike, Egypt (a surface find).[16]

The figures on the Parallel 5-8 and on the Parallel 4 above mentioned have all a profiled helmet-shaped head with a curled forelock and a wisp on the nape, a muscular body which is three-quarters turned to right, and their face, head, body were facet cut. The blue colour, the extraordinarily large size and the plate-shape of the Parallel 6 are quite different from those of the MECCJ piece, but dots behind their toes, and several parenthetic short lines which were added by freehand engraving on the facet cut are common to MECCJ piece.

Band of grapevine decoration

A similar combination in terms of both the iconography and engraving technique of the MECCJ piece's band of grapevine decoration can also be found in the following four examples:

- Parallel 9: A conical beaker in Berlin Antiquarium.[17] Nenna classified this example as "Vase with vegetal and historic decoration" dated to the late 1st to first half of the 2nd century.[18]
- Parallel 10, 11: Two rim fragments of deep bowls (beakers?) with herringbone cut and a grapevine decoration found at Dura Europos.[19] Dated to the first half of the 3rd century (prior to AD 256).
- Parallel 12: A fragment of a deep bowl from Lyon, France, Musée de la Civilisation Gallo-romaine. Dated to the 3rd century.

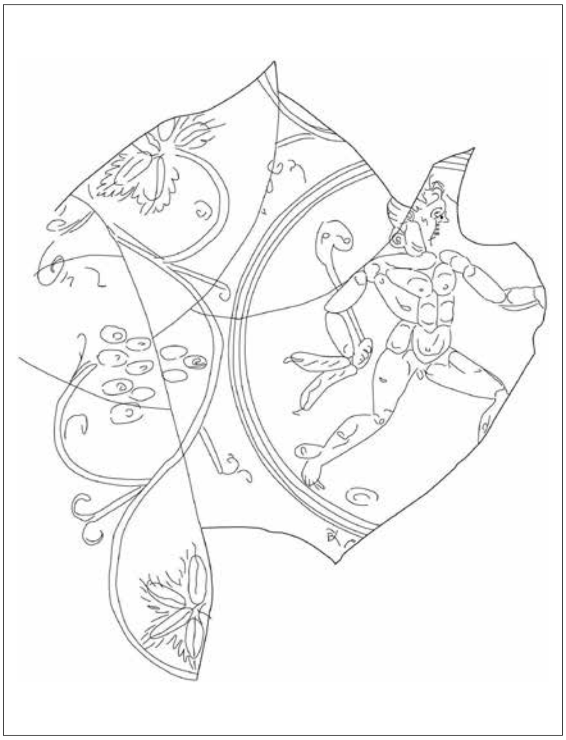

Fig. 3: Particular drawing of the MECCJ piece.

Most of them are fragmented except Parallel 9, however, we can assume a scroll of alternating vine leaves and bunches of grape. The Parallel 9 shows 1) facet-cut clusters of grapes arranged in a 4-3-2-1 pattern, 2) facet-cut five-lobed grape leaves with freehand scratched indentations around the leaves, and 3) wheel –cut stalks were first wheel-cut and then little circles were added as same as the MECCJ piece.

Parallels in Dionysiac retinue motif

The MECCJ piece shows a young naked man, striding satyr. He is one of the Dionysiac *thiasos* (retinue) which is usually composed of satyrs, old Silenus, Maenads and also Pan. The original image of the Roman Satyr, the woodland spirit, is a man with a goat's ears, tail and horns, but the satyr also appears as a young man with the attributes of a *pedum,* a *syrinx* (a six-piped flute) or a *pardalide* (a panther pelt). In the MECCJ piece, he holds a *pedum*-like object in his left hand (unfortunately, his right hand is lacking). The two festoon-like objects floating downwards from his left hand is more likely ribbon than *pardalide,* fastened on a *pedum*.

14 Massabò 2001, 183-193, 201, no. 136.
15 Harden 1987, 182, 200, no. 109.
16 Nicholson 2000, 151-155, fig. 1.
17 Harden 1936, 139, fig. 3-b.
18 Nenna 2003, 360.
19 Clairmont 1963, 77-79, group j, nos. 300-301, pls. VII-300, XXVIII-300, 301.

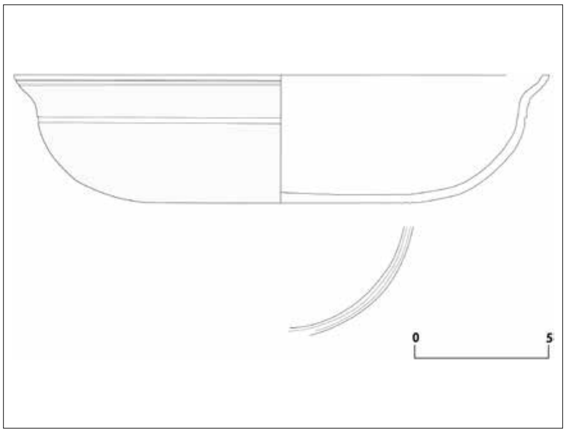

Fig. 4: Reconstruction of the form of the MECCJ piece.

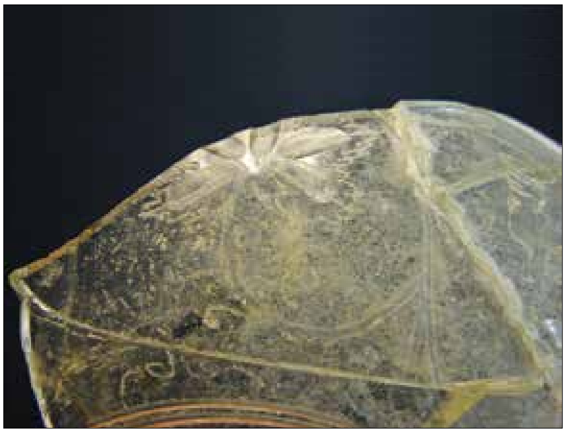

Fig. 5: Part of the grape leaf decoration (photograph of exterior of the MECCJ piece).

The image of the young naked satyr is found on some of the other parallel pieces. For instance on the Parallel 5, a satyr is lying with his left elbow leaning on a wineskin and holding up a *pedum* in his right hand; on the Parallel 6, although the pair of satyrs are depicted as young *amorini*, they are holding the typical attributes of satyrs; the one on the right holds a *syrinx* and a *pedum*. The one on the left has a wineskin on his back and holds a *thyrsus*; and on the Parallel 8, there is a naked bust of a satyr with a *thyrsus* to his right (as seen from inside). As for the 'Lynceus group', there is among them a masterpiece which should be mentioned, a double-handled bottle with a Dionysiac *thiasos* from Hohen-Sülzen ('the Hohen-Sülzen piece') which bears a young half-naked satyr holding a *pedum* in his raised right hand, and there is a *pardalide* hanging from his raised left elbow to touch the cup of Dionysos that he holds in his left hand. A *syrinx* can be seen between his legs. The striding type of satyr on the MECCJ piece cannot be found among the engraved glass, but it has been identified on a fragmented silver jug from Traprain Law dated to the 4th century in the National Museums of Scotland, Edinburgh. It shows part of a Dionysiac *thiasos*, a naked satyr striding towards the right swinging his arms and holding a *pedum* and waving a *pardalide* in his left hand.

Conclusion

In light of the foregoing, it can be seen that the MECCJ piece, which has been revealed to depict a young satyr, surrounded by a band of grapevine decoration from my recent research, is difficult to classify in terms of placing it exactly in one of the existing subgroups of Roman engraved glass.

Due to its similarity to the earlier group dated to the late 1st to early 2nd century, in other words, the 'VH group', in relation to the combination of engraving style (head, torso and limbs are indicated by shallow facets and details are scratched with parenthetic lines) and motif (Dionysiac or grapevine), it is tempting to associate the MECCJ piece with this group. However, the shape and size of the pieces in the group are rather different. The similarity that the MECCJ piece has with some of the 'CG group' in the combination of colour (colourless or colourless with yellowish-greenish ting), shape (shallow bowl, Isings form 116), size (around 5 cm in height and 19 cm in diameter) and technique (wheel-cutting and freehand engraving) has led to the dating of the MECCJ piece to the second half of the 2nd to the early 3rd century. However, the style of wheel-cutting used to outline the figures appear mainly in bust on this group. Moreover, there is no trace or possibility that the MECCJ piece bore a fish or marine creature, which is one of the typical features of the 'CG group'.

Hence, the Parallel 4 shows greater similarity to the MECCJ piece not only in the combination of colour, shape, size and technique, but also in the wheel-cutting style. However, I would hesitate to assign the MECCJ piece to the 'Lynceus group' because other typical 'Lynceus group' pieces, such as 'the Lynceus beaker' itself and 'the Hohen-Sülzen piece' mentioned above, have multiple lines on the limbs or torso of their figures which I believe is one of the characteristic features of the 'Lynceus group' but is not found on either the Parallel 4 or the MECCJ piece.

If we turn our attention to the decoration of scroll of alternating vine leaves and bunches of grapes, similar decoration to that on the MECCJ piece has been reported on fragmentary deep bowls dating to the 3rd century such as those from Dura Europos and Lyon (Parallels 10-12).

Therefore, all in all, I would not associate the MECCJ piece to any sub-groups abovementioned but just date it around the early 3rd century. As for its production place, an Egyptian (Alexandria) workshop rather than a Rhineland one could perhaps be assumed, considering also the fact that it was later purchased in Cairo.

Acknowledgements

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VASES GRAVÉS À DÉCOR GÉOMETRIQUE À *BRIXIA* (ITALIE)

En 1998, lors de fouilles de Palazzo Pallaveri, qui se trouve sur la partie occidentale du *Capitolium* romain de Brescia (*Brixia*), on a découvert un dépôt d'objets provenant du temple, objets intentionnellement cachés pendant la phase d'abandon de l'édifice sacré survenue au IVe siècle après J.-C.[1] Parmi ces objets figurent beaucoup de verres (coupes, bols, assiettes, gobelets, bouteilles, cruches) portés en offrandes ou utilisés dans le sanctuaire. La plupart des verres retrouvés dans le dépôt sont datés entre la fin du IIe et la fin du IIIe siècle après J.-C.

Outre les quatre pièces de verre gravé à décor figuré déjà publiées,[2] on trouve beaucoup de vases gravés à décor géométrique. Toute cette vaisselle de luxe est en verre incolore, soufflé, épais pour quelques groupes, très irisé et fortement altéré pour la plupart.

Il s'agit d'au moins 44 vases gravés, mais il est probable que leur nombre est plus élevé en raison de plusieurs fragments de panse ou de lèvres appartenant peut-être aux vases mêmes, mais peut-être aussi à d'autres vases ayant les mêmes formes et les mêmes décors que ceux que l'on a reconnus.[3]

Ces verres représentent une découverte exceptionnelle pour l'Italie du Nord, tant pour la variété de leurs formes et de leurs décors que pour leur quantité. Leur intérêt apparaît évident si l'on considère que F. Paolucci dans son étude sur les verres gravés de l'Italie du Nord et de la Rhétie a répertorié en tout 23 pièces semblables à celles retrouvées à Brescia[4] et que seule une dizaine de pièces avec des décors gravés analo-

1 Rossi 2002.

2 Roffia 2002; Roffia 2011.

3 L'appartenance des fragments au même exemplaire se fonde à la fois sur des analogies morphologiques et décoratives et sur des ressemblances strictes en ce qui concerne le type du verre et les phénomènes d'altération de la surface. Il est évident qu'il s'agit de jugements non objectifs, car des variantes légères dans le décor sont possibles étant donné qu'il s'agit d'une production en série, dépendante des habilités techniques et manuelles de l'artisan qui grave la surface. Aussi, les phénomènes d'altération de la surface des fragments d'une même pièce peuvent changer selon la couche conservée.

4 Paolucci 1997, 99-120.

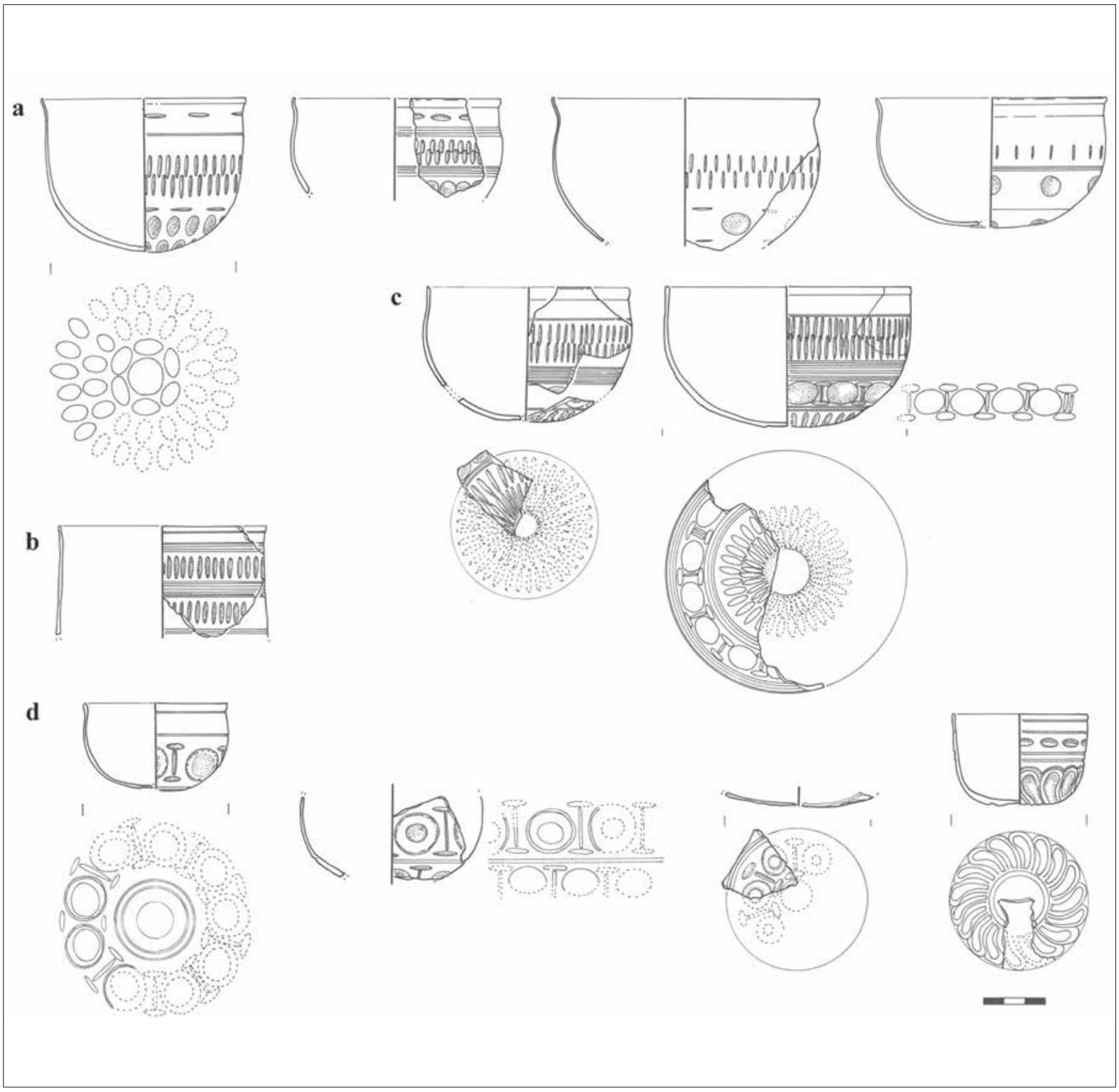

Fig. 1 : Groupe 1. a: 1-4; b: 5; c: 6-7; d: 8-11.

gues sont présentes dans le récent catalogue des verres du Musée National d'Aquiléé.[5]

Dans l'analyse des verres de Brescia, on a opéré une subdivision fondée sur les formes et sur les nombreux décors qui parfois se répètent à l'identique sur différentes formes. Ainsi, on a distingué les groupes suivants :

Groupe 1 (Isings 96b/T 49a/AR 60.1) (Fig. 1)

a. Coupe à panse hémisphérique; lèvre évasée. Verre fin.

Décor à grains de riz verticaux dans une ou deux rangées ou bien horizontaux dans une rangée, sous le bord ou sur la panse; à cercles; à ovales. Des lignes incisées horizontales séparent les rangées de facettes; parfois une fine ligne gravée sépare les décors, peut-être comme une ligne qu'il faudrait suivre. Sous le fond, au centre, cercle ou grain de riz, autour quatre ou six ovales (10 exemplaires).

b. Coupe à panse presque cylindrique; lèvre verticale. Verre fin.

Décor à grains de riz verticaux, séparés par des lignes incisées horizontales (1 exemplaire).

c. Coupe à panse hémisphérique; lèvre presque verticale. Verre épais.

5 Mandruzzato et Marcante 2005, 28, nos. 254-262, 278; 38, no. 345.

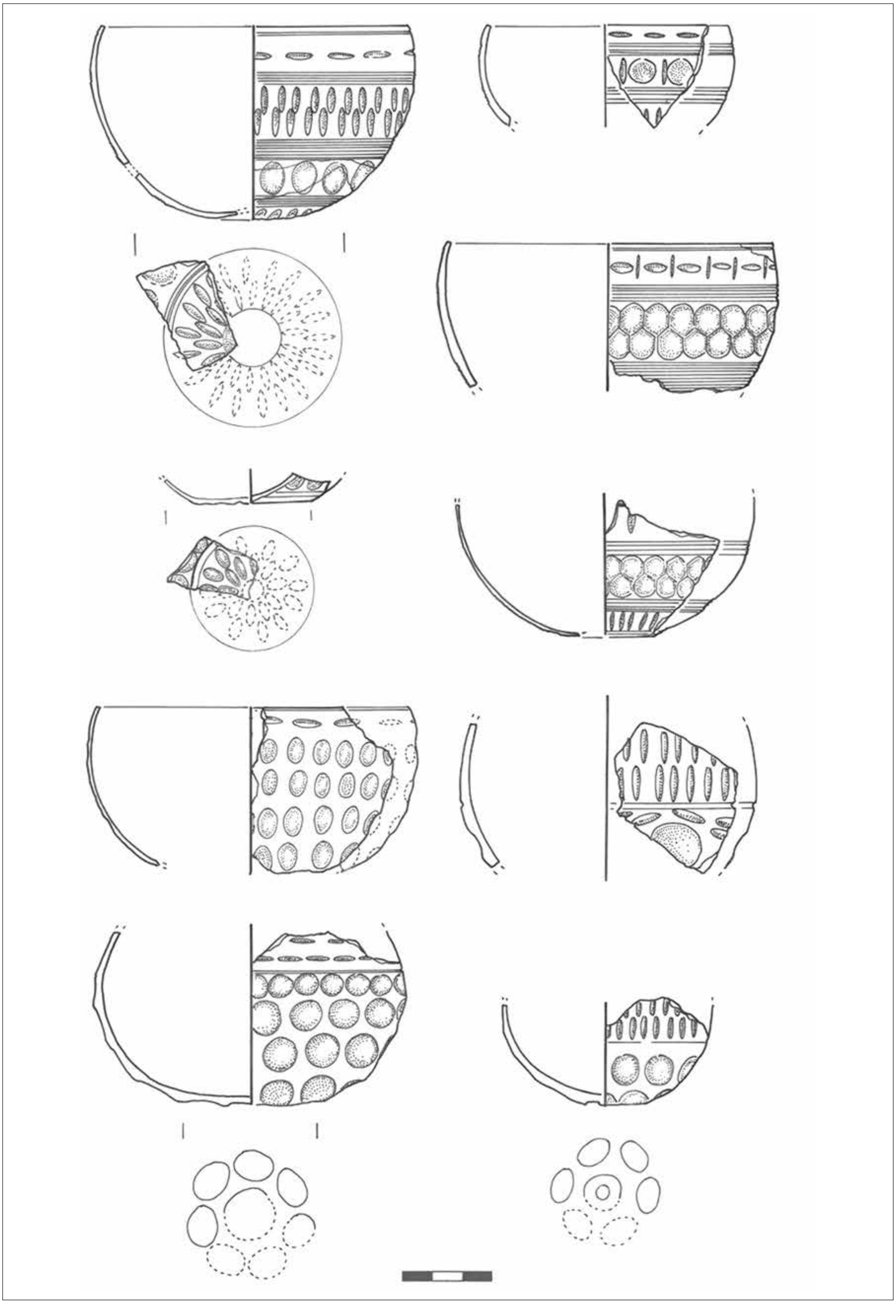

Fig. 2 : Groupe 2.

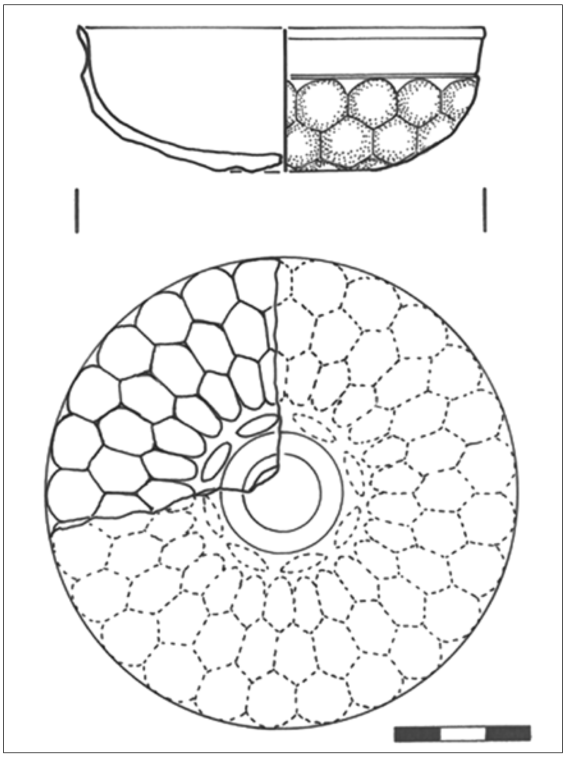

Fig. 3 : Groupe 3.

Décor à grains de riz verticaux dans deux rangées; à cercles; à cercles séparés par une ligne verticale fermée de tirets horizontaux. Des lignes incisées horizontales séparent les rangées de facettes. Sous le fond, deux cercles concentriques de grains de riz (2 exemplaires).

d. Coupe à panse hémisphérique; lèvre verticale. Verre épais.

Décor avec rangée de boucliers délimités par une ligne incisée, dont le centre est abrasé ou pourvu d'un ombon. Les boucliers sont séparés par une ligne verticale fermée de tirets horizontaux (3 exemplaires); à ovales horizontaux sous la lèvre et à strigiles taillés (1 exemplaire).

Les coupes des sous-groupes *a* et *c*, qui sont décorées sur la panse et sur le fond de petits motifs géométriques gravés, très simples, placés sur plusieurs registres, parfois séparés de lignes incisées horizontales, appartiennent à la phase initiale de cette production, quand, au milieu du II[e] siècle, la technique à décor gravé de facettes, déjà attestée à l'époque des Flaviens sur les gobelets Isings 21, est reprise après une période d'apparente interruption.[6] Les coupes avec ces décors sont répandues dans tout l'Empire et il peut y avoir eu plusieurs centres de production.

Ainsi, en Occident,[7] pendant le II[e] siècle et jusqu'à la fin du III[e] siècle, les décors attestés à Brescia sont aussi fréquents que dans les régions de la Méditerranée orientale.[8]

La coupe n[o] 5 du sous-groupe *b* rappelle, par sa paroi au profil vertical, un gobelet de Cologne, mais avec un décor gravé plus élaboré.[9]

Le décor à cercles séparés par une ligne verticale fermée de tirets horizontaux[10] est attesté sur quatre coupes des sous-groupes *c* et *d*; dans le premier, il est associé à des motifs de grains de riz.

Ce décor, rarement présent en Italie du Nord,[11] se trouve aussi bien sur des verres découverts en Occident qu'en Méditerranée orientale dans des contextes de la première moitié du III[e] siècle. Les

6 Paolucci 1997, 63-69; Stern 2001, 24 e 137.

7 Davidson 1952, 95, no. 592, fig. 6 (II[e] siècle); Barkóczi 1996, 186-189 (première moitié III[e]- début IV[e] siècle); Rütti 1991, I, 92-96, fig. 52-53; Cool et Price 1995, 76-79, fig 5.8; Hoffmann 2002, 105-106, C 3.3.1.9 et 409, W 45-47, pl. 83 (160-260 apr. J.-C. et *tpq* 248); Lazar 2003, 83-84, gr. 2.6.2, fig. 30 (III[e] siècle). En détail, voir pour no. 1, Fremersdorf 1967, 92, pl. 75; Barkóczi 1996, 187, fig. 1, 14; 3, 6-7, 16; 4, 2; Rütti 1991, II, 68, no. 1328, pl. 59 (150-250 apr. J.-C.); pour no. 3, Fremersdorf 1967, 92, pl. 76a; pour no. 4, Fremersdorf 1967, 92, pl. 76b; Rütti 1991, II, 68, no. 1335, pl. 60 (II[e]-III[e] siècle); pour no. 6, Barkóczi 1996, 187, fig. 5, 1; Rütti 1991, II, 68, no. 1327, pl. 59; Foy 2010, 363, no. 680 (première moitié III[e] siècle).

8 Voir pour no. 1, Harden 1936, 102, classe III B II a I, 120, no. 317, pl. XIV; Sorokina 1978, 113, fig. 1, 9; 2, 9; Brun 2003, 385, fig. 9, 4, première moitié III[e] siècle; von Saldern 1980, 16-17, no. 64, pl. 3 et 20 (mais tous sans grains de riz horizontaux sous le bord); Silvano 2012, 32-33, nos. 143-146; pour nos. 3 et 6, Schwarzer 2009a, 71, fig. 24; Schwarzer 2009b, 91, fig. 20-21; pour no. 4, Sorokina 1978, fig. 2, 6; pour no. 6, Sorokina 1978, fig. 2, 7.

9 Fremersdorf 1967, 73, pl. 39.

10 Dans la coupe no. 7, il y a en un cas deux lignes verticales fermées par des tirets horizontaux, tandis que dans la coupe no. 8 il y a seulement les deux tirets horizontaux sans la ligne verticale faute d'espace.

11 Paolucci 1997, 69. Il est présent à Aquileia, *ibidem*, 119-121 (Mandruzzato et Marcante 2005, 28, 38, nos. 255 et 345).

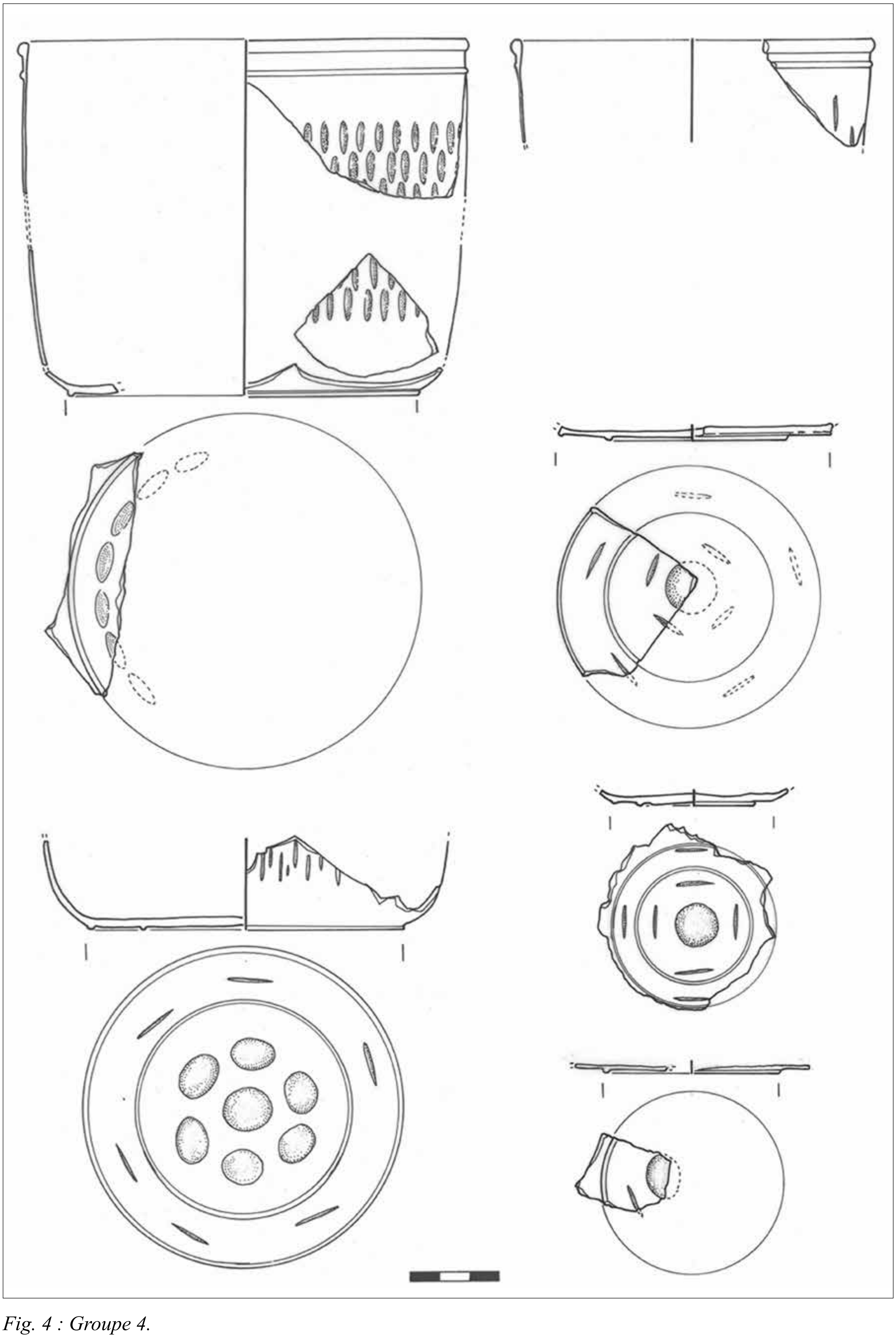

Fig. 4 : Groupe 4.

décors des pièces de Brescia sont différents entre eux : la coupe no. 7 a des simples cercles avec la surface intérieure abrasée[12] tandis que les deux coupes nos. 8-9 ont des boucliers délimités par une ligne bien incisée, avec seul le centre abrasé, disposés sur un ou deux registres. Cette variante comporte de nombreux parallèles aussi bien en Orient qu'en Occident, où, parmi les verres de Cologne, on observe précisément, pour la coupe no. 8, un parallèle aussi au niveau des dimensions.[13] Dans la coupe nº 10 enfin, il y a des petits boucliers avec un ombon au centre. Ce décor a des comparaisons en Méditerranée orientale et en Pannonie, où on l'a considéré comme typique de la production locale de la première moitié du III^e siècle.[14]

Le décor à strigiles taillés de la coupe no. 11 rappelle le décor du gobelet no. 1 du groupe 5, qui toutefois est délimité par une ligne incisée à arête vive. Tous les deux ont sous la lèvre des ovales horizontaux délimités par des lignes incisées. Un décor très semblable se trouve sur une coupe hémisphérique de Augst[15] et sur un bol ovoïde de la nécropole de Beauvais (seconde moitié du IIIe - première moitié du IVe siècle),[16]

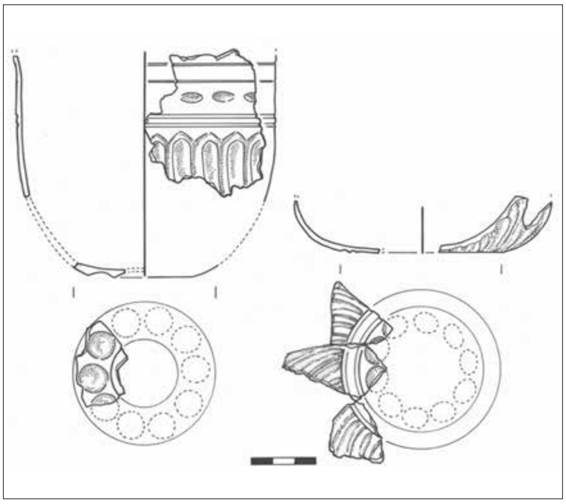

Fig. 5 : Groupe 5.

dont on pense qu'ils ont été fabriqués dans la région de Cologne.

GROUPE 2 (T 49B/AR 56) (Fig. 2)

Coupe à panse hémisphérique; lèvre rentrante. Verre épais.

Décor à grains de riz verticaux dans une ou deux rangées (dans deux cas avec alternance d'ovales ou cercles sous le bord ou sur la panse) ou horizontaux dans une ou deux rangées sous le bord; à cercles; à ovales; à ovales, avec des rangées serrées à nid d'abeilles. Des lignes incisées horizontales séparent parfois les rangées de facettes. Sous le fond, au centre, un cercle et des ovales ou des grains de riz (12 exemplaires).

Comme le précédent, ce groupe aussi est documenté par des nombreuses pièces. Le décor rappelle en partie celui qui est présent sur certaines coupes du groupe 1*a-c*.

Il s'agit d'une forme bien connue en Occident.[17] À Augst, on situe au IVe siècle après J.-C. des pièces semblables, mais de telles coupes apparaissent déjà au cours du IIIe siècle après J.-C.[18]

12 Fremersdorf 1967, 75, pl. 42; Barkóczi 1996, 187-188, fig. 8, 11; 9, 1a-b; Follmann-Schulz 1988, 106, fig. 46. On peut la comparer, y compris pour le décor du fond (mais il y a une rangée supérieure de facettes ovoïdes et boucliers avec ombon), à une coupe publiée in Harden *et al*. 1988, 196, no. 106 (deuxième moitié IIe siècle, atelier de Rhénanie).

13 Paolucci 1997, 69 et 119-20. En outre Clairmont 1963, 70-72 nos. 266-268, pl. XXVI; Fremersdorf 1967, 95, pl. 83; von Saldern 1980, 16-17, nos. 70-73, pl. 3 et 20; Barkóczi 1988, 64, no. 39, pl. IV et LXXI; Czurda-Ruth 1989, 133, fig. 3, 34; Barkóczi 1996, 187-188, figs. 7; 8, 1, 2, 5, 6, 8, 9, 14; 11; 13, 3,8; *Trasparenze imperiali*, 88, fig. 167; Canav Özgümüş 2009, 18, fig. 2.

14 Clairmont 1963, 72, no. 270, pl. XXVI; Barkóczi 1988, 65, nos. 41-42, pl. IV et LXXI; Czurda-Ruth 1989, 133, fig. 3, 35; Barkóczi 1996, 187-188, figs. 6, 2; 12, 2 (mais aussi figs. 5, 18; 6, 1, 3-4; 12, 4; 13, 1c, 6, 7, où les boucliers pourvus d'un ombon sont séparés par une ligne double); Paolucci 1997, 120-121.

15 Rütti 1991, II, 64, pl. 54, 1255 (la coupe, de forme AR 56, est associée à des monnaies et à des céramiques du IIIe siècle, 91-92).

16 Arveiller-Dulong *et al.* 1996, 29, no. 23.

17 Alarcão 1965, 67, no. 84; Barkóczi 1996, 187, fig. 4, 1 (identique à no. 7); Paolucci 1997, 100-101 (Mandruzzato et Marcante 2005, 100, no. 254); Hoffmann 2002, 106-107, C 3.3.11.9; 307, pl. 15, R 232-233; 429, pl. 96, H 9. Pour le décor, voir Fremersdorf 1967, 96, pl. 86; Barkóczi 1996, 187, figs. 5, 4, 8, 13a, où il y a des facettes ovoïdes allongées disposées en quinconce.

18 Rütti 1991, I, 45 e 91-92, pl. 15-17 et II, 64, nos. 1254-1258.

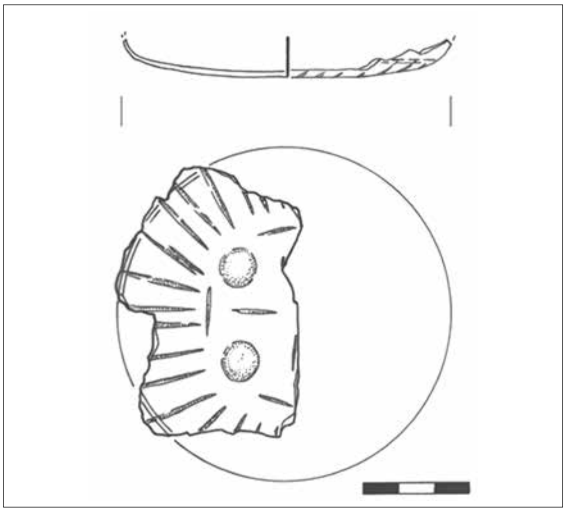

Fig. 6 : Groupe 6.

Groupe 3 (Isings 116b/AR 58) (Fig. 3)

Coupe avec lèvre légèrement évasée, fond plat. Verre épais.

Lignes incisées sous la lèvre et à la transition du bord et de la panse, décor à trois rangées serrées de facettes disposées “en nid d’abeilles”; sur le fond, une ligne circulaire incisée et autour des grains de riz (1 exemplaire).

La forme et le décor de la coupe de *Brixia* ont des parallèles avec des pièces de Nida-Heddernheim, de Doura-Europos, de Medinet Madi, de Quseir al-Qadim et de Bérénice,[19] bien que la coupe de *Brixia* soit évidemment plus petite. Pour toutes ces coupes, on peut localiser l’atelier de production en Méditerranée orientale. Tandis que le décor du fond de la coupe de Nida-Heddernheim est différent, la coupe de Doura-Europos a, semble-t-il, le même décor du fond que la pièce de Brescia. La première vient d’une sépulture datée entre 140-170 après J.-C.; on date aussi la coupe de Bérénice au IIe siècle. La même forme, mais avec un décor gravé différent, se trouve à Medinet Madi, à Augst, où elle est datée entre le deuxième quart du IIe et la moitié du IIIe siècle et au Landesmuseums di Mainz, de provenance inconnue.[20]

19 Clairmont 1963, 61-62, no. 241, pl. VII, XXV; Welker 1985, 27, no. 85, pl. 7 et 19; Nicholson 1998, 283, fig.14,4; Silvano 2012, 34 no. 136, pl. XIII.

20 Silvano 2012, 33-34, nos. 134-135, pl. XIII; Rütti 1991, I, 45 et fig. 83, 012; II, 65, pl. 55, 1263-1266; Harter 1999, 50, no. 212, pl. 8.

On a déjà remarqué comment le décor disposé “en nid d’abeilles”, qui occupe presque toute la panse de ces pièces, rappelle de près celui présent sur les gobelets Isings 21 de l’époque des Flaviens : le décor sur les coupes peut bien représenter son évolution finale.[21] On note que dans la coupe de Brescia les rangées supérieure et inférieure portent des facettes arrondies sur l’une de leurs parties alors que dans la rangée intermédiaire les facettes prennent la forme de losanges, de la même façon donc que le décor qui se trouve sur les gobelets Isings [21].

Groupe 4 (Isings 85b/T 47a/AR 98.2) (Fig. 4)

Coupe à panse cylindrique; double pied annulaire. Verre fin.

Décor à rangées de facettes en forme de grains de riz qui ornent tout la surface; au milieu du fond, un cercle et une frise concentrique composée de facettes en grains de riz et/ou de facettes circulaires ou ovales; sur le pourtour extérieur du médaillon, des grains de riz (8 exemplaires).[22] On peut supposer que les pièces proviennent d’un même atelier en raison de l’homogénéité de la forme, du verre, du décor et aussi des phénomènes d’altération de la surface. Des coupes avec des décors identiques sont présentes dans la Méditerranée orientale, à Chypre, en Égypte, en Syrie dans des contextes de la fin du IIe siècle et de la première moitié du IIIe siècle,[23] alors

21 La forme plus allongée des facettes hexagonales se transformerait graduellement en facettes oblongues qui se trouvent dans les coupes Isings 96 de la fin du IIe siècle. Sur l’origine du décor en forme de grains de riz et sur sa dérivation du décor à nid d’abeilles, voir Paolucci 1997, 64-68.

22 Il s’agit du nombre minimum. Il y a plusieurs fragments décorés à grains de riz verticaux, étroits et allongés, plus semblables à ceux qui se trouvent dans ce groupe que dans le groupe 1a-b. Ces fragments n’ont pas été attribués aux grandes coupes nos: 1-3 à cause de différences concernant le décor, l’épaisseur du verre et l’altération de la surface, mais ils pourraient être reliés à des coupes dont on a repéré seulement les pieds (nos. 4-8).

23 Harden 1936, 103 et 124, fig. 2, a; Clairmont 1963, 81-82, nos. 322-326, pl. IX e XXX (le pied no. 326 est identique à celui de la coupe no. 3); Brun 2003, 385, fig. 9,5; Silvano 2012, 35, nos. 138-139.

qu'elles sont presque absentes en Pannonie, sur les côtes de la Mer Noire, dans la région du Rhin, où la même forme sans décor est très fréquente entre les dernières décennies du II^{e} siècle et la moitié du III^{e} siècle après J.-C.[24] Les pièces de *Brixia*, comme les autres coupes semblables retrouvées en Italie du Nord et en Rhétie, sont à associer, comme F. Paolucci l'avait déjà précisé, à des ateliers de la Méditerranée, Syrie ou Égypte, en activité entre le II^{e} et le III^{e} siècle[25].

GROUP 5 (T 43/AR 63 ?) (Fig. 5)

Gobelet. Verre épais.

Décor à lignes incisées et à ovales sous le bord; en dessous, des facettes verticales allongées délimitées par des lignes incisées; sur le fond, un décor à cercles (4 exemplaires).

Le décor est bien attesté dans la Méditerranée orientale, à Sardis, Éphèse, Doura Europos.[26] Ici, on le trouve sur de nombreuses pièces de formes différentes de la fin du II^{e} siècle et du début du III^{e} siècle, qui sont toutes à considérer de production locale. Le même décor se retrouve aussi en Occident (Trèves, Augst, Aquincum, Intercisa).[27] Les deux gobelets entiers de Trèves sont comparables à la pièce n° 1 de Brescia, mais l'association dans les gobelets de Trèves du décor à réseau et à simples facettes verticales allongées laisse supposer qu'ils ont été produits en Rhénanie, où ce type de grille est particulièrement fréquent aux III^{e} siècle et IV^{e} siècle, bien qu'il soit connu aussi parmi les verres gravés de la Méditerranée orientale.[28]

Parmi les verres de Brescia le décor rappelle celui de la coupe n° 11 du groupe 1*d*, où toutefois la ligne incisée qui délimite la facette verticale est arrondie dans la partie supérieure.

GROUPE 6 (Fig. 6)

Coupe à fond plat. Verre fin.

Décor au centre du fond à grains de riz et à cercles. Autour, des lignes gravées en éventail (2 exemplaires).

Comme on n'a pas pu reconnaître quels étaient les fragments appartenant à la panse ou à la lèvre, cela a été un obstacle pour identifier la forme du verre. Il s'agit, peut-être, d'une coupe à panse cylindrique, semblable à la coupe découverte à Corte Cavanella (Rovigo), une forme connue grâce à d'autres pièces de l'Empire occidental.[29]

Tous ceux qui ont étudié les verres incolores à décor gravé de petits motifs géométriques ont mis en évidence la difficulté de reconnaître les ateliers d'origine parce qu'il s'agit d'une production de style international, bien représentée dans tout l'Empire.[30] Réalisés à la fois en Orient et en Occident, les vases présentent des variantes dans le décor et dans les formes, mais il est rare que l'on puisse définir avec certitude le lieu de production. Il en est de même pour la plupart des groupes qui figurent à Brescia : les ateliers d'origine n'ont pas pu être identifiés avec certitude, mais on peut penser que les coupes des groupes 3 et 4 proviennent des ateliers de la Méditerranée orientale. Comme l'étude des verres gravés à décor figuré l'avait déjà montré, *Brixia* se confirme donc un marché ouvert, participant au commerce inter provincial de l'Empire tout entier.

24 Rütti 1991, I, 49. Ici, il y a au contraire des coupes à décor gravé d'inscriptions, de poissons et plus rarement de scènes figurées, qui sont à rapprocher à une production d'ateliers locaux: Roffia 2002, 414-420. Voir aussi Paolucci 1997, 121-126.

25 Paolucci 1997, 104-106, 107-108, 110-112. Une pièce semblable est présente aussi dans la Péninsule ibérique, Marcos Herrán 2002, 103 et 309, San Millán 1453. En Corse et à Marseille, il y a une variante avec un profil moins raide et un décor différent, probablement d'importation orientale, Foy et Nenna 2003, 279, figs. 187-189, premier tiers du III^{e} siècle.

26 Clairmont 1963, 73-74, nos. 275, 277-289, pl. VII e XXVII; von Saldern 1980, 16, no. 69, pl. 3 et 20; Czurda-Ruth 1989, 133, fig. 3, 36.

27 Fremersdorf 1967, 84-85, pl. 63 et 65; Rütti 1991, II, 57, pl. 51, 1187, 1189; Barkóczi 1996, 187-188, fig. 9, 4, 6, 8; 13, 11.

28 Paolucci 1997, 121. Pour l'association de ce décor à celui à réseau, voir aussi Rütti 1991, II, pl. 51, 1187; 61, 1338-1339.

29 Paolucci 1997, 109. Voir aussi Barkóczi 1988, 63, no. 37; Foy et Nenna 2003, 279, fig. 185, III^{e} siècle.

30 Rütti 1991, I, 92-95; Paolucci 1997, 63-71; Foy et Nenna 2003, 277-279; Foy 2010, 341.

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GLASS PRODUCTION IN ANTINOOPOLIS, EGYPT

Introduction

Located in Middle Egypt, 286 km south of Cairo, on the east bank of the Nile, the ancient city of Antinoopolis was founded by Hadrian in AD 130, in memory of his beloved Antinoos.[1] In the 2nd and 3rd century AD, the town, which enjoyed great favour from several Roman emperors, must have been one of the most beautiful towns in Upper Egypt. Parts of this splendor, such as the theatre, a triumphal arch and a hippodrome were still standing at the time of the Napoleonic Expedition to Egypt. The city survived until the 8th century AD.

The excavations carried out by the Istituto Papirologico "G. Vitelli" (University of Florence) since 2007 have uncovered several thousand glass fragments that represent important material for the study of Late Roman and Early Byzantine glass in Egypt.[2] Under the direction of Rosario Pintaudi, the archaeologists have been digging in two different parts of the town: the northern necropolis and a vast area in the southeast quarter of the town, where a large basilica with five naves and another church were unearthed. Over 3000 glass fragments were found in these two areas. The amount of glass finds is not surprising considering that, under Diocletian (AD 286), the town became the capital of the Thebaid nome and flourished in the 4th and 5th century.

Local workshops must have produced at least part of such a large glass assemblage; these workshops, intended for the fashioning of glass vessels and objects, must have been located either inside the city or in the neighbourhood in order to supply the daily demand of tableware, lamps, cosmetic containers and window panes. This big city must have had an area used for craft and industrial activities with workshops for glass working as the numerous chunks of unworked or raw glass found all over the city seem to prove.

The archaeological evidence suggests the presence of a glass industry in different parts of Egypt where raw glass production was sepa-

1 Pintaudi 2008.
2 Silvano 2012, 272-276.

rated from vessel manufacturing; raw glass production centres were usually located near raw materials, such as the natron of the Wadi Natrun, while workshops for the fashioning of glass vessels were usually situated in the industrial area of the city.[3] Three primary glass production sites of the 1st–2nd century AD were identified in the Wadi Natrun region (Beni Salama, Bir Hooker and Zakik).[4] These are the best-preserved raw glass furnaces discovered so far in Egypt and in the Near East, and are also the oldest furnaces of this kind, confirming Egypt's importance in the production and trade of glass between the East and the West during the Greek-Roman Period.[5] Two other primary workshops were found on the shores of Lake Mariout, near Alexandria (Taposiris Magna and Marea-Philoxenité),6 and another in North Sinai.[7]

Primary glass, made on big slabs, was then broken up into chunks and distributed to the secondary glass workshops where it was reheated and manufactured into various shapes. Many finds indicate glass vessel production at different Egyptian sites.[8]

Excavations have unearthed remains of glass workshops, including traces of furnaces, chunks of raw glass brought for melting, debris from glassblowing activities and a concentration of similar types of vessel in large quantities. Examples of such installations have been unearthed at Kom el-Dik in Alexandria[9] and Marea-Philoxenité along the southern bank of Lake Mariut, near Alexandria.[10]

Secondary glass workshop in Antinoopolis

An area probably linked to glass working has been found in the southern part of Antinoopolis (sector III, zone XII); three small rounded kilns

Fig. 1: Kilns 1 and 2 along the river bank.

were discovered near the Nile bank. Two kilns were built next to each other (Fig. 1). The kilns have a roughly circular structure: the interior diameter of Kiln 1 is approximately 0. 96 m; its preserved depth is 0.29 m ca.

At first we were reluctant to assume that these very small kilns were used to make glass; it is more likely that they were used to melt raw glass chunks and recycled glass shards to make glass objects. No trace of glass has been found on the walls of the kilns, which were covered by a thick lime coating. This particularity is not common, but it has been found, for instance, in three circular kilns in ancient Edessa, an important city of Macedon,[11] and in a furnace from the late 6th century[12] in Thessaloniki.

In 2007 and 2009 a survey near this area carried out by P. Ballet, M.C. Guidotti and myself, unearthed several chunks of unworked or raw glass;[13] the assemblage from zone XII (XII A, B, C, D) includes 47 examples with most of them derived from zone XII D (Fig. 2), which is nearest to the kilns. These are cube-like in shape and range in size from 0.9 to 4-4.5 cm on one side. The raw glass chunks come in three distinct colours: most of them are of bluish-green hues; some are light green; others are dark translucent green. A fine, clear fabric, lacking in bubbles characterizes the glass; some pieces display a lower quality fabric that are less clear with lime impurities. None of the

3 Nenna, Picon, Vichy 2000, 107-112.
4 Nenna, Picon, Thirion-Merle,Vichy 2005, 59-63.
5 Nenna 2008b, 61-66.
6 Nenna, Picon, Vichy 2000, 110.
7 Nenna 2014, 178-193.
8 Nenna 2012, 309-325, fig. 1.
9 Rodziewicz 1984, 239-243; Kucharczyk 2007, 45-46.
10 Nenna, Picon, Vichy 2000, 110; Nenna 2012, 310-312.
11 Antonaras, Chrysostomou 2015, 293.
12 Antonaras 2014, 95-113. I would like to thank my friend and colleague for a very stimulating discussion about this technical particularity.
13 Ballet, Guidotti 2014.

Fig. 2: Chunks of raw glass, furnace debris and melted green glass from zone XIID.

Fig. 3: Remains of the glass making furnace.

fragments bear direct evidence of the crucible or melting pot. The chemical analysis of a selection of chunks is in the process of being carried out.

Large quantities of raw glass are usually found around glass workshop locations: they represent primary glass probably made elsewhere and then brought to the site to be worked. Although this site, located near the river and areas of cultivation, has been severely damaged by local farmers over the centuries, its proximity to the water and the pottery workshops found further south in zone V[14] seems to confirm that this place was part of an industrial estate inside the city walls, located near the theatre. Raw glass chunks were usually traded and purchased to be melted again in furnaces.[15] The artisans probably melted the raw glass chunks in these three small furnaces and worked the hot glass to make vessels and other objects.

Surface finds retrieved from the area surrounding the site also included 9 fragments of furnace debris; these are pieces of dismantled glass furnaces showing the conglomerate structure with some veins of partially-vetrified glass and opaque layers. The site also yielded fragments of the furnace floor with a glass layer on top. Fragments of Islamic glazed pottery were also recovered from this area as well as a 9th century coin found in zone XII A.[16]

Missing from the survey in zone XII are the most diagnostic remains of glass blowing, such as glass drops or deformed vessels, which would indicate the presence of a furnace; the only exception is one piece of melted green glass from zone XIID (Fig. 2).

Primary glass workshop in Antinoopolis

There is another area in Antinoopolis, in addition to the area along the riverbank, which is very closely connected to glass production. It is located in the middle of sector II of the town, between *decumanus* and Wadi Abada. Here, a glassmaking furnace (Fig. 3) was discovered, probably dated back to late antiquity, considering the numerous fragments of Islamic glazed pottery unearthed in the proximity during the survey.[17] It was a primary workshop for the manufacture of the material, built on the pieces of pottery scattered all over the site, which indicates a later construction.

The furnace remains were so badly damaged that it was impossible to determine its layout and appearance; only a part of the furnace survived and was built with bricks and stone blocks in different stages (approximate preserved length 2.50 m; preserved width 2.10 m; preserved height 2.40 m), whereas a big piece on the eastern side had collapsed. A layer of melted glass,

5-6 cm thick, covered part of the floor of the melting chamber (Fig. 4); the glass was green, transparent and with few bubbles or other impurities. The chemical analysis of the material,

14 Ballet, Guidotti 2014.
15 Nenna 2008a, 125-147.
16 Ballet, Guidotti 2014.
17 Ballet, Guidotti 2014.

carried out by Soprintendenza Archeologica della Toscana,[18] revealed that the glass failed to melt completely and the manufacturing process was not entirely complete. As a result, the glass was left there.

A tiny glass sample has been analysed to establish its chemical composition. For this purpose, energy dispersion microanalysis has been used (EDX: EDAX, DX-4), coupled with a microscopy electron scan (SEM: FEI, Quanta 200).

A sample was collected from the transparent part of a light green fragment, featuring subspherical white opaque areas of ~ 1 mm dimension.

The chemical analysis highlighted a Na-Ca composition with a different ratio for the two portions of glass: transparent and opaque. The transparent portion is highly similar to Roman glass, which usually has a SiO_2 content of around 60-70%, Na_2O in the range of 14-22% and CaO between 4 and 10% (Table 1).[19] The different portions of the object vary in the ratio between Na_2O and CaO, and the opacity is explained by calcium density. The material can therefore, be described as an intermediate phase of the vetrification process: a raw glass with non-completely homogenised fractions.

In October 2012, a large number of raw glass chunks and fragments of furnace debris were discovered a few hundred meters southwest of this furnace installation; the glass chunks are in three distinct colors. The first is bluish-greenish (29 ex.), the second light green (10 ex.) and the third black (4 ex.). Several pieces of dismantled glass furnaces were unearthed in the same area: they show a structure with transparent glass on top, a layer of partially vetrified glass and remains of furnace floor on the lower part (Fig. 5). The color is light blue, transparent in the upper part and opaque in the lower part that is closest to the floor of the furnace; a possibile explanation for this is that artisans removed the transparent glass of the upper part, where the temperature was higher, leaving the opaque layer on the furnace floor. Something similar can be seen on a fragment of furnace debris from Taposiris Magna.[20] Another possible explanation is that raw materials were added to the melting chamber in stages so that the raw glass was melted in layers rather than all at once.[21]

Fig. 4: Detail of the furnace floor.

Fig. 5: Glass debris discovered in 2012.

18 Analysis carried out by P. Pallecchi and G. Giachi from Soprintendenza Archeologica della Toscana, Lab. di analisi, L.go del Boschetto 3, 50100 Florence.

19 De Francesco, Ciarallo, Scarpelli, Vite, 2010.

20 Nenna, Picon, Vichy 2000, 103, fig. 19.

21 Also one of the large glass chunks from Tyre showed two distinct layers (see Aldsworth, Haggarty, Jennings, Whitehouse 2002, 65, fig. 18).

	Percentage Composition				
	Transparent portion			Opaque portion	
Na_2O	27,24	23,00	25,33	9,09	6,14
MgO	0,00	0,00	0,00	2,63	2,52
Al_2O_3	2,01	3,73	4,47	3,00	3,20
SiO_2	68,60	66,63	65,69	41,10	60,74
Cl_2O	1,20	1,30	1,02	4,96	1,91
K_2O	0,21	0,25	0,10	2,06	1,62
CaO	4,98	4,77	3,23	35,96	23,09
Fe_2O_3	0,60	0,33	0,16	0,59	0,78

Table 1: The chemical composition of the glass sample from Antinoopolis. The components are given as weight percent.

Usually, a mixture of raw materials was placed on the floor of the melting chamber before the manufacturing process began. When all raw materials were melted, the glass was allowed to cool down in the melting chamber itself. After that, the large solidified glass tile was broken up into chunks; only the transparent part was removed and sent to secondary workshops.

For this reason, the debris found here from the glassmaking process confirms the use of this area for primary glass production.

Due to the high temperature at which they functioned, the furnaces probably had relatively short life spans. The furnaces were dismantled after each firing and could be recontructed in the same place, as in Wadi Natrun, or moved to another place, as in Bet Eliezer. Further excavations will be needed to obtain a more accurate identification of the structure, to understand its importance and the nature of production in the town. Additionally, a comparison with other similar buildings, if there any are still remaining, would be useful.

Conclusions

The evidence gathered from the Antinoopolis site suggests that some glass vessels and objects were made in the southern industrial suburb along the river, near the pottery workshops. Further surveys and more careful excavations will be needed to fully understand the working area located inside the town walls. At present, it is not certain when this area was used. However, it is surprising that there was just one characteristic of glass working waste. Some raw glass chunks found in zone XIID of the town will be analyzed to understand their origin.

The glass furnace, in the middle of sector II of the town, was certainly a structure used to make raw glass; the chemical analyses of the material revealed a failure in production and the glass found on the floor of the melting chamber was probably left there as a result of this unfinished process.

Continued excavations and documentation related to primary and secondary workshops in the city and its environs should help us gain a more complete picture about glass making and glass working in Antinoopolis and in Middle Egypt; the finds from Hermopolis Magna,[22] on the other side of the river Nile, could suggest a system of glass production and distribution which probably originated in a few locations.

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22 Bimson, Freestone 1991, 64-65.

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DIGITAL RECONSTRUCTION OF A ROMAN BIRD-SHAPED GLASS VESSEL FROM PATRAS IN 3D CAD ENVIRONMENT

Introduction

The development of efficient technological means and methods for the digital, three dimensional (3D) reconstruction and further documentation of Cultural Heritage (CH) artefacts constitutes a challenging research field that is currently attracting much interest from all scientific disciplines involved in this area. The capacity to create, display and manipulate a Computer Aided Design (CAD) model of a physical object can play an important role in the areas of digital documentation, automated restoration, computational monitoring, remote fruition and true replica reproduction of CH items. The rapid advancement in computational capacity in conjunction with the development of hardware technologies have recently made CH digitization a more appealing practice both in terms of time and money. However, the extreme diversity that characterizes shapes, details and materials of such objects, still make the creation of their *accurate* 3D-CAD model a highly demanding, high-cost and time consuming engineering design task.

An overview of the current methodologies for 3D digitization that are applicable to CH recording and state-of-the-art 3D acquisition technologies as applied to CH items are presented in several publications.[1] Considerable applied research for the development of appropriate strategies and methods has been conducted and published through major projects, such as the 3D digital model construction of Michelangelo's Florentine Pietà,[2] the Minerva of Arezzo restoration project[3] and the reconstruction of missing elements of the Guerriero di Castiglione stone sculpture.[4]

The necessity of an *exact* 3D digital reconstruction and the importance of accuracy in a broad range of CH applications, although well acknowledged, is so far briefly addressed in published technical literature. The potential engagement of CAD/ CAM/ CAE technologies in CH

1 E.g. Pieraccini *et al.* 2001; Pavlidis *et al.* 2007; Dongming Lu and Yunhe Pan 2009.
2 Bernardini *et al.* 2002.
3 Fontana *et al.* 2002.
4 Fatuozza *et al.* 2011.

applications is directly linked to the accuracy of the constructed CAD model.[5] For the purposes of Michelangelo's Florentine Pietà project,[6] the resolution threshold - in order to capture shape and surface details of a statue of 2.25 meters tall - was on the scale of 1 to 2 mm. Furthermore, Pieraccini et al. 2001 proposes that for archival – quality digital models, accuracy must be better than 1mm in each direction and that higher accuracy can be requested for acquiring small details. For CH virtual reality applications, it is suggested that both high accuracy/ resolution models and low-cost hardware should be combined depending on the application needs.[7] Nevertheless, the particularities emerging in different kinds of CH artefacts and applications and their relationship with digitization accuracy requirements remain ambiguous.

Focusing on vitreous finished CH items, the paper presents a systematic approach for their digital reconstruction that is based on 3D-CAD techniques. The approach, to the extent of the authors' knowledge, is first of a kind for this type of 3D reconstruction that deals with *glass CH artefacts*. The main aim of this research is to achieve a *high accuracy* 3D-CAD model reconstruction of the whole original object, even in the case where several of its fragments are not available. The availability of this digital 3D model offers a broad range of key benefits, such as high-accuracy automated production of archaeological 2D line drawings, computer-aided restoration assistance, scholar studies on fabrication techniques and efficient exhibition mounting/ transportation/ storage design. The effectiveness of the proposed approach is illustrated in a case study that concerns the digital reconstruction of an Early Roman bird-shaped glass vessel of fragmentary condition from the region of Patras, Greece.

Problem definition

In a broad sense 3D digital reconstruction of cultural heritage may concern:

- Physical objects with dimensions between some fractions of a meter and several meters, e.g. statues, works of art, arms, tools, toys, objects of everyday life.

- Sites of archaeological and/ or architectural interest, e.g. tombs, temples, monuments, etc.

It should be noted that 3D-CAD modelling is of importance only where solid geometry is involved. Small sized CH objects of the first category usually exhibit complex characteristics and details which typically need much more sophisticated techniques to be accurately recorded than the large sized ones. The analysis that follows is focused on the first category of CH objects and especially on small and mid – sized items that can be contained within a bouncing box with dimensions between some fractions of a meter and a maximum of 1-2 meters.

Moreover, a usual case in archaeological excavations is that unique objects of cultural interest, e.g. statues, gradually revealed glass vessels that are fragmented and/ or several parts of them are missing. The recognition and correct matching of these fragments to the appropriate geometrical region of the original object is a rather complicated and sophisticated task that is still strongly based on human expertise and intuition. Modern computational tools that are based on the digital reconstruction of the CH object have to be investigated in order to facilitate and accelerate this task.

An overview of the major stages of the 3D digital documentation process together with relevant tools and potential applications for CH objects is presented in Fig. 1. Digitization is usually performed by using non – contact methods (e.g. laser scanners), whereas data processing is done through the use of data filtering algorithms and surface reconstruction tools. Computational tools such as rendering and texture simulation are used to address digital CH applications whereas those of CAD/CAM/CAE involve Finite Element Analysis (FEA) and Rapid Prototyping and Tooling (RP/ RT) manufacturing processes. The core role of the 3D-CAD model in the whole process is stressed here as it constitutes the vital link between the physical CH artefact and the digital and/or CAD/CAM/CAE applications.

5 Kaisarlis *et al.* 2004.

6 Bernardini *et al.* 2002.

7 Bruno *et al.* 2010.

From the engineering design point of view, the digital reconstruction of a CH object is considered as a rather challenging Reverse Engineering (RE) problem.[8] Well-established over the past decades, RE deals with physical components for which technical data are not available or accessible, that have to be reconstructed by recording their 'as – produced' shapes and dimensions. The RE process must ensure that the RE manufactured component will fit and perform perfectly without affecting function and quality of an existing assembly. In that context, the required accuracy for the digitization tools is strictly specified by the dimensional and geometrical tolerances of the reversibly engineered component. This is not, obviously, the case for CH objects. Almost every such item is unique, presents its own particularities and has a *sui generis* character that makes the application of the conventional RE approach difficult or even impossible. In addition, CH digital models are not intended to meet functional needs, but rather those connected with research, safe handling/exhibition, restoration or replica-making. Engineering concepts, such as critical dimensions, nominal values and tolerances are not consequently applicable. The geometrical accuracy of the 3D digital reconstruction is nevertheless crucial for the applications shown in Fig. 1. A different approach is therefore, needed for the establishment of the accuracy requirements for 3D digital and/ or physical reproduction than that observed in functional reversibly engineered components.

Methodology

Digital reconstruction of CH vitreous artefacts is accomplished by the present method in four sequential steps. This work flow is based on the generic steps for data acquisition and processing that are proposed in several research publications.[9] However, the methodology is appropriately implemented in order to efficiently deal with the particularities that emerge from the specific properties of the *vitreous materials*, such as reflectance and transparency.

Step (a): Raw data collection

The starting point for 3D reconstruction is the digital capture of the form and dimensions of the physical object. In order to achieve the highest level of accuracy, low-power laser scanners are used here to acquire the overall geometry of the artefact as a 'point cloud'. The emitted thin laser stripe is projected onto the surface of the object and recorded by a high resolution digital camera providing the 3D coordinates of the digitized surface points. For the efficient accomplishment of raw data collection, it is of paramount importance to confront the issues of glass reflectance and transparency that may produce a large amount of noise i.e. points that do not belong on the actual surface. In the proposed approach, technical parameters of the laser scanner such as *(i)* exposure time settings, *(ii)* scan density and scan lines per second that are captured and *(iii)* laser stripe strength, have been experimentally optimized. Furthermore, a set of guidelines for the location of the artefact safeguards the laser stripe so as to ensure it remains perpendicular to the scanned surface. The methodology also used for on-site laser calibration requires the adoption of current lighting conditions. Finally, in cases of extremely transparent vitreous materials, the option of applying a thin layer of chemically neutral powder with a cotton swab on the surface is also considered.

Step (b): Processing of raw data – Polygon modelling

In the second step of the methodology, several important tasks that concern the processing of raw data acquired at an earlier stage are performed. Such tasks are primarily aimed at the cleaning of the point cloud and typically include the removal of outliers, overlap and disconnected points that have been recorded, but do not actually belong to the digitized artefact. In cases of artefact relocation for complete scan coverage, the partial scans are unified through iterative registration techniques. The remaining data points are then approximated by triangular facets; hence the scanned surface is described as a

8 De Almeida and Barcelo 2011.

9 E.g. Pavlidis *et al.* 2007; Karasic and Smilansky 2008; Dongming Lu and Yunhe Pan 2009.

polygon mesh. Step (b) also encompasses mesh editing tasks that repair any possible intersecting faces of the created triangles and provide for an optimized mesh density, with finer mesh in areas of high detail.

Step (c): CAD Surface modelling

In this step the *CAD surface model* of the artefact is created. Based on the polygonal model of Step (b), a grid of curves is generated that provide the geometrical 4-sided boundaries required for NURBS (Non-Uniform Rational B-Spline) patch construction. CAD surface manipulation tasks that are involved in Step (c) include curve editing operations, such as edges and corners reconstruction, boundaries creation and optimization of patches layout. Here it is important to quantify the level of approximation from points to surface patches in order to keep the desired surface details of the physical CH artefact on the CAD model.

Step (d): CAD Reconstruction of missing fragments

Finally, Step (d) concerns the *reconstruction of missing fragments* by 'filling the gaps' on the crated surface model with appropriately designed surface patches. The key concept of the method is that, even in typical free form objects such as CH artefacts, geometrical features such as *curvature continuity, axes of symmetry, groups or patterns of elements and repetitive decorative features* can be identified and further utilized for modelling unavailable fragments by 3D-CAD tools. Based on the examination of curvature continuity, an extensive iterative search in a user-defined orientation range of cutting planes is performed in order to provide the set of planes that allow for the safest assumption of continuity interpolation. Starting from the linear interpolation between two neighbouring points on the modelled surface, a parametric cubic spline is adopted as the potential curve that bridges their gap. The process leads to the generation of a grid of parametric curves that serve as boundaries for the new surface patches designated in order to achieve the reconstruction of the missing areas on the CAD model.

Case study: an early Roman bird-shaped glass vessel from Patras, Greece

To illustrate the effectiveness of the proposed approach, a fragmented Roman bird-shaped glass vessel was totally reconstructed in a 3D-CAD environment. This free blown glass vessel *(88 x 86 x 40 mm)* is formed in the shape of a small bird, most probably a pigeon, Fig. 2. Pigeons are connected with the goddess Aphrodite and female beauty as well as with *psyche*-the spirit of the dead. Therefore, this type of *unguentarium* may point to female graves.

Bird-shaped flasks (Isings 1957, type 11) are well-known containers of cosmetic powders manufactured for single use. They were produced and used between the first quarter of the 1st century AD and the first quarter of the 2nd century AD, while the sites of Ticino, Avenches and Lyon have been recognized as their main production and distribution centres.[10] Possible local production in Thessaloniki, Northern Greece, has also been suggested.[11]

The inventory no 2115 bird-shaped glass vessel from Patras was found as an offering in a grave in the North cemetery, the wealthiest cemetery of the Roman city. It is colourless and overall, naturalistically executed.[12] According to archaeological evidence, it is dated within the 1st century AD. There is a poetic quality to the vessel's design: the inevitable damage involved in fulfilling its function.

The vessel was digitized by the use of a laser scanner *[FARO LASER LINE PROBE]* that was mounted on a portable Articulated Arm Coordinate Measuring Machine (AACMM) – *[6-axis FARO PLATINUM ARM]*, with overall volumetric accuracy ± 0.036mm, according to ANSI B89.4.22-2004. Commercially available RE/CAD/CAE software packages *(3DS SolidWorks, Raindrop Geomagic Studio)* that provide task-specific computational tools for surface re-

10 Biaggio-Simona 1991, 125-129; Motte and Martin 2001, 303-319.

11 Antonaras 2009b, 27-31.

12 Antonaras 2009, type 120a.

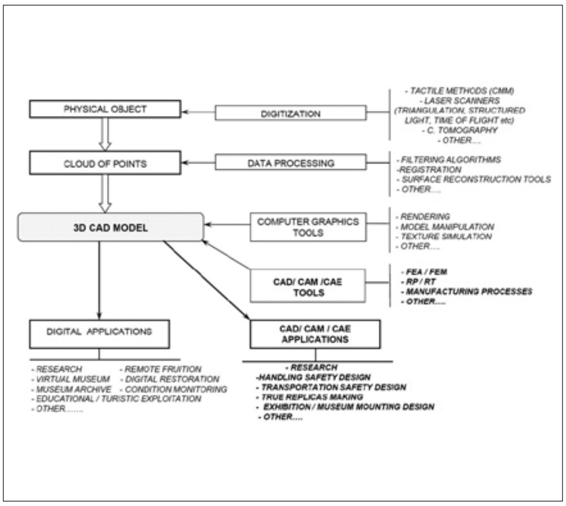

Fig. 1: Major stages of the 3D digital documentation process for CH.

Fig. 2: Case Study artefact: early Roman bird-shaped glass vessel from Patras.

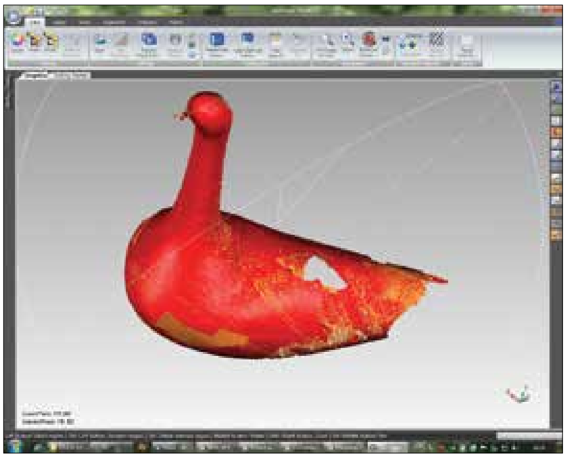

Fig. 3: Point cloud of the digitized artefact.

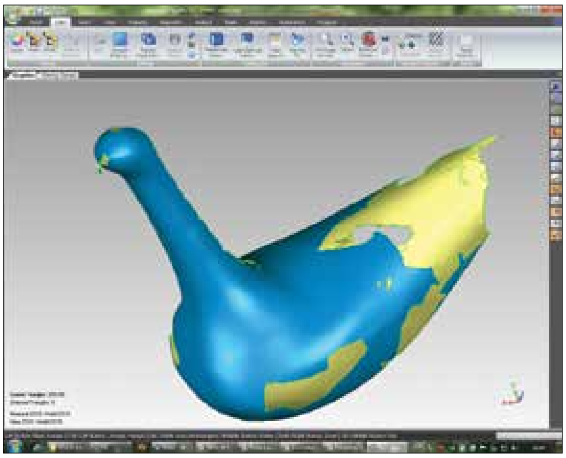

Fig. 4: Polygon model of the case study vessel.

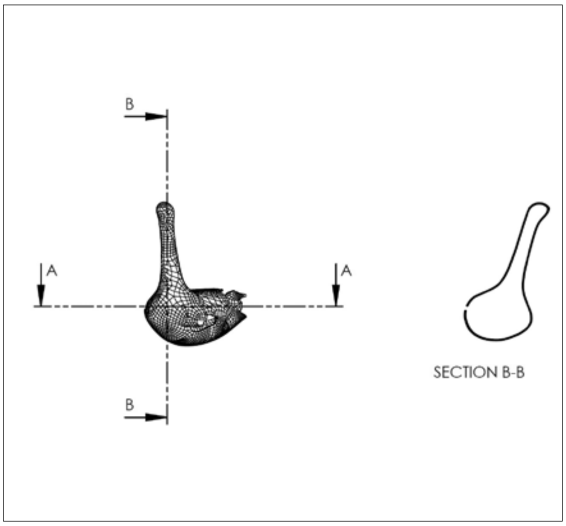

Fig. 5: Reconstruction of missing fragments technique.

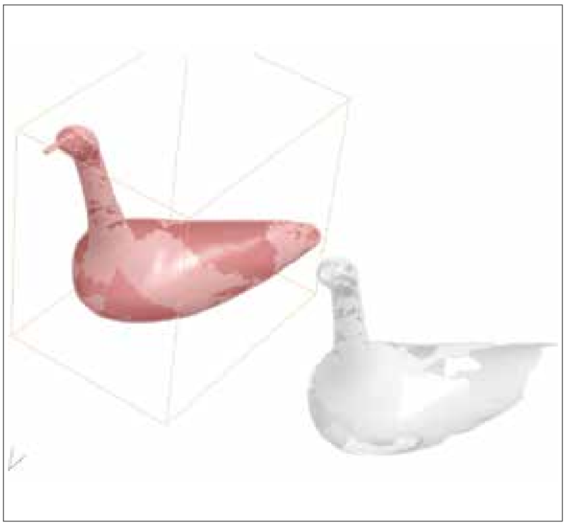

Fig. 6: Final 3D-CAD models.

construction were then used for data processing and CAD modelling.

The artefact took approximately 10 minutes to scan whereas steps (b) to (d) that lead to the complete digital reconstruction took almost 4 hours. The digitization step produced a point cloud of approximately 190.000 points (Fig. 3), and the post-processing step resulted in a polygonal model of approximately 370.000 triangles (Fig. 4). In Fig. 5 and Fig. 6, the technique used for the reconstruction of missing fragments and the final CAD models are respectively illustrated. The estimated accuracy (6σ) of the produced model is ± 0.048mm.

Conclusions

Digitization of CH objects has recently become a field of application for innovative technologies and a challenging topic for both engineering and archaeology researchers. Accurate 3D digital models overcome problematic aspects of traditional methodologies and meet the technological needs of contemporary museum practice, regarding materials and artefact analysis, conservation, documentation and interpretation.

The presented work reports the results of an ongoing study that aims to develop an easily-applicable methodology for high-accuracy 3D-CAD reconstruction of vitreous finished CH artefacts. In its current stage, the approach is semi-automated and eventually is strongly dependent on the guidance and estimation of the archaeologist. In that context, it should be stressed that the produced results are only valid when the reconstruction steps and relevant decisions are performed and based on both the technical and archaeological points of view.

The results that were so far obtained encourage further development of the methodology. Inevitably, the hitherto recorded drawbacks and limitations, e.g. modelling of the interior construction of an object, can only be overcome through the joint effort of researchers from both the engineering and the CH community.

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GLASS VESSELS AND OBJECTS FROM RECENT EXCAVATIONS IN MILAN. THE ROMAN BURIAL GROUND IN VIA MADRE CABRINI

This paper presents an analysis of the glass vessels and objects found during a recent archaeological campaign in Milan, Italy (2007-2008). The site lies between Via Madre Cabrini and Corso di Porta Romana. The area flanks the main road to Rome, close to the Roman city walls and was used as a suburban cemetery from the 1st to the late 2nd century AD.[1] Some other finds are associated with the same burial ground, such as the wealthy "Casa Binda 1859" grave from the Augustan period, now housed in the Archaeological Museum of Como,[2] and a grave excavated in 1934 on the corner of Corso di Porta Romana and Via Vaina.[3]

Glass vessels and objects

From the table (Fig. 1), it is clear that the largest group of glass vessels is the unguentaria. Up to four of these were present in all of the graves with glass goods. The forms are typical of the 1st century AD (Fig. 2).

1 Consonni 2008-2009.
2 Bolla 1988, 119-120; Bolla 1992-93, 253-254, fig. 9.
3 Bolla 1988, 120-121.

Second in number to the unguentaria are the five fragments of Is. 55a jugs, among which, three come from the same grave (Grave 8), coinciding with a further nine from other early burial sites in Milan.[4] For Milan, this constitutes the most significant class of vessel in funerary contexts from Tiberian-Claudian times up to the second half of the 1st century AD. Examples of this form are very common in Northern Italy. However, their distribution spreads beyond the Cisalpine borders, suggesting the existence of a vast complex of workshops (along the northern coast of the Adriatic Sea, in the Lomellina, near the towns of Brescia and Verona, in the abandoned town of Luni and perhaps also in Central Italy, and finally in Canton Ticino-Switzerland).[5] A recent

4 4 examples from a grave in Parco Sempione (Bolla 1988, 155-157), 3 examples in Grave 60 and 2 in Grave 21 of Policlinico burial (A. Marensi, pers. comm.).
5 Biaggio Simona 1991, 189-192; Roffia 1993, 138-139, nos. 320-333; Larese 2004, 64, fig. 34; Mandruzzato and Marcante 2005, 32, nos. 157-159; Permunian 2009.

GRAVE NUMBER	PHASE	BURIAL RITE	GLASS					OTHER GRAVE GOODS
			unguentaria	bottles	beakers	bowls	glass objects and ornaments	
T. 5	Phase V	Direct incineration	4 Is. 8					*Terra sigillata*, thin walled cups, coarse pottery
T. 8		Direct incineration	2 Is. 28b/82A1-2	3 Is. 55a	1 ??			Jug
T. 10		Direct incineration	2 Is. 28b/82A1-2				Lead mirror	
T. 12-14		Direct incineration	1?	1 Is. 50	2 ??		1 game piece	*Terra sigillata*, thin walled cups, lamp
T. 16		Direct incineration	2 Is. 8, DT 12/14	1 Is. 55a	1 Is.33			Thin walled cups, coarse pottery, 2 lamps Bronze pendent, gold beads
T. 18		Indirect incineration		1 Is. 55a				Coarse pottery
T. 26		Direct incineration	1 Is. 28b					*Terra sigillata*, thin walled cups, coarse pottery
T. 28-46		Direct incineration	3 Is.8, DT 67, ?					Coarse pottery, *terra sigillata*, jug, lamp Bronze buckle, bronze mirror
T. 31	Phase IV	Indirect incineration	1 Is.8					*Terra sigillata*, coarse pottery
T. 34		Indirect incineration	3 Is.8					*Terra sigillata*, thin walled cups, coarse pottery, jug, 2 lamps
T. 40	Phase II	??	1 Is. 16					Amphora, coarse pottery, coin
T. 39	Phase I	Child inhumation	3 Is.8	1 Is. 50		1 Is. 42	1 game piece, faience pendent	Jug, miniaturist glazed pottery cup. Iron fibula

Fig. 1: Glass from the burial ground in Via Madre Cabrini. Twelve of close to 50 excavated graves include glass goods.

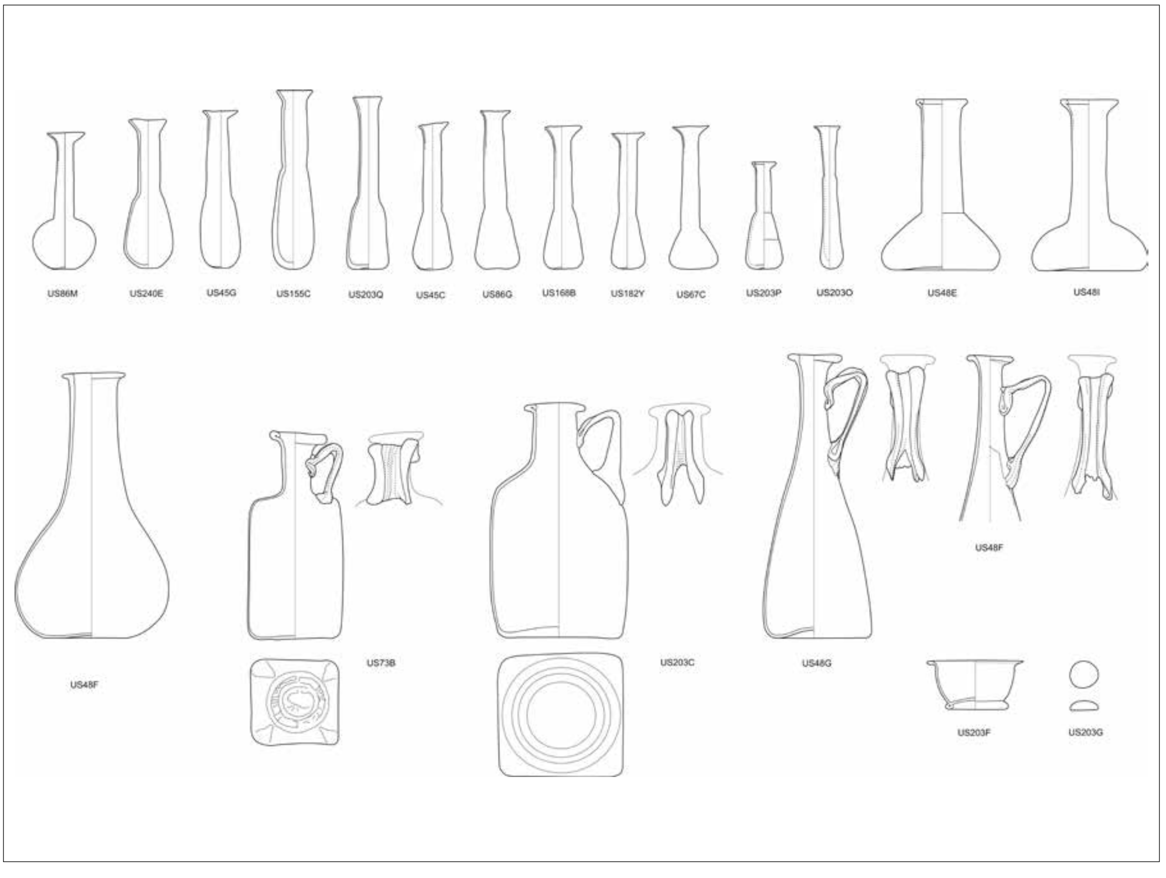

Fig. 2: Glass vessels from the graves.

typological analysis highlighted the existence of some dimensional and formal groups as well as certain distinctive decorative characteristics, but did not answer the question of the area of production.[6]

Beyond that, there are two medium sized examples of Is. 50 square bottles (Grave 39 and Grave 12/14), one of which has an illegible mark on the bottom that could be interpreted as letters (or vegetal motifs) within two concentric circles. The mark on the bottom of the other squat shaped bottle has a far more common plastic concentric circle motif.

An example of an Is. 33 beaker is easily recognisable in a photo taken during the excavation of Grave 16 (Fig. 3). Though not yet restored, it can be identified as a comparatively tall variety of beaker (height of approximately 15-17 cm) with a base pushed in to form a small foot for an elongated body. Despite the difference in size, the characteristic relief decoration of oval rings can be identified as type b in the Biaggio Simona 1991 classification. The form first appears in the Flavian period and was widespread right up until the early 2nd century AD. It is documented from Gaul to Pannonia and in Central and Northern Italy. Several fundamental differences imply the existence of a variety of glass workshops. A concentration of examples in Southern Switzerland stands out in particular, where the vessels were probably manufactured in the same local workshop.[7] There are also several fragments from the Northern Adriatic area (Aquileia, Veneto and the Dalmatian coast).[8]

Grave 39, belonging to a child, included a very small Is. 42/41bowl, perhaps deliberately chosen to complement a miniaturist glazed pottery cup.

Two game pieces of opaque glass, one white and one black, in two different graves (39 and 12/14), were probably placed there to recall the games loved and lost in life by the deceased.

Fig. 3: Beaker Is. 33 from the grave 16 during excavation.

Fig. 4: Faience pendent representing Harpocrates (grave 39).

The child: grave 39

The child's grave (39) dates to the earliest phase of the burial site. It includes several elements of interest although most of all, it bears witness to the grief and affection of the buried child's loved ones. A series of large nails, demarcating an area of approximately 0.45 x 0.80 m, indicates the presence of a wooden coffin or vault. The grave goods were placed within the vault and the grave cut before being dispersed around the grave. These include a fine ceramic bottle, a square glass bottle, a tin-plated cup and three glass unguentaria. The concentration

6 Permunian 2009.

7 Biaggio Simona 1991, 104-108.

8 Ravagnan 1994, nos. 248-249; Larese 2004, 55; Mandruzzato and Marcante 2005, 14, nos. 18-21.

Fig. 5: The lead mirror from the grave 10 during excavation.

of highly carbonaceous soil mixed with small fragments of burnt animal bone within the grave is probably what is left of a food offering. The small Is. 42/41 bowl, a miniaturistic pottery cup and the game piece are gifts that were symbolic of childhood pleasures.

In addition to the grave goods, a very unusual faience pendent (height of 2.2 cm) in the shape of a human figure was found in the grave (Fig. 4). Although unfortunately headless, it is almost certainly identifiable as Harpocrates, represented as a young boy with a finger to his lips. This Egyptian god, the son of Isis and Osiris, personifies the newborn sun each day and in Roman religious syncretism, acquires magical and apotropaic powers to protect the fertility of man, beast and the cosmos.[9] The faience pendent undoubtedly belongs to the category of amulets given to children to protect them from the "evil-eye".

The lead mirror

The last object, which is very interesting given its state of preservation, is a small mirror (Fig. 5) found in Grave 10; direct incineration remains were unfortunately largely resected by subsequent interventions. It has a lead disc-frame decorated with 24 triangular points in relief and a side-handle. The most significant comparison in terms of the decoration is a sample from the necropolis of Ljubljana, published by Nowotny. It has been proposed that the dating of this specimen can be placed sometime between the 2nd and 3rd century in light of the association with other glass finds.[10]

A fragment of glass preserved in the frame is part of a convex slab cut from a blown globe and was sealed with a layer of lead or tin. Only after restoration (it is currently not possible to examine the back of the glass) will we be able to provide further observations regarding this find. Some finds[11] and ethnographic parallels[12] indicate that convex mirrors are fragments of blown glass globes. The mirrored surface is obtained by pouring molten lead into the glass globe and then rotating it until the inside is completely coated with lead.[13] In order to better understand the technique used to make the small mirror in question, we are putting together a campaign of chemical analysis and a detailed breakdown of the evidence we have at hand.

A number of these mirrors, originally considered typical of Central Europe and of the

9 Tran Tam Tinh *et al.* 1988, 415-444.

10 Emona, Grave 828: see Nowotny 1910, fig. 34; Plesničar-Gec 1972, pl. LVII, 25. Twelve points and a similar decoration characterize specimens from Urbisaglia (Macerata) and the Gorga Collection, Baratta 2009.

11 Nowotny 1910; Bellelli and Messineo 1989; Baratta 2012.

12 Kock and Sode 2002.

13 On the technique see: Forbes 1957, 188; Amrein 2001, 41-48; Santopadre *et al.* 2002; Kock and Sode 2002.

Balkan-Danubian area,[14] have since been found throughout the Roman Empire.[15] These include several specimens from Northern Italy and at least three examples from Milan.[16] In fact, a specimen that is no longer preserved has come to light and was found on Corso Venezia in Milan during 1877 – described as "un cerchietto di piombo con leggero fregio tracciatovi mediante impronta" near fragments of a very thin sheet of glass.[17] Three other examples are from the burial sites of the Catholic University (inv. UC 2748, Grave 407; inv. 1726/5, Grave 1724; inv. 7810/9, Grave 7809).[18]

The impractical size of these mirrors and the choice of lead might imply that the reflective surface may have no more than a symbolic as opposed to a practical purpose. This has led some scholars to assume a religious function for these mirrors rather than considering it a toy.[19]

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14 Tudor 1959.

15 For a list of the attestations from Egypt to Central and Eastern Europe, see: Bellelli and Messineo 1989; Amrein 2001, 46-48; Arveiller Dulong and Nenna 2011, 310-311.

16 In Northern Italy, several examples are preserved in the National Archaeological Museum of Aquileia; to these we must add those from the necropolis "ai Paradisi", Riva del Garda in Trento, (*Ai Paradisi* 1990, 26, no. 5 e p. 104), and from the necropolis of Porta Palio in Verona, (Invernizzi 2011, 265, nota 51). A circular frame comes from Bedriacum-Calvatone (Slavazzi 1992-93) and a square frame from Casteggio, "Area Pleba", grave XXXI (Invernizzi 2011, 264-266, pl. XXXIV, 9a-b; fig. 125); a disc-frame was also found in a woman's grave from Como, via Benzi (Lambrugo 2006, 259, 263, pl. VI, 4).

17 Bolla 1988, 69-71, R 19; Bolla 1992-93, 250.

18 Airoldi 1995-96, 71; Palumbo 2001, 131-132, fig. 6, 2; Bazzana 2006-2007.

19 Bellelli and Messineo 1989, 56; Baratta 2012.

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VOMER GOJKOVIČ Mojca

GLASS FINDS FROM POETOVIO GRAVE AT LJUDSKI VRT

In Roman times, Poetovio was one of the biggest and most developed Pannonian towns, acting as the seat of many state offices, where the customs office retained the most importance.[1] Among the residents were many immigrants, soldiers, officials, merchants and customs officials, who brought various cultures and religions to the town.[2] It is worth noting the influence of eastern cults,[3] and five discovered Mithra temples.4 Of additional importance is the cult of *Nutrices Augustae*, which originated from the Celtic tradition.[5]

In the former Roman town of *Poetovio* (modern Ptuj) archaeological research has revealed burial grounds with more than one thousand cremation and skeleton graves. Today the burial grounds of *Poetovio* are divided into the west burial ground in Hajdina at the amber road *Celeia–Poetovio*, the east burial ground in Ptuj at the amber road *Celeia–Savaria*, the north burial ground in Rabelčja vas and in Vičava with the Panorama Hill, and finally the south burial ground in Zgornji and Spodnji Breg. There are also some smaller groups of primarily Late-Roman graves on the terraces of the castle hill in Prešernova ulica and at Potrčeva cesta, among the remains of the foundations of what were once Roman villas or craftsman buildings from the 4th and the 5th century.[6]

Recent archaeological research in the area of Ljudski vrt[7] has revealed a burial ground with more than 600 graves along with finds of different glassware.

Cremation grave 155 was 115 cm long, 53 cm wide and 40 cm deep. The rectangular shaped

1 Abramić (Abramić 1925, 9-23) had already described Poetovio as a tradesmen and merchant centre.

2 Vomer Gojkovič 2011; Vomer Gojkovič and Kolar 2013.

3 Fitz 1998; Vomer Gojkovič, Djurić, Lovenjak 2011; Vomer Gojkovič 2011, 59-74.

4 Vomer Gojkovič 2001.

5 The belief in *Nutrices Augustae*, or wet nurses, was common in Poetovio. Their temples were usually in the vicinity of Mithras shrines (Šašel Kos 2001).

6 Horvat *et al.* 2003, 153-189.

7 Excavations by Regional Museum Ptuj - Ormož led Ivan Žižek, whom I thank for permission to publish.

grave pit was dug into yellow clay and had burnt edges. The grave had a brick construction made of *tegulae* that was, unfortunately, damaged. The grave was destroyed in the Roman era and was filled with yellow-grey clay, fragments of burnt clay, fragments of brick, burnt material and calcined bones (Fig. 1). Various grave objects were found in the grave: iron, an oil lamp, fragments of *terra sigillata*, a pair of amber distaff and glass.

1. Iron.
2. An oil lamp of the Buchi type Xb with the stamp *VRSVL[I]* (Fig. 2.1).[8]
3. Fragments of *terra sigillata*.
4. A small pot.
5. A pair of amber distaff made of 30 amber beads attached together on a bronze wire (Fig. 3, Fig. 2.2).[9]
6. A small bottle with indents on its elongated body; it also has a tabular rim and a neck that is wound up with a trail made of greenish translucent glass (Fig. 4; Fig. 2.3).[10]
7. A balsamarium with a bell-shaped body, long cylindrical neck and concave bas (Fig. 2.4).[11]
8. A glass fragment.
9. A rod needle with a duck-shaped head. The lower part of the needle is twisted and sharp ended (Fig. 5, Fig. 2.5).[12]
10. A second rod needle with a duck-shaped head. The lower part of the needle is twisted and sharp ended (Fig. 6; Fig. 2.6).[13]

8 Material: ceramic; size: length 9.02 cm, width 6.14 cm, height 2.8 cm; PMPO, Inv. No. 09LV155/05; date: the end of the 2nd to the beginning of the 3rd century.

9 Material: amber; size: length: 9.6 cm, size of pearls 0.7 – 1.3 cm; PMPO, Inv. No. 09LV155/01; date: 2nd century.

10 Material: greenish translucent glass; size: high 11.23 cm, wide 3.26 cm, diameter of the bottle neck 2.22 cm and the bottle bottom size is 2.33 x 2.12 cm; PMPO, Inv. No. 09LV155/02.

11 Material: light-green translucent glass; size: high 27 cm; diameter 8.7 cm; PMPO, Inv. No. 09LV155/08; date: 2nd-3rd century.

12 Material: greenish translucent glass; size: length 15.2 cm, size of the head: 2.70 × 1.49 cm; PMPO, Inv. No. 09LV155/03; date: 2nd century.

13 Material: greenish translucent glass; size: length 15.9 cm, size of the head: 2.87 × 1.4 cm; PMPO, Inv. No. 09LV155/04; date: 2nd century.

Fig. 1: Grave 155 during the excavation in 2009.

Oil Lamp

Oil lamps imported from Italy were in still circulation in Poetovio during the era of Emperor Mark Aurelius.[14] The oil lamp found in this grave was Buchi type Xb with the stamp *VRSVL[I]*. Oil lamps of Buchi type Xb are of average quality and usually have a red coat, although occasionally, they also have a grey coat; a small number of oil lamps have no coat. The production of this sort of oil lamp began in Poetovio in the first third of the 2nd century; most of them were produced in the second half of the 2nd century and in the first half of the 3rd century. Most locally produced oil lamps belonging to this group were based on the models of Italic masters. The discoveries of moulds of potters *CRESCES* and *VRSVLI*[15] suggests that such oil lamps were made in Poetovio.

Amber distaff

Spinning played an important role in the lives of women in the ancient world. The tools used in spinning could be made in various shapes and materials. Distaffs used in the Roman period could be made of wood, metal, bone, ivory, amber, jet or even glass. The amber or jet implements most often consist of separate beads strung on a piece of metal wire.

Poetovio is among one of the major Roman sites that contains items of amber and is where

14 Istenič 2000, 153-155 and quoted literature.

15 Vomer Gojkovič, Žižek 2012, pp. 11-13

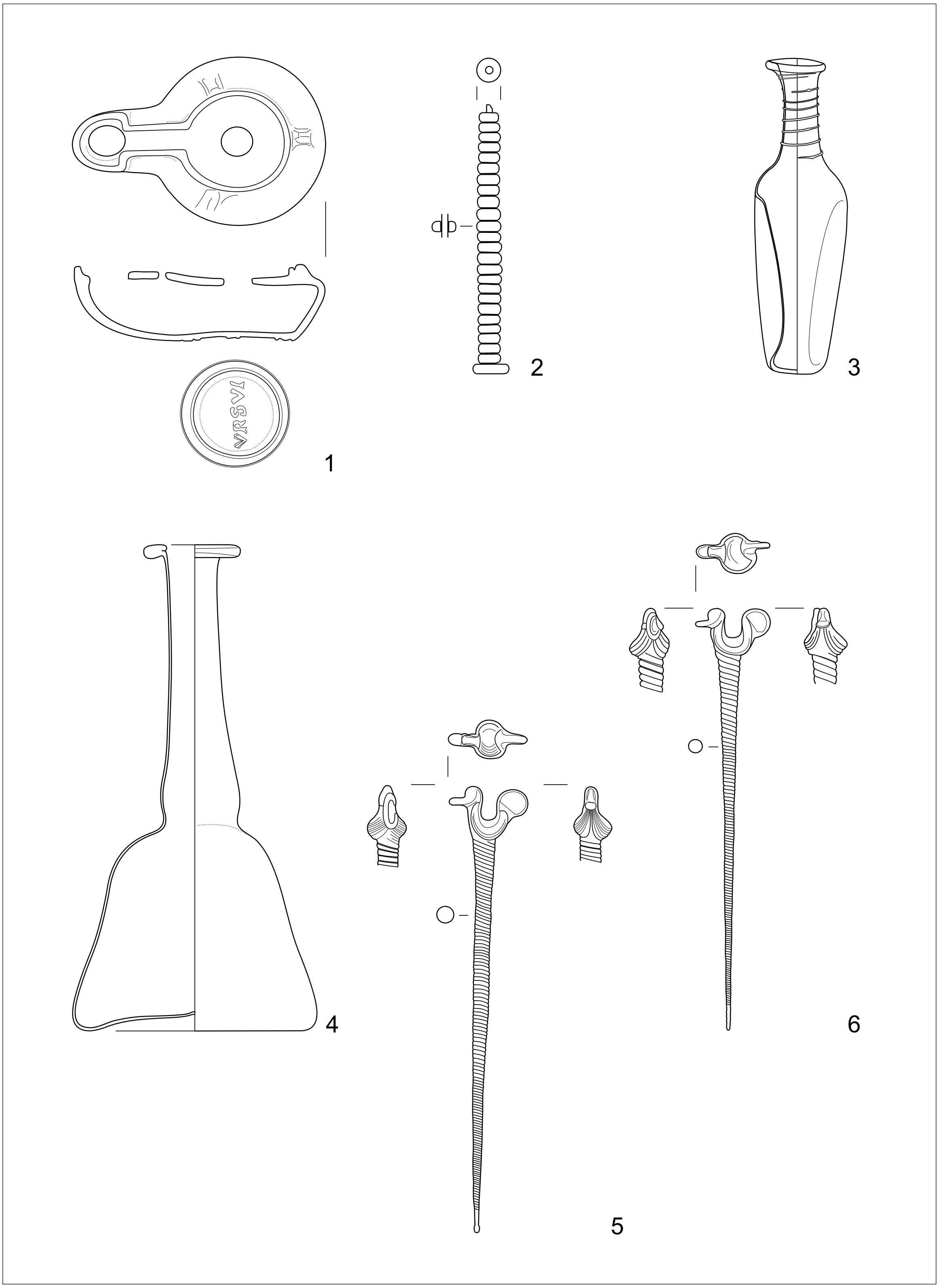

Fig. 2: Oil lamp with the stamp VRSVL[I] (1), amber distaff made of 25 amber beads (2), small bottle with indents on the walls (3), balsamarium with bell-shaped body (4), rod - needle with a duck shaped head and twisted and sharp end (5) and rod - needle with a duck shaped head and twisted and sharp end (6) from the grave 155.

Fig. 3: Amber distaff made of 25 amber beads.

Fig. 4: Small bottle with indents on the walls, the neck is decorated with a glass trail.

amber mainly appears as an item in graves or beside them. The graves of Poetovio contained in most cases more than one such object: several nicely designed rings, shells, boxes and so forth. Some finds boast rough amber pieces and pieces with traces of initial elaboration. Distaffs made of amber beads strung on a bronze wire most often appear in graves dated to between the 1st and the 3rd century.[16]

Small bottle

The small bottle was probably used as a balsamarium. Comparisons can be found in Dalmatia, in Augst and in Hungary. Finds from Dalmatia were dated to the 3rd and 4th century; bottles from Hungary mainly to the 2nd century. Finds from graves in Slovenia originate from the 2nd century.[17] In Poetovio, graves with similar balsamaria bearing indents appear frequently. A bottle from grave 155/2009 has a tall and narrow elongated body; indents on the walls extend from the shoulder almost to the bottom. The short neck is wrapped with a glass thread and terminates in a tabular rim.

Balsamarium with a bell-shaped body

A balsamarium made of light-green glass with a bell-shaped body, long cylindrical neck and a concave base has been dated in the 2nd and 3rd century. Similar balsamaria were found along the Adriatic coast in Croatia and were probably produced in a local glass workshop in Zadar during the 2nd and 3rd century.[18]

Twisted glass rods

The most important findings in that grave are glass rods – needles with a head in shape of a

16 Vomer Gojkovič 1996.

17 Lazar 2003, 197-198.

18 Fadić 1989, 11, 21. Lazar 2003, 193, 196.

Fig. 5: Needles with duck shaped heads and twisted lower part.

Fig. 6: Duck shaped heads of the needles.

duck. The lower part of both needles is twisted and sharp ended; both needles are made of greenish translucent glass. They have been dated to the 2nd century.

The rod made of greenish translucent glass (Ising, Form 79) is twisted and narrows slightly towards the end. At one end, it has a terminal in the form of a very simplified figure of a bird. The stylised bird is shown with wings; its flat tail is turned upwards. In spite of the simplification, certain characteristic features are easily recognisable: the wide and rounded beak and the short wings suggest it may be a water bird. The lower part of the twisted glass rod is smooth and sharp ended.

The function of these rods is uncertain. They were probably used for mixing small quantities of cosmetic or medicinal preparations; this conclusion is supported by their frequent association with toilet bottles in graves, usually those of women.[19] On the other hand, based on the size, shape and perhaps even the ornamentation, it is most likely that it served as a distaff in one of the domestic activities of the deceased (spinning).[20] In this case, they seem to be hairpins.

Fragments of similar glass rods have been found in all parts of the Roman Empire[21] (Pompeii, Aquileia, Xanten, Aquincum[22] and Intercisa[23]). As they are fragmentary, their original function cannot be determined with certainty. The rods, which are made of different coloured glass with varying degrees of purity, have a thickness ranging from 0.7 cm to 1.3 cm and are up to 30 cm long. Their intact upper parts, with the exception of one fragment with a rounded top, are decorated with animal figures whose main features are characteristic of the animal represented. Rod with the conclusions in the form of loops attach distaff.[24] Glass stirring rods have mainly been dated to between the 1st and 2nd century.[25]

19 Biaggio Simona 1991, 221-222.
20 Facsády 2008, 168-170.
21 Ising 1957, 49-95; Biaggio Simona 1991, 214.
22 Facsády 2008, 170-171.
23 Erdélyi *et. al.* 1954, Cat. 6, fig. XXVIII/7.
24 Facsády 2008.
25 Isings 1957, 94-95; Biaggio Simona 1991, 214.

Conclusion

During recent archaeological excavations in the area of Ljudski vrt, a burial ground with more than six hundred graves was found. Cremation grave 155 had a brick construction made of *tegulae*. The following was discovered in the grave: iron, an oil lamp, fragments of *terra sigillata*, an amber distaff and glass. The amber distaff and a pair of twisted glass rods found in the grave were probably of symbolic significance to the most important woman in the family – *mater familias*. It is therefore likely that grave 155/2009 belonged to a woman and has been dated to the 2nd, or at the latest, the beginning of the 3rd century AD.

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VERRES DU BAS-EMPIRE À VANNES (MORBIHAN, FRANCE): LES DÉCOUVERTES DU IVE SIÈCLE DU SITE DE LA PLACE DES LICES

Introduction

Cette présentation concerne un lot de verres découvert à Vannes, dans l'ouest de la France. Au Bas-Empire, la ville était capitale de cité des Vénètes d'Armorique (en Lyonnaise II).

Le site dont il est question est localisé dans un secteur relativement méconnu sur le plan archéologique, qui figure au sein du *castrum*. Il a été fouillé à l'occasion d'une petite opération archéologique (10 m²) nécessitée par des travaux d'aménagement de réseaux souterrains.[1] Si la faiblesse de la surface explorée n'autorise pas de certitudes quant à la nature précise du site, les découvertes s'avèrent bel et bien exceptionnelles. On a découvert un angle d'un imposant bâtiment maçonné, associé à des éléments d'architecture ornementaux importés. Outre son parti architectural, ce bâtiment s'est révélé atypique du fait de la qualité des mobiliers qu'il a livré (verres, céramiques, monnaies).

Ainsi, bien que la verrerie compte une majorité de pièces d'usage courant pour l'époque (surtout des vases à boire), elles sont aussi associées à des vases décorés et tout particulièrement à une coupe à décor gravé dans le style dit de Wint Hill (que j'avais signalé à H. Chew à l'occasion de son recensement publié dans le Journal of Glass Studies de 2003).[2]

La céramique associée montre également des assemblages peu communs, avec notamment une sur-représentation de la vaisselle de table, faisant la part belle aux importations lointaines. Un important lot monétaire (217 monnaies, avec quelques exemplaires de thésaurisation) contribue au caractère exceptionnel de cette découverte.

Le mobilier est daté de façon large entre le début du IVe siècle et le début du Ve siècle.

Le verre

La fouille a permis de recueillir 384 tessons de verre. Cette catégorie de mobilier, fragile, présente une fragmentation marquée, comme

1 Baillieu *et al.* 2001.

2 Chew 2003.

c'est généralement le cas en dehors des dépôts funéraires, par nature préservés.

Il s'agit exclusivement de récipients, en l'absence, par exemple, de fragments de verre à vitre ou de parure en matière vitreuse. Un nombre minimum de 23 individus a pu être déterminé, le plus souvent d'après des fragments de bords.[3]

La majorité de ces vases consiste en formes ouvertes et, tout particulièrement, en vases destinés à la boisson (gobelets, bols, no. 1-14, 16-17). Quelques coupes et une coupelle sont attestées (no. 15, 18-20), liées peut-être à la boisson également ou bien encore à la présentation. Les formes fermées, en revanche, se limitent à deux individus, à savoir des bouteilles (no. 21, 23). Enfin, le fond d'un récipient n'a pu être déterminé (no. 22, flacon?).

La gamme chromatique attestée par ces fragments est assez limitée, avec une majorité d'éléments incolores, présentant souvent des reflets vert clair ou encore bleu-vert clair. Les autres teintes attestées sont le vert et ponctuellement le bleu-vert.

Les vases ont été réalisés pour l'essentiel dans une matière de qualité correcte, quelques uns montrant même un aspect brillant, tandis que d'autres peuvent être marqués de filandres.

Ces caractéristiques techniques sont généralement celles des productions propres au Bas-Empire, bien que la "couleur naturelle" bleu-vert se rencontre surtout au cours du Haut-Empire.

Les gobelets sont de plusieurs types. A une exception (no. 10), il s'agit de productions à bord coupé, qui a été soit laissé brut (no. 1, 3, 5, 9), soit adouci par meulage (no. 2, 4, 6-8). Certains d'entre eux possèdent un sobre décor, consistant en séries de fines lignes gravées en surface de la paroi (no. 2, 4-8).

La plus grande part de ces gobelets se caractérise par un bord infléchi (no. 1-7). Ils présentent un profil tantôt cylindrique (no. 1-4), tantôt d'allure conique (no. 5-7). Ces vases à boire peuvent avoir eu une partie basse portée par un pied, à l'image de l'exemplaire no. 2, qui répond au type Isings 109 / AR 70, ou bien une base apode, caractéristique du type Isings 106/ AR 64.1/66.1. C'est probablement plutôt à ce dernier qu'il faut rattacher les exemplaires coniques no. 5-7 (variante AR 66.1), tandis qu'un autre gobelet conique, possédant un bord rentrant (no. 8), peut être considéré comme une variante supplémentaire du type Isings 106. C'est vraisemblablement encore au type Isings 106 qu'il faut attribuer la portion de paroi ornée no. 17. Le décor consiste en un façonnage de facettes à la meule, technique de taille à froid que l'on retrouve également sur quelques petits fragments présents dans ce lot, dont le no. 16. Toutes ces formes sont bien connues dans le courant du IVe siècle, avec des débuts à la fin du IIIe siècle et des prolongements dans les premières années du Ve siècle.

La partie haute d'un gobelet incolore parfaitement cylindrique, sans bord marqué, constitue l'unique représentant du type AR 63/ Trèves 43, daté de la fin du IIIe siècle au IVe siècle (no. 9).

Enfin, l'attribution typologique du seul gobelet à bord épaissi et arrondi au feu no. 10, avec, là encore, un profil cylindrique, reste incertaine. Il pourrait éventuellement être attribué aux types AR 99-100, datés de la fin du IIe siècle au milieu du IIIe siècle (donc un élément 'ancien' dans ce contexte).

La gamme des bols est représentée par quatre exemplaires exécutés sur un même modèle, à savoir Isings 96/ AR 60.1 (no. 11-14). Il est caractérisé par une paroi hémisphérique, un bord infléchi non repris au feu, qui a été laissé brut pour ces quatre bols. L'un d'eux est orné d'une large série de lignes finement gravées (no. 14). Il est également possible que quelques uns des fragments présentant un décor de facettes meulées, comme le no. 16, puissent avoir appartenu à ce type, qui connait aussi des exemplaires présentant une telle ornementation. Ce type est très fréquent dans les corpus relatifs au IVe siècle. Il est cependant de datation plus large, puisqu'il est connu du dernier tiers du IIIe siècle à la première moitié du Ve siècle, bien que surtout en usage de la fin du IIIe siècle au début du Ve siècle.

3 Les références typologiques employées renvoient à Isings 1957 [typologie Is.], à Rütti 1991 [typologie AR].

Les formes de taille moyenne, coupe et coupelle, sont également des productions à bord découpé, dans les trois cas adouci par meulage (no. 18-20).

Une coupelle possède une paroi à dépressions, formée par soufflage de la matière entre des tiges (no. 18). La partie supérieure du vase comporte une large série de lignes finement gravées. Il correspond au type apode Isings 116/117 / AR 59.2, daté du IV^e siècle et première moitié du V^e siècle.

Des équivalents de grande taille à cette coupelle se présentent sous la forme de coupes en calotte à bord plus ou moins incurvé (no. 19-20), l'extrémité du bord étant soulignée d'une étroite zone meulée pour l'une d'elles (no. 19). Elles appartiennent au même type Isings 116, dans sa version *a priori* dépourvue de dépressions.

Un fragment de paroi présentant un décor gravé est encore à attribuer à ce modèle de coupe Isings 116 (no. 15),[4] d'après les parallèles connus pour le style dont il relève. Il appartient en effet au "groupe de Wint Hill", défini à partir de la découverte d'un vase complet à Wint Hill dans le Somerset en Grande-Bretagne.[5] Ces coupes se caractérisent par un décor exécuté à main levée, habilement gravé à l'aide d'une pointe dure. Le dessin est toujours tracé à l'envers, c'est-à-dire à l'extérieur des vases, afin d'être contemplé de l'intérieur, comme en attestent clairement les individus comportant une inscription (formules à boire, souhaits de longue vie, messages amoureux, acclamation chrétiennes[6]). Les thèmes illustrés comportent majoritairement des scènes de chasse, mais aussi des scènes mythologiques, ainsi que quelques scènes chrétiennes. Cette iconographie témoigne ainsi d'un lien avec les classes supérieures de la société romaine provinciale (sensibles aux mythes païens, dont l'un des loisirs favoris est la chasse[7]).

Ce qui nous permet de rattacher le fragment de Vannes à ce groupe stylistique, fort aujourd'hui d'une quarantaine d'individus, est la façon de délimiter les silhouettes, avec un cerne doublé intérieurement de courtes incisions obliques régulièrement espacées. Le motif central est certainement un animal, dont le corps est signifié, de manière codifiée, par un remplissage de courtes lignes incisées espacées. Le motif représenté reste cependant de lecture délicate (avant-train d'un quadrupède ? monstre marin ?).

La répartition des lieux de découverte des vases décorés dans le style du "groupe de Wint Hill" montre une concentration en Rhénanie, mais aussi des occurrences dans le nord de la France, en Belgique et en Grande-Bretagne, plus ponctuellement au Danemark, en Suisse, ainsi que quelques exemplaire en Espagne et dans le sud de la France.[8] Elle permet de poser l'hypothèse d'une importation rhénane, de Cologne ou de Trèves selon les propositions de nos prédécesseurs, vraisemblablement au sein d'un atelier où plusieurs mains se distinguent. Dans ce schéma de répartition, le fragment de Vannes représente, ainsi, l'une des diffusions les plus occidentales. Enfin, on notera que les contextes de découverte, lorsqu'ils sont connus, sont variés : sites funéraires, habitats ou encore sites militaires (notamment en Grande-Bretagne).

La datation généralement attribuée à ce groupe concerne le IV^e siècle, avec des contextes de découverte datés de la première moitié, du milieu et du troisième quart du siècle. La question a été débattue de l'attribuer plus spécifiquement au courant de la première moitié du siècle, certainement pas avant les années 320, en tous cas, pour les coupes à décor chrétien. On considère également la possibilité d'une production concernant les décennies centrales du siècle.[9]

4 Fragment gravé, de profil faiblement incurvé ; épaisseur 1,8 mm, dimensions maxi. 30 x 33 mm ; teinte vert très clair, recouvert d'une fine pellicule d'irisation.

5 Harden 1960, ainsi que Fremerdorf 1967, 31, 159-171, XVI-XVII, pl. 206-229, 308; Follmann-Schulz 1988; Perse 1991; Chew 2001; Chew 2003 et Chew 2007.

6 Chew 2003, 94.

7 Chew 2001.

8 Harden 1960; Chew 2003; D. Foy pers. comm.

9 Chew 2003, 91; Harden 1960, 78-79; Follmann-Schulz 1988, 10; Perse 1991, 270-273.

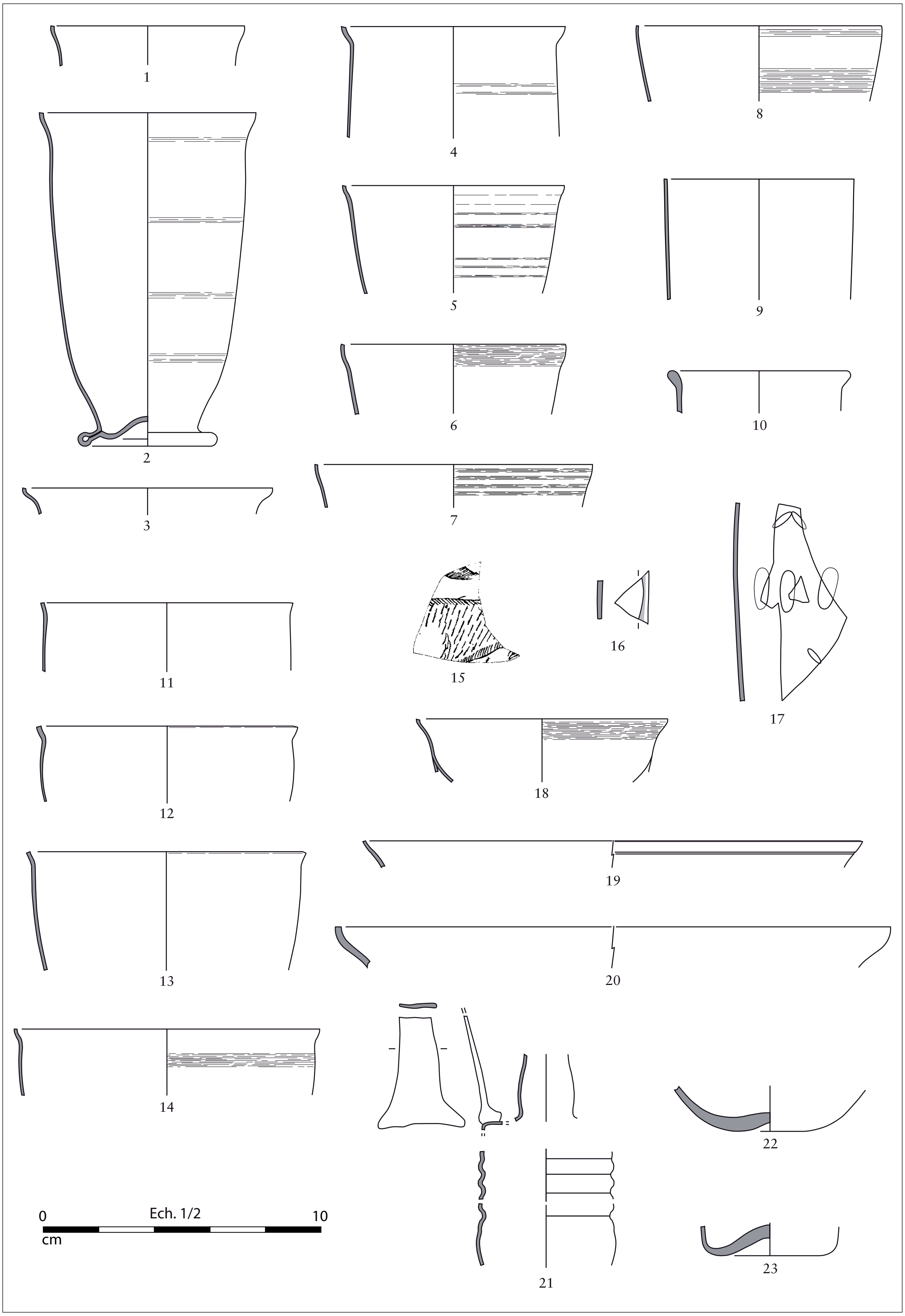

Fig. 1 : Verres du IVe s. de Vannes (Morbihan), site de la Place des Lices (relevés et DAO L. Simon / Inrap.).

Quant aux rares formes fermées attestées dans ce corpus de verreries, elles sont liées à des bouteilles à panse cylindrique, obtenues par soufflage dans un moule. Cela est nettement visible pour l'exemplaire no. 21, caractéristique des 'barillets frontiniens' avec sa paroi cannelée. Cela l'est également pour le fond no. 23, bien qu'il soit dépourvu de marque moulée. Ces deux séries de fragments semblent bien correspondre à des récipients distincts, d'après leur différence de teinte, même s'ils sont dans les deux cas bleu-vert. Le fond no. 23 peut, néanmoins, avoir appartenu tant à une bouteille moulée à panse cylindrique lisse qu'à un modèle à panse cannelée, à l'image du vase no. 21. Il existe plusieurs types de bouteilles cylindriques lisses, pendant le Haut-Empire tout comme au cours du Bas-Empire, ce qui ne permet pas de proposition chronologique précise. Les barillets possèdent, quant à eux, deux variantes, selon le nombre d'anse (une ou deux) et se classent sous les types Isings 89/128 / AR 161. La variante mono-ansée Isings 89 existe dès le dernier tiers du I^er siècle et plus certainement au début du II^e siècle, tandis que la diffusion des exemplaires à deux anses Isings 128 n'interviendrait pas avant le milieu ou la deuxième moitié du III^e siècle. Toutes deux sont en usage jusqu'à la fin du IV^e siècle. Si une importante portion d'une anse a été découverte sur ce site vannetais, il n'est pas possible de déterminer si elle était ou non unique. Mais la constatation qu'aux petits modules, parmi lesquels se range l'exemplaire no. 21, ne correspond que le type mono-ansé, va dans le sens d'une attribution à la variante la plus ancienne[10]. De plus, sa teinte bleu-vert parait également plaider pour une production du courant du Haut-Empire, ce que tend du reste à confirmer la morphologie de son anse, plate[11]. Il se pourrait donc que l'exemplaire no. 21 (et peut-être aussi le no. 23) constitue un vase 'ancien' sur ce site, son éventuel état résiduel restant par ailleurs difficile à établir (vase toujours en usage?).

Conclusion

Au final, on soulignera le fait que, malgré sa surface réduite (10 m²), cette intervention archéologique a permis de recueillir un lot de tessons de verre non négligeable, le nombre minimum d'individus étant également appréciable (384 fragments, 23 individus).

Il s'agit exclusivement de vaisselle, avec des formes bien connues au cours du IV^e siècle et de rares formes plus anciennes. L'un des gobelets, le seul exemplaire à bord arrondi (no. 10), qui peut relever des types AR 99-100, présente en effet un décalage dans ce lot (de la fin du II^e siècle au milieu du III^e siècle). Il convient aussi de prendre en compte que les rares formes fermées attestées (notamment le barillet no. 21) qui semblent correspondent à des modèles 'anciens' pour une occupation du IV^e siècle, ne peuvent pour autant être définitivement considérées comme résiduelles (de même que cela a été constaté pour la céramique).

C'est donc le service de la présentation à table, et tout particulièrement la boisson (avec des séries de formes), qui est prédominant dans ce corpus (tout comme c'est le cas pour la céramique là encore). La plus grande part de ces récipients est d'usage courant, mais un petit nombre de vases ornés d'un décor facetté montre une gamme de qualité supérieure (no. 16, 17 et quelques petits fragments de panse non illustrés), tandis qu'est attesté un exemplaire nettement plus prestigieux du fait des caractéristiques de son décor gravé, qui permet de le considérer définitivement comme un verre de luxe (no. 15).

L'ensemble de ces découvertes invite à différentes interprétations sur ce bâtiment, dont nous ne connaissons qu'une infime partie, sur une éventuelle fonction cultuelle (actuellement privilégiée) ou bien sur une fonction profane (lieu de commerce).

10 Cabart 2006, 153.

11 Des exemplaires à anse plate sont notamment attestés dans les corpus de Haute-Normandie au cours du IIe s., principalement pour les petits modules (Sennequier 1989, 12). Il a également été constaté que les anses des exemplaires datés des III^e et IV^e s. présentent généralement trois nervures (Cabart 2006, 152).

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LATE ANTIQUE GLASS IN SLOVENIA

Introduction

Due to its position between the Alps, the Dinarides and the Pannonian plain the territory of present-day Slovenia was in the Roman period divided between different provinces: *X. Regio* (later *Venetia et Histria*), *Noricum Mediterraneum*, *Pannonia Prima* and *Pannonia Savia*. The main Roman roads connecting Italy with the North and the East ran from *Aquileia* through *Emona* (Ljubljana) to *Celeia* (Celje), *Poetovio* (Ptuj) and further north or to *Siscia* (Sisak), *Sirmium* (Sremska Mitrovica) and towards the eastern part of the Empire (Fig. 1) .

In the turbulent Late Roman period of these roads often served both the Emperors and the usurpers during the civil wars and also functioned as the main incursion routes to Italy from the north and east. Between the late 4th and the late 5th century the political and military situation along these communications seems to have been so unstable that in the course of the 5th century the settlement pattern changed from the usual towns, villages and *villae* to a landscape of fortified settlements on hilltops, often in remote, inaccessible areas.[1] The lowland settlements appear to have been mostly abandoned (with exceptions in the sheltered coastal area). Despite some contrary opinions by historians,[2] archaeological evidence suggests the former Roman towns no longer functioned as administrative and ecclesiastic centres.

In Slovenia fortified hilltop settlements were the main form of settlement between the late 5th and at least the late 6th or early 7th century.[3] They served various functions, from refuges to largely civil settlements, ecclesiastical centres, military posts or any combinations of these. Some of them developed into regional centres almost

1 Ciglenečki 2008; Ciglenečki 2011.

2 Šašel Kos 1994; Wolff 2000, 32.

3 In this paper only Slovenian sites are discussed but this settlement pattern is a much wider phenomenon, especially typical of the southeast Alpine region of northeast Italy, southern Austria and Slovenia, but also present elsewhere around the Mediterranean. See e.g. Steuer, Bierbrauer, Hoeper 2008.

comparable to urban settlements and performing most of the necessary functions.[4]

The aim of this paper is to present an overview of glass finds from these sites which have so far not been given much attention. On the whole small finds from hilltop settlements give an impression of largely autarkic communities with few signs of luxury[5] and this impression is also confirmed by the architecture. Long distance trade is mainly evidenced by imported pottery.[6]

Traditionally, studies of Roman glass only included the material up to the Late Roman period (until ca. mid-5th century)[7] and the impression was that after the settlement shift and the abandonment of town-based workshops glass vessels were not produced anymore.

The first ones to prove this assumption wrong were S. Ciglenečki and D. Božič who discussed Late Antique hanging lamps with three handles in a paper on the fortified hilltop settlement of Gradec near Velika Strmica in eastern Slovenia.[8] Soon after R. Cunja published glass finds from the excavations of Late Antique and Early Medieval (5th-9th century) layers in Koper, Late Antique *Justinopoli*s and now a town on the Slovenian coast.[9] The first work on glass finds from central Slovenia was done by M. Sagadin who published glass material from Kranj, a well-fortified Late Antique and Early medieval regional centre, also known from Late Antique written sources as *castel Carnium*. He focused on the presumed 6th century glass workshop.[10] The rest of the glass material from Kranj is included in his doctoral thesis[11] but not yet published. The drawback of these two important works is that the stratigraphic contexts in which glass was found are not published and the conclusions are thus difficult to make and not verifiable. Recently, 5th-7th century glass finds from the fortified hilltop settlement of Tonovcov grad near Kobarid in western Slovenia were discussed and published.[12]

The above mentioned works, together with some more or less individually published vessels, showed that at some sites from the time between late 5th-early 7th century glass is present in surprising quantities. It seems to have been continually produced and used at least in the coastal area and in larger regional centres. At most of the other settlements glass vessels are not very common finds but this could be due to the fact that not much attention had actually been given to them during excavations. It is very probable that in the future we shall be discovering more Late Antique glass even from the already known sites.

Late Antique glass vessels

The most common colour of glass vessels and window panes are the shades between green and yellow or brown (naturally hued glass).

The most common vessel is the goblet (Isings 111) on hollow stem with a conical, cylindrical or bell-shaped recipient (Pl. 1: 1-4; Fig. 2: 1, 4, 5; 3: 1-4), which appears at almost every site.[13] Other forms of goblet stems and feet are only present in Koper[14] and Kranj[15] (Fig. 2: 2, 3, 6; 3: 5, 6). Among the goblets from Koper, group 3 (Fig. 2: 6) appears to be an Italic import[16] while groups 1 and 2 (Fig. 2: 1, 2) could have been produced locally. Group 4 of stemmed goblets from Koper with conical recipients and hollow stems with a globular knob (Fig. 2: 3) is later than the rest of the vessels discussed here, it can be dated to the 8th-9th century according to the rare analogies.[17]

Beakers, especially the ones with applied blobs, are a typical form of the Late Roman period and since many of the Late Antique sites

4 Ciglenečki 2011.
5 Ciglenečki, Modrijan, Milavec 2011, 290-291.
6 Modrijan 2011, 123-158.
7 Lazar 2003a; Lazar 2003b; Lazar 2004.
8 Božič and Ciglenečki 1995, 254-257.
9 Cunja 1996.
10 Sagadin 2000; Sagadin 2004.
11 Sagadin 2008, 80-84.
12 Milavec 2009; 2011a.
13 Milavec 2011b, 103-104.
14 Cunja 1996, 71-78.
15 Sagadin 2004, fig. 6.
16 Most analogies can be found in Italy, see: Milavec 2011b, 104.
17 Two such goblets were found in graves, dated to around year 800: Belošević 1980, pl. XXVI: 34; XXXIV: 80.

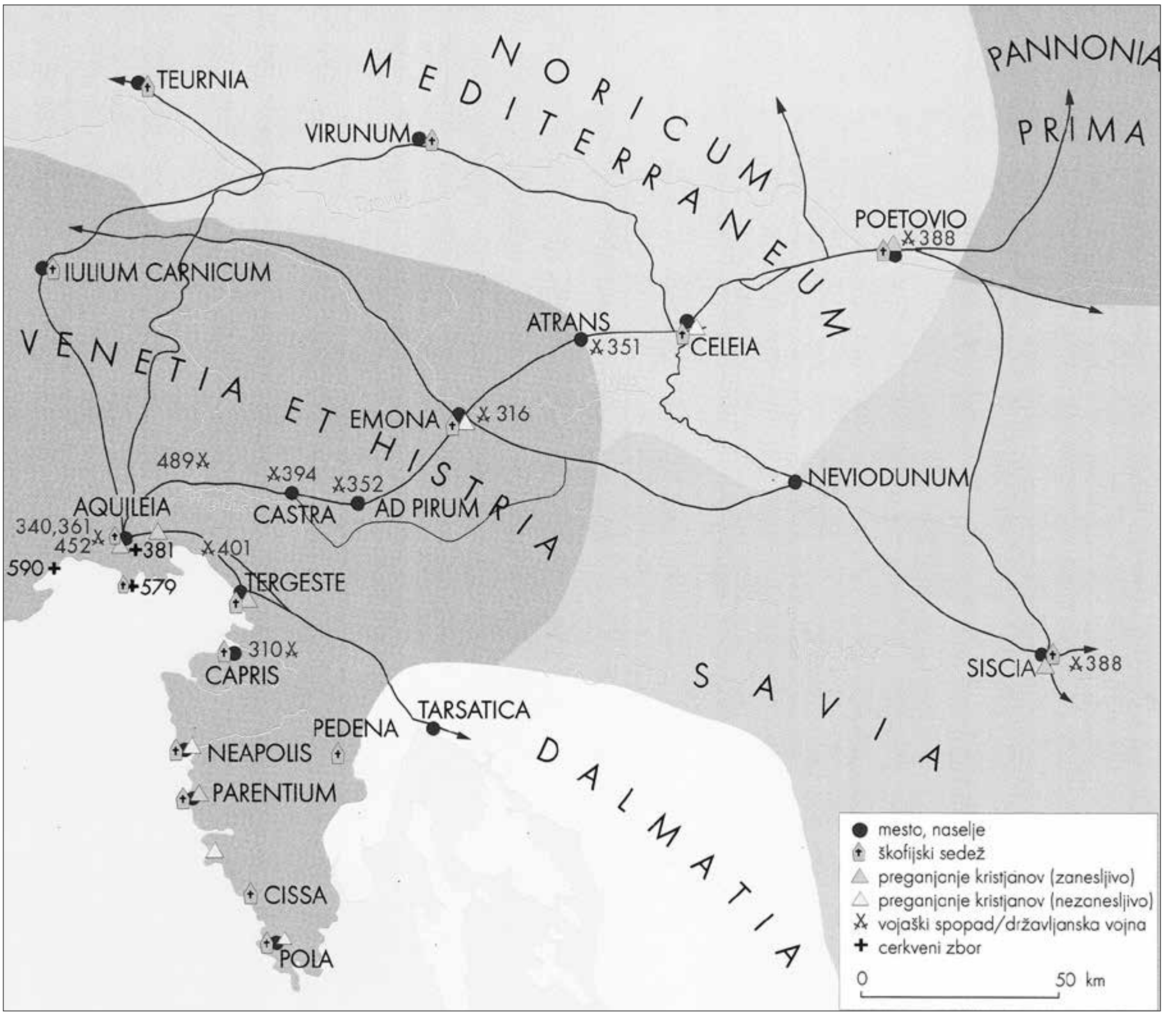


Fig. 1: Provinces, main roads and settlements on the territory of Slovenia during the Late Antiquity (after Bratož 1999, 294).

discussed here also have a Late Roman phase the beaker fragments could represent residual finds. Beakers with applied blobs are rarely found on hilltop settlements,[18] but the other variants (Isings 106 and 109) are quite common and it appears they were widely used in the late 5th-early 7th century as well (Pl. 1: 5-7, 9).[19] They could have also been used as lamps. Footed beakers of the 5th century are quite rare (Pl. 1: 8, 10).[20]

Of the closed forms bottles in Late Roman tradition, with funnel mouths and globular bodies appear most often and seem to form drinking sets with stemmed goblets and beakers (Pl. 1: 7-13; Fig. 3: 7).[21] Fragments of a jug were found in Koper (Pl. 2: 7).[22]

Balsamaria are heterogeneous and difficult to distinguish from those belonging to earlier periods (Pl. 1: 14-17).[23] They are often found in churches and similarly to the rest of the Mediterranean they were probably used in liturgy.[24]

Lamps with a conical or globular recipient, concave base, and three small handles, type I according to M. Uboldi (Isings 134),[25] are most often found in ecclesiastical buildings, but also

18 Milavec 2011a, pl. 54: 5.
19 Milavec 2011b, 105.
20 Milavec 2011a, 85.
21 Milavec 2011b, 106.
22 Cunja 1996, pl. 5: 78.
23 Milavec 2011b, 109.
24 Foy and Nenna 2001, 149-152, 157; Antonaras 2007, 54.
25 Uboldi 1995, 104-108.

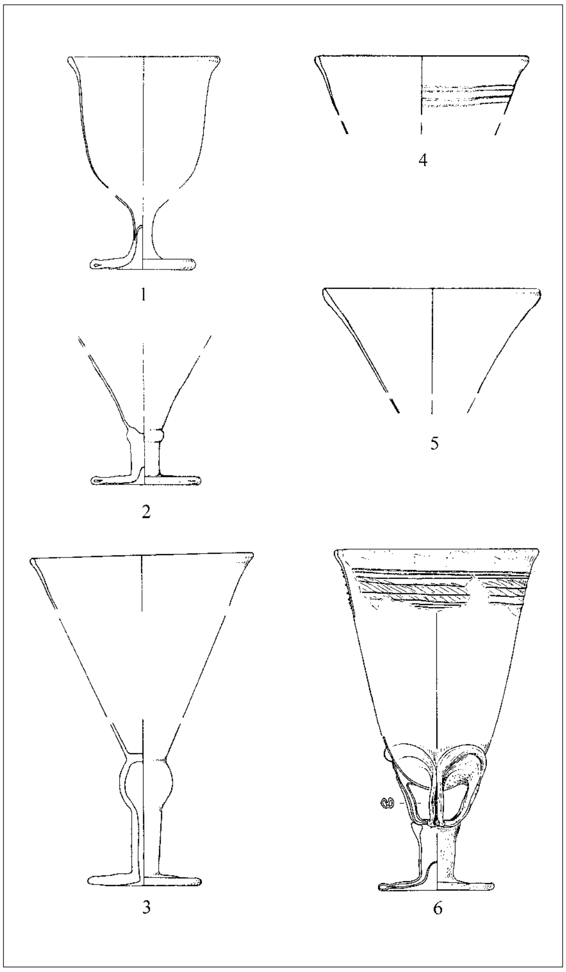


Fig. 2: Koper, glass finds (after Cunja 1996, pl. 3, 4).

in private houses (Pl. 1: 18, 19; 2: 6).[26] Other types of lamps (types II-V according to Uboldi) were not found at Slovenian sites of the end of the 5th and 6th century.[27] Considering this we can probably assume that *polycandela* were not used.

Open forms, plates and bowls, are very rare (Pl. 1: 20, 21; 2: 1-5).[28] Apart from the simplest pieces they are most probably Italic imports.[29]

A Germanic glass drinking horn of the 6th-7th century with the decoration of trailed threads was found at the Kranj cemetery at Lajh.[30]

The use of window glass has been proven in ecclesiastical buildings and other contexts.[31] The state of fragmentation does not allow for exact reconstructions of window shapes but most probably they were square or rectangular. The window panes usually exhibit one shiny and one matt surface and slightly thicker edges. Elongated bubbles are found in the panes suggesting they were made using cylinder technique.

Analyses

Archaeometric analyses were made on 43 glass fragments from the settlement of Tonovcov grad near Kobarid in western Slovenia. Mostly vessels, but also a window pane and a few glass beads were chosen from known stratigraphic contexts between late 4th and 7th century The results showed use of mostly Levantine I and also a few examples of HIMT glass.[32]

Analyses were also made on glass chunks and objects from the hilltop settlement of Gradišče above Bašelj near Kranj. They included glass from Late Antique as well as later (Carolingian) contexts and the results showed mostly heavily recycled Roman natron glass as well as a couple of beads made of plant ash glass.[33]

Workshops and supply

Some higher quality vessels are evidently imported, most probably from north Italian workshops (bowls from Ajdovski gradec and Fizine (Pl. 2: 1-5), goblet groups 3 and 4 from Koper (Fig. 2: 3, 6)). In the western and coastal part of Slovenia these trade connections could have persisted into the 9th century

A presumed secondary glass workshop from Kranj was very partially published[34] but the interpretation does not seem convincing.[35] Glass chunks were found in Kranj[36] and at Gradišče above Bašelj[37] but there is no other

26 Milavec 2011b, 107.
27 Exceptions Ajdovščina above Rodik and Ljubljana, see Milavec 2012.
28 Milavec 2011b,109-110.
29 Gaspari *et al.* 2007, 202.
30 Stare 1980, pl. 131: 1; Lazar 2003a, 203; Evison 1975, 79-80.
31 Milavec 2011b, 110-111.
32 Šmit *et al.* 2013.
33 Šmit *et al.* 2009.
34 Sagadin 2000; Sagadin 2004.
35 Lazar 2003a, 217-218; Lazar 2003b, 78-79.
36 Sagadin 2008, pl. 52: 8.
37 Šmit *et al.* 2009.

evidence of secondary workshops at Late Antique sites in Slovenia. In Koper, Kranj, and at Tonovcov grad, where relatively large amounts of stemmed goblets were found, we observe that goblets are at an individual site of quite uniform shapes, while shapes differ between sites. Thus for Kranj, for example, bell-shaped recipients are more characteristic (Fig. 3: 1), while at Tonovcov grad these are cylindrical (Pl. 1: 1, 2). This could be an argument in favour of the existence of several small workshops belonging to individual settlements such as are known elsewhere, but none were discovered so far.

Little is known about how the raw glass supply was organised. Pottery research has shown a great probability that the church was the main organising power in the region in Late Antiquity, at least until the mid-7th century[38] Roman administration ended by the late 5th century and the representatives of church hierarchy seem to have taken over. This process is beautifully depicted in the *Vita sancti Severini* for the province of Noricum Ripense in the second half of the 5th century.[39] The largest concentration of glass finds on hilltop settlements was found in churches and window panes and glass lamps are two of the most numerous groups of glass objects found.

Supply of raw glass was evidently organised until at least as late as the late 6th century in mainland Slovenia. In the following centuries the only glass objects we are confident were used are beads, found mostly in female graves.[40] At the hilltop site of Gradišče above Bašelj near Kranj glass chunks and objects belonging to (late Antique and) 9th century contexts were found. Except two glass beads all glass is Roman natron type glass which led the authors to conclude that Roman glassmaking persisted into the Early Middle Ages.[41] These are extremely interesting data but so far extremely summarily published as far as contexts and objects are concerned.

38 Modrijan 2011, 207-208.

39 Bratož 1994.

40 Šmit *et al.* 2012.

41 Šmit *et al.* 2009.

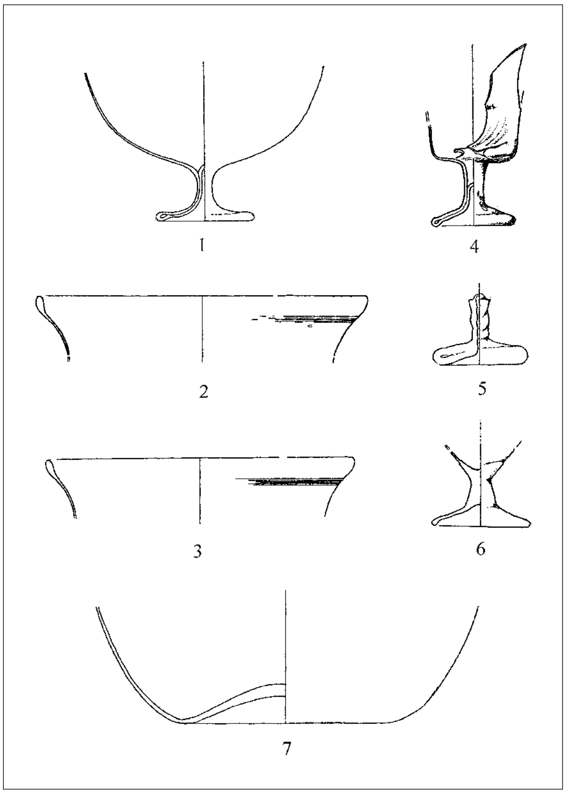


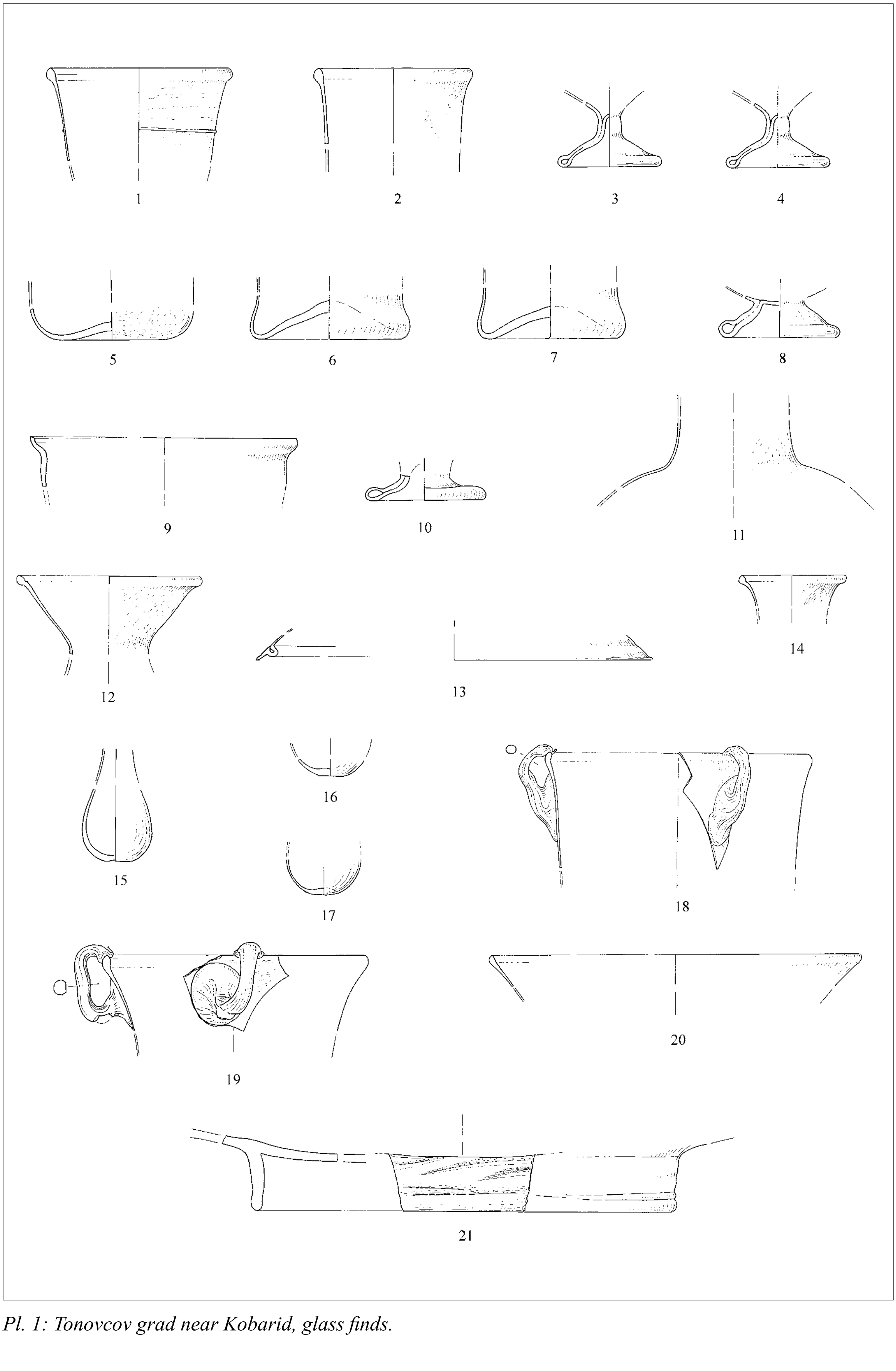
Fig. 3: Kranj, glass finds (after Sagadin 2004, fig. 6).

Conclusion

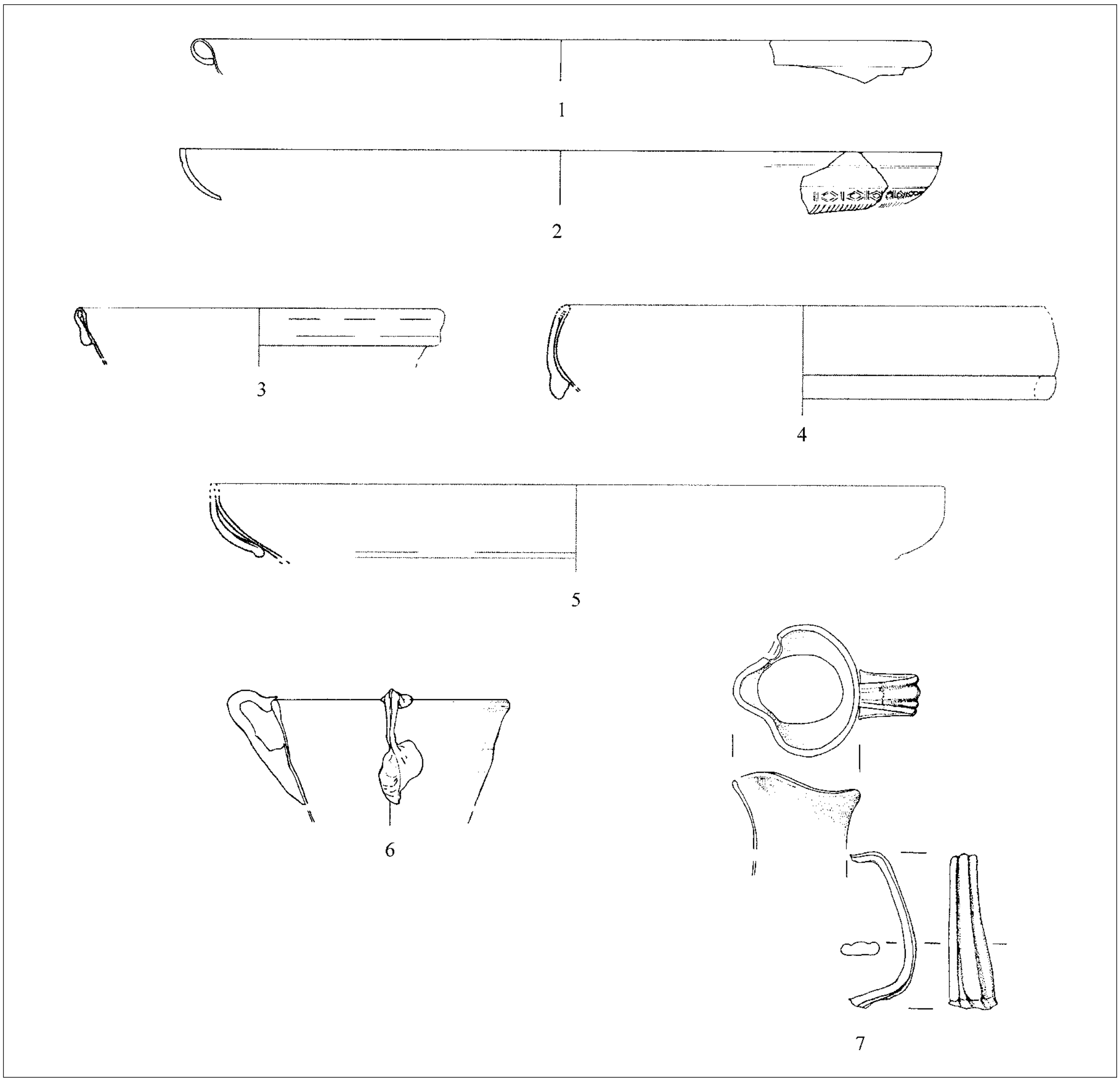
After the end of central Roman administration and military presence in this part of the Empire and due to the difficult circumstances of the Late Roman period the settlement pattern changed. The economy and trade also changed and it is significantly more difficult to follow it as imported goods became less common and the production largely regional. Some long distance trade remained, however, best represented by pottery[42] and raw glass until about mid-7th century. After that long distance trade is for a while almost invisible, perhaps inexistent.

Between the late 5th and the early 7th century drinking sets (stemmed goblets, beakers and bottles), hanging lamps with three handles and window panes were the most common glass objects used which corresponds well with wider Mediterranean area. Trade in glass mass and high quality vessels and secondary workshops, as yet unknown, were probably organised by the church authorities who seem also to have been the main

42 Modrijan 2011, 123-158.



Pl. 1: Tonovcov grad near Kobarid, glass finds.



Pl. 2: 1-2 Ajdovski gradec above Vranje near Sevnica (after Vogelpohl 1975, fig. 31: 27, 44); 3-5 Fizine near Portorož (after Gaspari et al. 2007, pl. 7: 202-204); 6-7 Koper (after Cunja 1996, pl. 5: 76, 78).

consumers of glass objects. After the Slavic settlement during the 7th century this pattern came to an end. Glass vessel production was in most of the region probably discontinued until the High Middle Ages. From Early Medieval sites there is evidence of use of glass beads, mostly from recycled Roman glass.[43] In the case of "Mosaikaugenperlen" and segmented glass beads we can be sure of long distance trade, but there are also signs of other plant ash glass beads which could have been produced locally.[44] Sites in the vicinity of Italy or situated on the coast remained part of the Byzantine or Lombard cultural sphere until the 9th century They show signs of continuous use of glass, even of luxurious pieces such as stemmed goblets from Koper (group 3, Fig. 2: 3). Goblets from Koper are among the rare vessels that belong to the 8th-9th century. On the coast Early Medieval settlement changed much less than in the hinterland and glass supply or even production could have functioned there undisturbed until the 9th century but more evidence is necessary to confirm this.

43 Šmit *et al.* 2012.

44 Two plant ash glass beads were found at Gradišče above Bašelj, see Šmit *et al.* 2009, fig. 1: 3, 7.

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LELJAK Mia

GLASS VESSELS FROM THE LATE ROMAN CEMETERY AT ŠTRBINCI (CROATIA)

The archaeological site of Štrbinci (Roman *Certissia*?) is situated 3 km southeast of the town of Đakovo in north-eastern Croatia (Fig. 1). It consists of two gentle hills split by a depression, with a water source to the south and a plateau to the north. The site of Štrbinci was first referred to in archaeological literature at the beginning of the 20th century, owing to the archaeologist Josip Brunšmid, who unsuccessfully tried to save a Roman building with mosaics and frescoes that was found there when the land was used for ploughing (Brunšmid 1901, 137).

Since no geodetic documentation survives from that time, the remains of the building so far have not been traced. In 1966, in the watching brief during the construction of a power station, two Roman graves were discovered although further excavations were not conducted. A frescoed tomb appeared in 1991 during the digging of defensive trenches, which led to the rescue excavation in 1993, conducted by Zoran Gregl from the Archaeological Museum in Zagreb. The first systematic excavations of the site began in 1999 and since then the late Roman cemetery has been excavated on the plateau of the south hill, although not on a regular yearly basis. The excavations have been subsequently conducted by Branka Migotti of the Department of Archaeology at the Croatian Academy of Sciences and Arts, Zagreb.

So far, 160 graves have been found. The cemetery has yielded abundant and various late Roman and early Christian finds. Glass objects present the most abundant group among the recovered finds, including both vessels and jewellery (bracelets, pendants and beads). In this paper only glass vessels will be discussed.

The most interesting findings at Štrbinci to date are two gold-sandwich glasses. The first was discovered in 1965 during construction work, but unfortunately the context of the find remains unknown (Migotti 2002, 21). On the gold foil placed between two pieces of glass, there is a depiction of a married couple and an inscription FLOP-N-TIS (sc. *florentes*), squeezed into an empty space between their heads. The preserved portion of the vessel points to a shallow bowl. On the basis of the iconographic anal-

Fig. 1: Map of Pannonia Secunda with the location of Certissia (after Migotti 2002).

ysis of the depiction and the inscription, as well as the comparison with similar pieces, this find was dated to the second third (330-360) of the 4th century (Migotti 2002, 25-34).

The second glass bottom was found during excavations in 2001. It was placed, with two more plain glass bottoms, near the head of a 10-12-year-old girl in grave 45. As only the bottom is preserved, the shape of the vessel remains unknown, although it was probably the same as in the first glass. It is assumed that vessels with gold-sandwich bottoms were ritually broken and only bottoms were placed in graves as grave goods or grave-markers (Migotti 2002, 17). The gold foil shows a family of four while around and beneath their heads is an inscription VIVATIS FELICIS (sc. felices) IN DEO and five rosettes. The same detailed analyses, as in the case of the first glass bottom, were made and they point to production in the second half of the 4th century (360-400) (Migotti 2002, 52) (Fig. 2).

It is quite interesting that two glass bottoms were found in this cemetery given that in the whole territory of Pannonia there are only seven pieces of sandwich-glass bottoms: two from Štrbinci, two from Carnuntum (Austria), one from Poetovio (Slovenia), and one each from Intercisa and Lugio (Hungary). It is considered that the majority of all gold-glass bottoms found are of Italian provenance. On the basis of only two finds in southern Pannonia and seven in the whole province of Pannonia, the concept of local production is unlikely, especially in the light of the fact that the majority of all other glass bottoms found so far were produced in Rome.

Several jugs of better quality have been found that differ from other specimens due to the absence of direct analogies. The question is: were they manufactured locally or imported from other provinces?

In grave 113, two very similar oval jugs were found, their necks decorated with glass threads (Fig. 3). No direct analogy can be made for this type of jug in southern Pannonia. There are lots of similar examples, both in the Croatian part of Pannonia as in north Pannonia, as well as among vessels from the Rhine re-

a) D. 6,8 cm

b) D. 6,5 cm

Fig. 2: Two gold - sandwich glass bases (Museum of Đakovo, foto M. Leljak).

gion and the eastern workshops, although close comparisons cannot be drawn. The lack of similarity with the Hungarian specimen automatically suggests the Pannonian origin of the jugs from Štrbinci. On the other hand, considering very similar examples from Eastern Mediterranean workshops (e.g. Kunina 1997, 222), these jugs could easily be considered imports from the Eastern Mediterranean. However, there is little evidence of the importation of goods from Eastern Mediterranean glass workshops in Pannonia, unlike the area of the eastern Adriatic coast, where imports were common. Therefore, it is interesting that at Štrbinci there are several vessel types that possibly indicate Eastern Mediterranean workmanship. It might be assumed that the two jugs in question came to Štrbinci from Dalmatia as the provinces of Dalmatia and Pannonia were connected by the road Salona-Servitium, which was joined by the longitudinal direction along the Sava valley basin (Migotti 2000, 196). Another possibility is that Syrian merchants themselves brought these vessels to Pannonia when they arrived in the 3^{rd} century and settled behind a section of limes protected by Syrian troops (*Cohors Milliaria Hemesenorum* in Intercisa). Alternatively, Syrian soldiers may have brought these vessels with them (Thomas 1980, 38). However, considering the quality of the two jugs from Štrbinci is far worse than the quality of similar Syrian imports found in other provinces, it is more likely that they were made in Pannonia by local craftsmen who modelled them on the types of vessel made in Syrian workshops. Nevertheless, the question still remains whether they were made in the Croatian part of Pannonia or in its northern part.

The jug from grave 103 also differs from al other examples from Štrbinci. An oval body decorated with wide ribs, the neck is short and decorated on the lower part with the glass ring of the same colour as the vessel. Below the mouth is another ring with the motive of blops. This motive also appears below the mouth of the jug from Vinkovci (Cibalae) whose ribbed body, however, is not oval but spherical.[1] There is also a jug from Dalj (Teutoburgium)[2] that bears the same decoration as the previous two examples (Fig. 4). The three jugs in question are not the same, but have the same elements of decoration that are typical for the period between the 3^{rd} and 5^{th} century: ribs, glass threads, blops and the ring on the neck, all of which are the same colour as

1 A Roman town (colonia) situated some 33 km east of Štrbinci.

2 A Roman settlement and fort situated on the Danube limes in eastern Croatia.

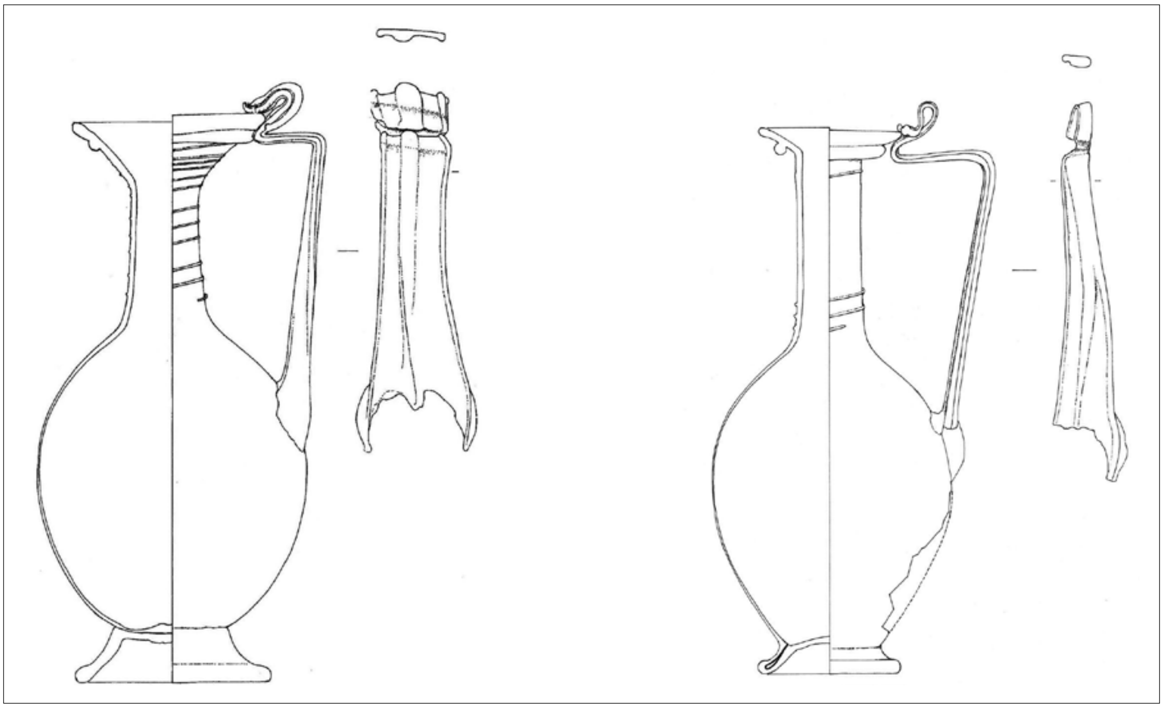

Fig. 3: Jugs from grave 113.

the vessel. Therefore, on the basis of these observations the jugs can be roughly dated to the same period. The jug from grave 103 at Štrbinci is most similar to the grave from Dalj, not in form, but due to the same elements of decoration: the ribs, the ring on the neck and the shape of the handle. However, the jug from Štrbinci has a decoration of blops below the rim as does one specimen from Vinkovci. Consequently, it can be assumed that the jugs from Vinkovci and Štrbinci are probably the result of south Pannonian production on account of their similarities and the small distance between the two sites. On the other hand, the jug from Dalj is better quality than the other two examples. Therefore, it is perhaps more logical to assume that the former were imported, probably from the Rhine region, and that it served as a model for the production of similar pieces made by local glassmakers.

Two vessels from Štrbinci do not correspond typologically to the late Roman material, but are similar to earlier Roman examples. On the other hand, their manufacture points to Late Antiquity and corresponds to the manufacture of the majority of glass vessels found at Štrbinci (poor quality of glass, poor technique of manufacture; Fig. 5).

Firstly, there is a conical jug made of light blue glass that is typologically similar to the same vessels from the period of the second half of the 1st and the beginning of the 2nd century AD (e.g. Roffia 1993, 145, no 320, 321). However, this jug is of the same quality as the late Roman vessels referred to before.

The same problem appears with one conical toilet bottle that also differs from other specimens found at the site and corresponds to the examples from the 2nd or possibly 3rd century (e.g. Roffia 1993, 127, 132, no 297; Mandruzzato, Marcante 2007, 100, no 265). It is hardly imaginable that those two vessels survived from as early as the 2nd century, but this cannot be ruled out completely. Given the archaeological evidence, the site of Štrbinci obviously had continuity from prehistory to Late Antiquity (Migotti 1998), so the discovery of early Roman vessels would come as no surprise. Nevertheless, these two vessels were found in a grave with regular late Roman artefacts; the jug having been discovered in the grave together with the conical beaker bearing a rounded base, dated to the period between the 4th and the beginning of the 5th century (Leljak 2011, 149). A toilet bottle was also found in the grave together with forty-

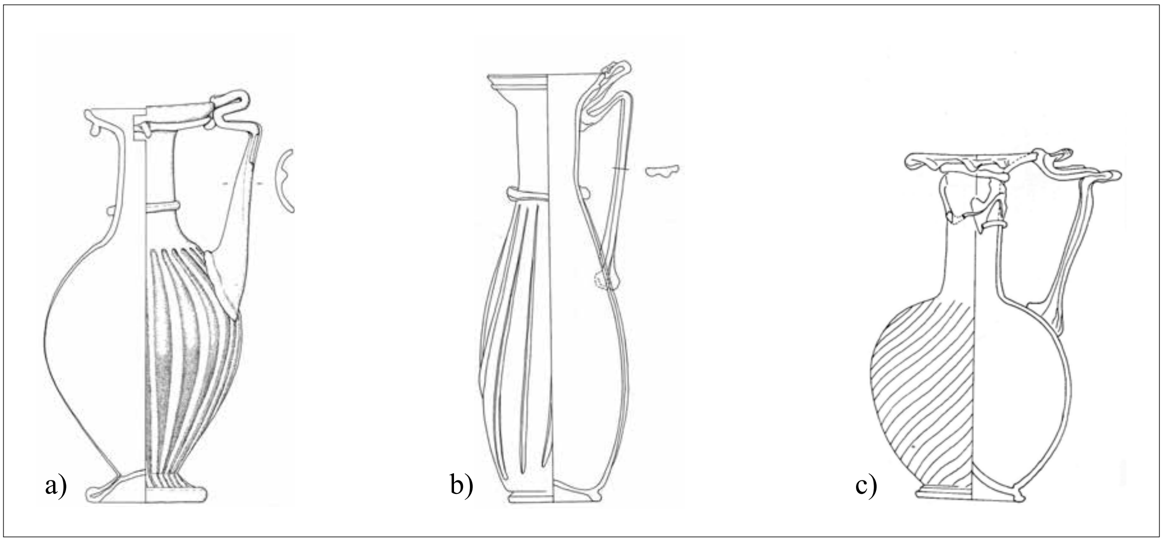

Fig. 4: Jugs from Štrbinci, Dalj and Vinkovci (4b and 4c after Šaranović Svetek 1986).

one other various objects, the most important of which are coins[3] (Raunig 1979-80, 157, 158). Given this, as well as the poor craftsmanship of the two vessels in question, it is more likely that we are dealing with early Roman pieces of probable domestic production that apparently managed to survive throughout a long period of use.

The largest group of vessels found at Štrbinci are usual, ordinary vessels made for everyday use: conical beakers, oval jugs, spherical bottles and different types of toilet bottles (Fig. 6). These vessels indicate local production, which is suggested by a number of indicators: poor production and poor quality of glass; the vessel walls, which are full of bubbles, vertical and diagonal streaks; the poor modulation and asymmetrical bodies of the vessels; and the improper design of elements such as a foot as well as rims, handles and decorations. There is a large quantity of discovered material, but apart from some exceptions, there are only a few major vessel types (globular bottles, oval jugs, conical beakers and rounded toilet bottles). There are broad analogies for most of the vessels found at Štrbinci while there are few direct comparisons. In other words, shapes and decoration as seen on the vessels from southern Pannonia can be found in the northern part of the province and in the Rhineland, but close analogies are mostly missing. Except for a few vessels that are made of yellowish or bluish glass, only one colour dominates: different shades of green.

Fig. 5: Jug and toilet bottle from Štrbinci (Museum of Đakovo, foto M. Leljak).

Given that the northern and southern parts of Pannonia constituted one and the same province, it is interesting to observe the disparity of their glass material. The production of several vessel types in north Pannonian workshops is proven (globular bottles, conical beakers) not only in Late Antiquity, but also in earlier periods (Thomas 1980, 381-383). Since late Roman types are frequent in the Croatian portion of the province as well, there is no reason why they could not have been produced there. An-

3 Eight coins were found in the grave: four of Constantine, two of Licinius and two of Crisp.

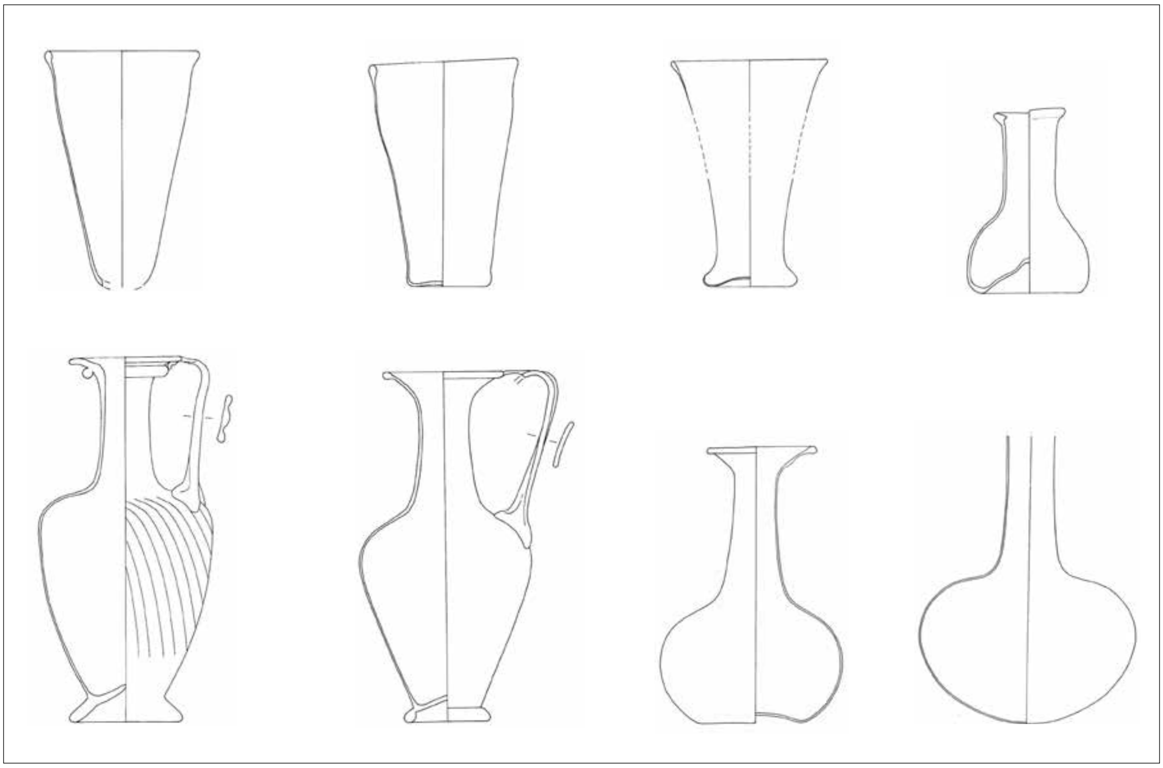

Fig. 6: Vessels from Štrbinci.

other possibility, which currently seems more convincing on account of the lack of evidence for south-Pannonian production and good traffic connections between the northern and southern sections of the province, is that production started in the north and subsequently spread to the southern region. The vessels in the south were apparently modelled on imported ones, not only from the northern part of the same province, but probably on the vessels from the Rhine and as well as those the East. This could offer an explanation for so many similarities between the vessels and so few identical specimens.

Unfortunately, except for the large number of vessels, no other elements (furnace, glass waste, tools, etc.) have been found yet, which could provide proof of glass production at Štrbinci. The main reason for this is certainly the fact that the settlement has not been excavated with the exception of part of the cemetery. B. Migotti, the conductor of the excavation, assumed the possibility of glass production on the site due to several indicators, such as a large number of bracelets made of black glass (Migotti 1998, 14) or a lump of flint found in one grave, which could directly and symbolically refer to the making of glass at the site (Migotti 2009, 164).[4] Unfortunately, except for the quantity, no other proof of bracelet manufacture in Štrbinci or anywhere else in this part of Pannonia has been discovered so far. The lack of archaeological evidence for domestic production of glass vessels is not only a problem regarding Štrbinci, but for the entire province as well. Therefore, due to the absence of evidence, the production of glassware in the Croatian portion of southern Pannonia remains inconclusive until further finds are made. At this point, given all the aforementioned facts, there are still many uncertainties concerning the origin of glass vessels found at Štrbinci. Fortunately, research of the site is continuing, so hopefully new findings will bring about fresh interpretations of the issues discussed.

4 This presumption is based on the fact that quartz sand is one of the basic ingredients of raw glass. However, so far no analyses of the glass from Štrbinci have been made, so at this point we do not know if the quartz sand is the ingredient of the glass that vessels from Štrbinci are made of.

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A SECONDARY GLASS WORKSHOP IN ANCIENT EDESSA

Glassworking workshops were small units, located in principle – at least during the early imperial period – at the periphery of the city in order to minimize the risk of fire and to avoid the disturbance of local residents.[1] During the late imperial period, they were often housed in abandoned public spaces, as well as in buildings at the city center. Glassworkers were often active in close proximity to other artisans who required furnaces for their work, such as metalworkers and potters; sometimes they even shared the same space. It appears, moreover, that workshops also operated in the vicinity of military camps in order to cater to the needs of the army.[2] In addition to archaeological evidence,[3] surviving inscriptions and literary sources also attest to the presence of glassworkers in various areas of cities.[4]

In the Macedonian region, glass workshops or evidence for glass working has come to light in Thessaloniki, Ioron, Louloudies, Philippi, and probably also at Dion. Although there are no specifics for the glass workshop in Ioron, we know that it was located *intra muros*.[5] In Philippi, a workshop operated in front of a public building, under the covered portico on the sidewalk sometime in the late

1 Cf. the 14th century, the jurist Konstantinos Armenopoulos, copying passages verbatim from Julian of Ascalon (6th century), in *Hexabiblos*, Book 2, title Δ' "Περί καινοτομιῶν" (On innovations), paragraph 19, "Περί ὑελουργῶν καὶ σιδηρουργῶν" (On glassworkers and ironworkers): Pitsakis 1971, 117-18. See also Pitsakis 1971, λη'-λθ'; Pitsakis 2002, 242, no. 54; Hakim 2001, 4.

2 Price 2005, 173-174; Antonaras 2013, 10-13.

3 Price 2005, 172-174; Antonaras 2009a, 61-66; Gorin-Rosen and Winter 2010, 177-178, pls. 10-11 For a detailed presentation of the glass workshops at Thessaloniki and their products as well as the glass objects circulating in Thessaloniki, see Antonaras 2010b, 93-105; Antonaras 2010c, 301-334.

4 *CIL* 6, no. 29844 [= 93]: seeTrowbridge 1930, 131, notes 38–40; *ILS* I, 1224b. Strabo, *Geog.* 16.2.25; Martial, *Epigr.* 1.41.1-5.

5 Antonaras and Anagnostopoulou-Xatzipolichroni 2002, 118, fig. 14.

4th - early 5th century.[6] At least four glassworking kilns have been identified in different parts of Louloudies, a late antique *quadriburgium* that survived until the 7th century. The workshops operated after the 7th century, when the entire complex was occupied by various workshops.[7] In Thessaloniki, glassworking activity took place on at least four sites: a late 6th - 7th century workshop with several glass furnaces came to light at 45, Vasileos Irakleiou Street, along with deformed vessels of various shapes. Several craft workshops, including a glass workshop, operated in the Roman forum in the 4th or 5th century, after which it ceased to have an official function. Glassworking also took place in the ruins of a public bath house over which a Christian basilica was built in the mid-5th century. A shop in the eastern necropolis, near the city walls, produced clay lamps for a time, probably in the 4th century, but was used by a glass worker in the late 5th or early 6th century.[8] Several forms of glass vessels, dated mainly to the 4th and 5th centuries, have been ascribed to local production.[9]

This contribution adds a new pin to the map of glass workshops - in Edessa, where a workshop came to light in the Lower city.[10] The area was already inhabited in the Neolithic period and by the late 4th- early 3rd century BC the city was surrounded with walls which were rebuilt in the late 3rd century AD. The triangular acropolis, on a naturally fortified, flat hilltop, covered an area of three to four hectares. The Lower city, located at the foot of the hill, was spread over an area of 20-30 hectares, approximately 1.2 of which has been excavated inside the South Gate. The urban planning of the Lower city was probably organized at the same time. The main axis connects the North and South gates of the Lower city. The glass workshop presented in this paper was located along this axis, called Main Street. During the Late Antique period the city suffered all the disasters and fluctuations that occurred in the region. After the late 6th century it began to decline and diminished in size. The Lower city was gradually abandoned, and the inhabitants moved to a higher area at the foot of the hill and on the acropolis. The Upper town continued to exist throughout the Byzantine and Ottoman periods up until the present (Fig. 1).[11]

In Late Antiquity, the city walls underwent several minor repairs and a second external wall was built in the northern part. The premises to the east of the South Gate are thought to have been used by a garrison at least until the 6th century. 85 meters of the Main Street, which is itself 4 meters wide and connects the North and the South Gates in a straight line, has been excavated. The original marble paved street underwent significant alterations and a monumental vaulted pipe line was constructed along its centre. Around the same time, the Main Street was flanked by two stoas, *ἔμβολοι*, which are 5.20m wide. Their roofs were supported by columns and pillars connected with arches towards the street and on the walls of the buildings on the other side.

Houses, shops and workshops have been identified in both the eastern and the western *insulae*. The glass finds included window panes; vessels (mainly stemmed beakers and lamps), beads and so forth.[12] The necropoleis produced similar finds used as grave offerings, in accordance with old regional traditions. Some of the glass from the necropoleis was probably imported, but the remainder products of local workshops.[13]

6 Gounaris 1995-2000, 323-331, 351, figs. 2-4, 6; Skordara, Gounaris, Maniatis 2002, 321-326; Gounaris 2002, 28.

7 Marki 1996, esp. 239-243; Marki 2002, 65-66; Aggelkou 2002, 65-67.

8 Antonaras 2009a, 61-75; Antonaras 2009b; Antonaras 2010b; Antonaras 2010c; Antonaras 2010d; Antonaras 2014; Antonaras forthcoming; Antonaras 2010e.

9 Antonaras 2010a; Antonaras 2009a, 75-84; Antonaras 2010b; Antonaras 2010c; Antonaras 2011.

10 Chrysostomou, 2008, 24.

11 Chrysostomou, 2000, passim; Chrysostomou, 2008, passim.

12 The Roman vessel glass found in these rooms included a fragmentary bluish, square bottle with a basemark (ΑΚΛ 2007/175). Cf. Nenna 2006, 425, MN-U 34. (fig. 15).

13 Chrysostomou 2000, passim; Chrysostomou 2010, 193-196.

Fig. 1: Ancient Edessa, the South Gate Area. The glass workshop is outlined.

Fig. 2: The insula of the glass workshop.

The glass workshop was located in the first city block/*insula* to the east, framed by the Main Street, the East Stoa, and two smaller streets to the south and the north (outlined in red in Fig. 1; highlighted in Fig. 2). The *insula* was initially investigated in 1971 and partially in 1980 under the direction of A. Vavritsas.[14] In 2005-2008, additional, limited excavations were conducted under the direction of A. Chrysostomou[15] in order to define the character and shape of the site by combining new and old results and making them accessible to the public after extended conservation and restoration.

The *insula* comprised rooms 2, 3, 5, 6, 11-14, all of which had a second floor (Fig. 2). The entrances were located in rooms 6 and 12. Finds from the two campaigns date its construction to the 4th century AD and its final destruction toward the end of the 6th century. The sealing of certain doors indicates the existence of intermediate phases.[16] The western part of the *insula* quite probably was used as a residence, while commercial use is evident in the eastern part, along the East Stoa and the Main Street.

The independent corner room 2 was identified as a commercial shop, probably in connection with room 5, during the last phase, based on the presence of pithoi and a bronze weight. Room 12 was excavated in 2005. After the removal of the fallen roof, few movable finds were found on the room's floor.[17] A niche 1.5 m wide and 0.50 m deep, located on the right hand side towards the entrance to room 3, may have served as the showcase of the glass workshop, given that at least in the last phase, it was only possible to enter the room with the furnaces through the doorway (1.60 m wide) located in the south wall of room 12. This suggests the workshop comprised rooms 12 and 3.

In 1971, the walls of room 3 (width 0.90-0.45 m) were excavated. The lower part of a window (0.80m wide), that would have provided ventilation for room 3, came to light in the upper northern part of the east wall. According to the excavation notebooks, traces of fire were detected on the earthen floor, after the removal of the inner fill. They are associated with the final destruction of the room, as is the case with several other rooms of the complex. Apparently, the excavation continued below this layer in the western half of the room, where a brownish layer of rubble and roof tiles was detected before reaching the sterile soil - an indication that it did not correspond to the earliest phase of the complex. The movable finds from the campaign of 1971 were scarce and included mainly unidentifiable early Christian coins.[18] After excavation, the area was refilled with soil.

In 2007 the soil was removed and the walls of room 3 (internal dimensions 5.70 x 4.60 m) were cleaned anew, prior to restoration. A sealed door (0.80 m wide) was revealed in the western wall after careful cleaning. After that, further research was conducted, especially in the apparently hitherto unexcavated southwestern part (2.30 x 1.20 m) of the room and in a 1.70 m wide zone along the east wall (Fig. 3). In the southwest corner, parts of pithoi were unearthed and the foundation of the west wall was found. A 'thermal' construction (apparently a hearth), came to light, and further to the north, a pithos pit in front of the sealed opening in the west wall. Chunks of raw glass,[19] an anomalous glass

14 Vavritsas 1976, 8-13 presents the results of the excavations between 1971-1976.

15 On the conservation and restoration work see Chrysostomou 2008, 136-160. Apart from the excavation of room 12, the rest of the excavation work conducted between 2005-2008 consisted of test trenches attesting the existence of earlier Roman and Hellenistic phases.

16 For a detailed presentation of the insula's rooms and their functions, see Chrysostomou 2007, 59-61; Chrysostomou 2008, 119-122.

17 On room 12, see Chrysostomou 2007, 60. Among the finds were masses of iron (ΑΚΛ 2005/88-90), fragments of window glass (ΑΚΛ 2005/87) and vessel glass (ΑΚΛ 2005/91), and a large number of 6th-century coins.

18 The finds comprised a clay bead (ΑΚΛ 1221), a glass counter or gem (diam. 1.5cm,_ΑΚΛ 1453), and a bronze fibula (ΑΚΛ 1455) in the south wall. Bronze coins (ΑΚΛ 1971/ 291, 302-3, 319, 328, 369, 370-1, 403-4) were found on and below the floor, mainly late-Antique; due to their bad condition they do not offer precise chronological indications.

19 (ΑΚΛ 2007/39 and 2007/38).

Fig. 3: View of the glass workshop from the South.

Fig. 4: View of the glass workshop from the West.

lump,[20] moils and other glass fragments[21] were also discovered here and were probably stored for melting in future batches.[22]

The three furnaces described below were unearthed in the zone along the east wall after removal of the fill. The finds comprised glass fragments,[23] part of a stirring rod,[24] and coins,[25] including one of Constantine I. After the furnaces were revealed, further work ceased in order to compile a conservation and restoration plan. Then the furnaces were protected and reburied (Fig. 4).

Only the lower parts of the combustion chambers of the three circular furnaces along the east wall near the south end of the room remained. At least one preserves the mouth of the combustion chamber. The furnaces were probably framed by a thin wall that united the system and formed a kind of shelf. Possibly the space between the furnaces was used for annealing. Although all three furnaces were constructed on the same level, we do not know whether they operated simultaneously. They may represent three different phases of use and repairs.

The inner diameter of the furnace next to the entrance is approximately 30 cm. The furnace at the other corner is larger, ca. 50-60 cm. The walls are ca. 20 cm thick; all are made from pieces of brick and roof tiles connected with mortar. They are reinforced externally by a thick layer of rubble. Internally they are lined with a 2 cm-thick layer of plaster.

Although the excavations are not yet completed, it is evident that the glasshouse at Edessa could have operated as a modest artisanal workshop during any of the later phases of the complex's period of use. Two, probably wooden, steps led into the workshop from the East Stoa and from the opening in the north wall leading to room 12 which was probably part of the workshop.[26] The window in the east wall would have created a draft of air, much needed for the operation of the furnace and the ventilation of the room due to the smoke from the furnace. A partly preserved, low construction against the opposite wall, in front of the workshop's sealed door, was apparently associated with the use of open fire, probably just a small hearth. Parts of pithoi unearthed to the right and left of this construction, probably held water for the workshop. The northern-most pithos at the west, which was apparently placed there after the opening to the East Stoa was sealed, shows the simplicity of this kind of installation.[27]

The glass collected for recycling comprises the following objects:

- Chunks of raw glass: mainly greenish, some yellowish green, and a few olive green[28] (Fig. 5: lower part).

- One deformed, dull lump of olive green glass. It was cooled rapidly, possibly in contact with cold water or an irregular surface. The lump is almost entirely covered with protuberances[29] (Fig. 5: lower central part).

- One trimmed lump of greenish glass (Fig. 5 lower right part) and two irregularly shaped lumps (Fig. 5: lower left part).

- Fragments of yellowish green moils from at least three different vessels. The rim diameters of the vessels produced is calculated at ca. 7.5 cm (Fig. 5: upper part).[30]

- Three fragments of crack-offs, revealing the dimensions of the blow pipe: 2.5 cm external diameter and 1.8 cm internal (Fig. 5: upper left part).

- The conical base of a greenish, stemmed beaker, folded and an integral part of the bowl,

20 (AKΛ 2007/46).

21 (AKΛ 2007/40).

22 The finds also comprised a small knife (AKΛ 2007/49) and bronze coins (AKΛ N1-18), among which a Maximinus and examples from the 4th-5th-century have been identified.

23 (AKΛ 2007/50, 51).

24 (AKΛ 2007/49).

25 (AKΛ N 1-4).

26 The floor of room 3 is ca. 90 cm lower than the doorstep of both entrances, an indication that it resembled a semi-basement. This was due partly to the fact that the entire area is built on a slope. The floors' heights change with every two to three rooms.

27 On similar contemporary installations, see Onder Kucukerman 1988.

28 (AKΛ 2007/38, 39).

29 (AKΛ 2007/46).

30 (AKΛ 2007/40).

Fig. 5: Refuse of the production. Raw glass, cullet and moils.

Fig. 6: Refuse of the production. Parts of glass vessels and objects.

plus a small fragment of a second base (Fig. 6: lower right). [31]

- Fragment of a tall cylindrical beaker (presumably), with traces of shallow incisions under the rim and at mid-height.[32]

- Handle fragment of a jug of the "distinctive blue group" (Fig. 6: central part). [33]

- Fragment of a greenish stirring rod, twisted and quite thick, with a spiraling turquoise thread in the center of its mass, ca. 1-1.2 cm diam (Fig. 6 lower left part). [34]

- Olive green fragments of a hemispherical or conical bowl.[35]

- Olive green ring-shaped strap handle, probably from a lamp, or a footed skyphos. A small fragment of a cut-off rim (diam. 10 cm) was probably from the same vessel (Fig. 6: upper right part).[36]

- Olive green base-ring of a vial (Fig. 6: at the lower right end). [37]

- Base fragment, probably of a greenish, cylindrical bottle with a base-mark showing raised concentric circles (Fig. 6: upper left part).

With regard to the dating of the workshop the following should be noted: Based on the archaeological data and the objects found, e.g. the stemmed beaker, the workshop was active approximately from the 5th century onward. The earliest fragments can be dated to the late 4th century. However, the latter are residual finds and not associated with the operation of the workshop, but with the earlier phases of the insula.

31 (ΑΚΛ 2007/50, 9). Isings 1957, form 111. For a recent review of the form, see Antonaras 2008, 24; Antonaras 2009a, 162-169 forms 35-36.

32 (ex ΑΚΛ 2007/40). Similar to the conical beakers Isings form 106; Antonaras 2009a, 153-155 form 31.

33 (ΑΚΛ 2007/43). Whitehouse 1997, 367-375; Antonaras 2009, 245-246 form 87.

34 (ΑΚΛ 2007/43). Spaer 2001, 262, 264-65. For a review of similar finds in the Macedonian region and beyond, see Antonaras 2009a, 330-332, form 148.

35 (ΑΚΛ 2007/9). Isings 1957, form 96; Antonaras 2009a, 117-124 form 12. Or, Isings 1957, 109 form 106; Antonaras 2009a, 153-158 forms 31-31.

36 (ΑΚΛ 2007/51). Cf. Antonaras 2009, 178-180 form 43.

37 (ΑΚΛ 2007/50). Similar finds have been identified in the excavation of the early Christian Solinos Basilica in Chalkidiki, roughly dated between the 4th and 6th c., in preparation by A. Ch. Antonaras.

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ERTEN Emel, GENÇLER GURAY Çiğdem

GLASS FINDS FROM VILLA-A IN ZEUGMA, GAZIANTEP – TURKEY

Archaeological research in Gaziantep, southeast Turkey, intensified following the construction of a series of dams in the region during the 1990s. Many salvage projects and excavation work for the protection and recording of the area's archaeological heritage took place; for example that of Zeugma, on the Euphrates, which was one of the ancient settlements partly flooded by the Birecik Dam reservoir.

Archaeological excavations of the site continued under the direction of Prof. Dr. Kutalmış Gorkay from Ankara University from 2005. Recent fieldwork at the site produced remarkable results concerning daily life in a provincial centre of the Eastern Roman Empire.

The settlement history of the site dates back to the Hellenistic period. According to Appian, the city was named "Seleucia" after Seleucus Nicator, the founder of the city. Later on during the Roman Imperial Period, instead of Seleucia, the name "Zeugma" was used for the city -meaning "bridge" or "bond".

During the 1st and 2nd century AD, Zeugma became a typical Roman settlement. The most notable event in the history of Zeugma was its destruction by Sasanid King Shapur in AD 253-256. Many buildings at the site were burnt and demolished during this Sasanid attack. Regular attacks in the 4th and 5th century AD led to a gradual decline of the settlement after the 7th century AD.

The excavations at Zeugma have revealed many Roman houses and villas. It has been stated that the number of domestic residences discovered during salvage projects carried out from 1992-2000 was approximately 20.[1] The continuing excavation work at the site added more dwellings to this total, including Villa A. Excavations at Villa A, located at one of the settlement terraces overlooking the Euphrates, produced an interesting collection of archaeological finds, such as pottery, metals, mosaics

1 Abadie-Reynal 2006, 1. Glass material from various phases of Zeugma excavation work was partly published: for a group of finds from the 2003 season see: Dussart 2006, 51-54, pl. LXXVI-LXXIX; for the Oxford Excavations' glass material in the 2000 season see: Grossmann 2013, 218-258.

and a number of glass vessels. These relatively rich finds reveal that the villa belonged to those with a high social status in Zeugma.

160 glass vessel fragments were uncovered during excavation work at Villa A. The archaeological analysis of this material reveals the following groups of finds, listed in chronological order from the Early Roman Imperial to the Early Byzantine Period.

Roman glass

Among the Early Roman glass finds from Villa A are a few examples of ribbed bowls that followed the Hellenistic tradition and technique (Figs. 1.1-2). The introduction of blowing to glass technology is represented by a fragment of a ribbed bowl (zarte Rippenschale),[2] a form which was not unknown in Zeugma as well as in many other centres in Asia Minor[3] (Fig. 1.3). Unguentaria (Fig. 1.4-7) and fragments of two stirring rods (Fig. 1.8-9) are the other finds that belong to the "Early Roman Imperial" group. Although it is not possible to determine the forms as a whole given that only the neck and certain rim fragments have been preserved, it appears that the "tubular" or "candlestick" unguentaria of natural green or blue glass were the main types in existence.

Stirring rods were probably produced following the popularity of their bronze or ivory prototypes, which were common both in Western and Eastern Roman contexts during the 1st and 2nd centuries AD. In addition to the find spots of Cyprus[4] or Egypt (Karanis)[5] in the East, Asia Minor appears to be a notable region for the discovery of such glass rods.[6] Two twisted stirring rod fragments made of natural green glass discovered at Villa A at Zeugma add new examples to this collection of finds.

The growing impact of imperial rule and the Roman lifestyle at Zeugma are marked by a larger variety of glass forms that have been dated to the Middle Imperial Period. For example, a number of vessel fragments with applied base rings or pinched out toes were discovered (Fig. 2.19). Sprinklers with similar pinched toes were dated to the 4th century AD (or earlier) and attributed to Syria, where examples of the same type from Dura-Europos[7] were also recorded.

A fragment of a bowl bearing facet-cut decoration is one of the notable finds from Villa A at Zeugma (Fig. 2.10). Such bowls are considered widespread both at Zeugma and Dura-Europos and it was suggested that the inhabitants of those cities had continued to use such vessels into the 3rd century AD.[8]

The base of a bowl or dish with three engraved concentric circles and made of smooth colorless glass is particularly interesting, due to its production technique (Fig. 2.11). It was stated that the glass casting method, which seems to have disappeared by the mid 1st century AD, somehow continued into the 2nd and possibly 3rd century AD, as was confirmed by the finds at the Athenian Agora.[9] The fragment from Zeugma could possibly be one example of these luxury wares that were cast at a later date.

Another remarkable piece is the base of a mould-blown square bottle with floral decoration (rosette), found within the burnt destruction level of Shapur's fire in AD 253 and which produces evidence for a precise dating of this

2 Isings 1957, Form 17; for a detailed definition of form see: Stern 2001, 47, 82, cat. no.24.

3 For examples from Zeugma: Dussart 2006, 52, pl. LXXVII, fig. 2.6 and from the other centres in Asia Minor: Sardis: von Saldern 1980, 12; Adana Museum: Stern 1989, 598 (Stern points out that the ribbed bowls in Adana were all a light green-blue color); Antakya (Antiochia) Museum: Erten Yagci 1988, 33, 108, fig. 33 f; Arykanda (Lycia): Tek 2007, 155; Tire Museum (from a findspot at Tire in Western Asia Minor); Gurler 2000, 72, cat. no. 90.

4 Vessberg 1952, 152, pl. X, 15-17 and pl. XX.6.

5 Harden 1936, 286, nos. 862 – 864, pl.XXI.

6 For the find spots where the glass rods were recorded in Asia Minor see: Eumeneia (Western Phrygia): Sogut 2011, 139, fig.23; Tire (Ionia): Gurler 2000, 117, no. 41, cat. no. 141; Mylasa (Caria): Ozet 1998, 93, no.55; Corum – Sungurlu (Central Anatolia): Ozet 1987, 602, no.4.

7 Stern 2001, 153, 249-251, cat. nos 135-137 (pomegranate-shaped sprinklers); examples from Dura-Europos: Clairmont 1963,50-51, pl. V.

8 Grossmann 2013, 224.

9 Weinberg and Stern 2009, 87-89.

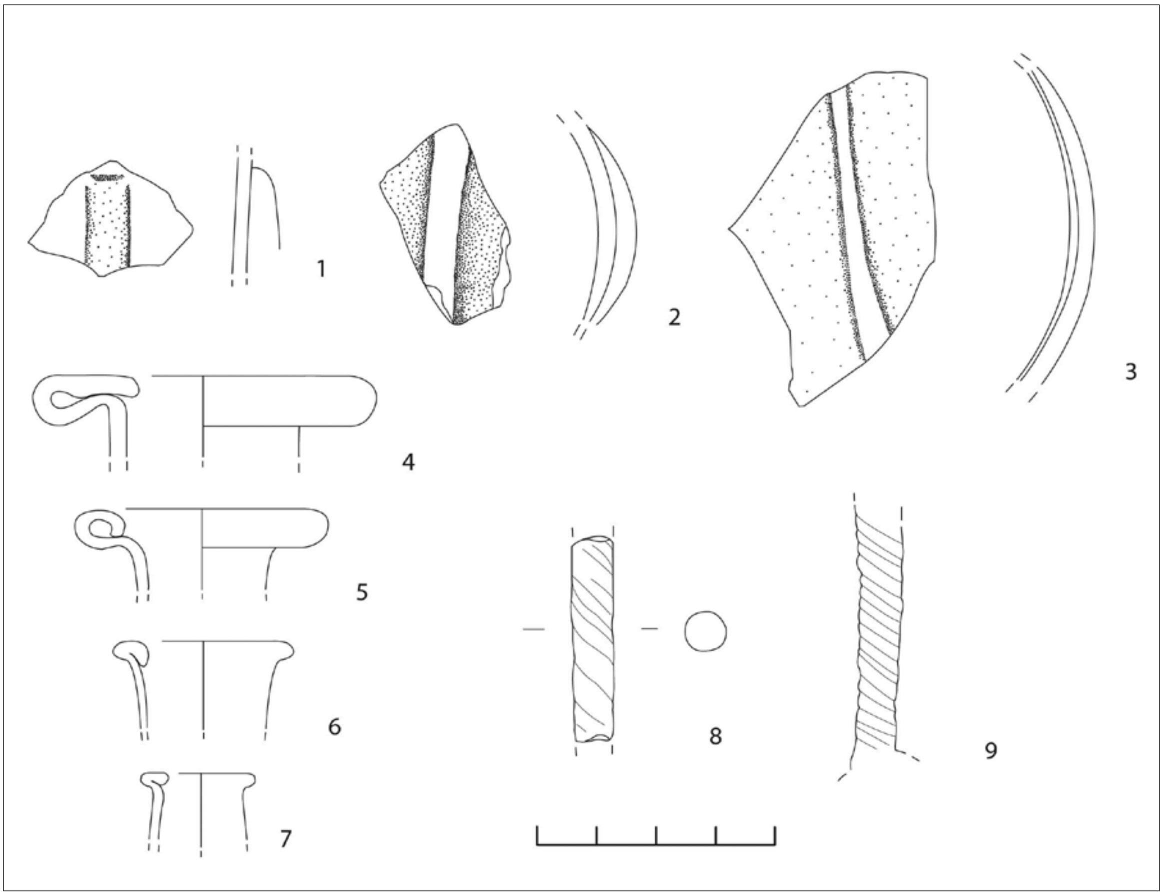

Fig 1: Early Roman Imperial glass fragments.

specific form (Fig. 2.12). It is worth noting that square or cylindrical glass bottles, some bearing very similar decoration in rosette form, were recorded by the Oxford Excavations at Zeugma. They were dated to the late 1st and early 2nd century, but their continued production and use until the 3rd century AD in the Eastern Mediterranean has been proven.[10]

According to the data provided by the excavation work at Zeugma, there is a lack of archaeological material from the 4th century AD. This could well be the case for glass material due to the destruction caused by the Sasanid attack and the clear change in settlement patterns that occurred thereafter.

Late Roman – Early Byzantine glass

The collection of Late Roman - Early Byzantine glass vessels from Villa A at Zeugma consists of bottles and jugs, bowls and beakers, conical vessels and goblets; all have been dated to between the 4th and 6th century AD.

Bottles and jugs

Bottles and jugs with a rounded rim and a funnel-shaped mouth were common throughout the Eastern Mediterranean during the Late Roman and Early Byzantine period.[11] Funnel-shaped mouths have plain, horizontal-thick or

10 Grossmann 2013, 237-238, G54, fig. 53.

11 Gençler-Guray 2012, 294, fig. 2.1-9 (Elaiussa Sebaste – Cilicia, 5th-6th cent.); Gorin-Rosen and Katsnelson 2007, 23-26, fig. 10-3 (Late Roman period, particularly 4th cent.); Israeli 2008, 286-287, nos. 210-212 (Caesareae Maritima, 6th-7th cent. some 5th cent.); Sternini 1988, 18-19, fig. 36; Weinberg 1988, 70-71, fig. 4-41 (Jalame); von Saldern 1980, 72-73, no. 502, pl.26 (5th-6th cent.); Barag 1978, 26-27, no. 53, fig. 13 (3rd and early 4th cent.); Crowfoot 1957, 410, fig. 94.9, no. 9 (3rd cent, from a tomb); Harden 1949, 155-156, fig. 2.2, pl. XLIX.4.

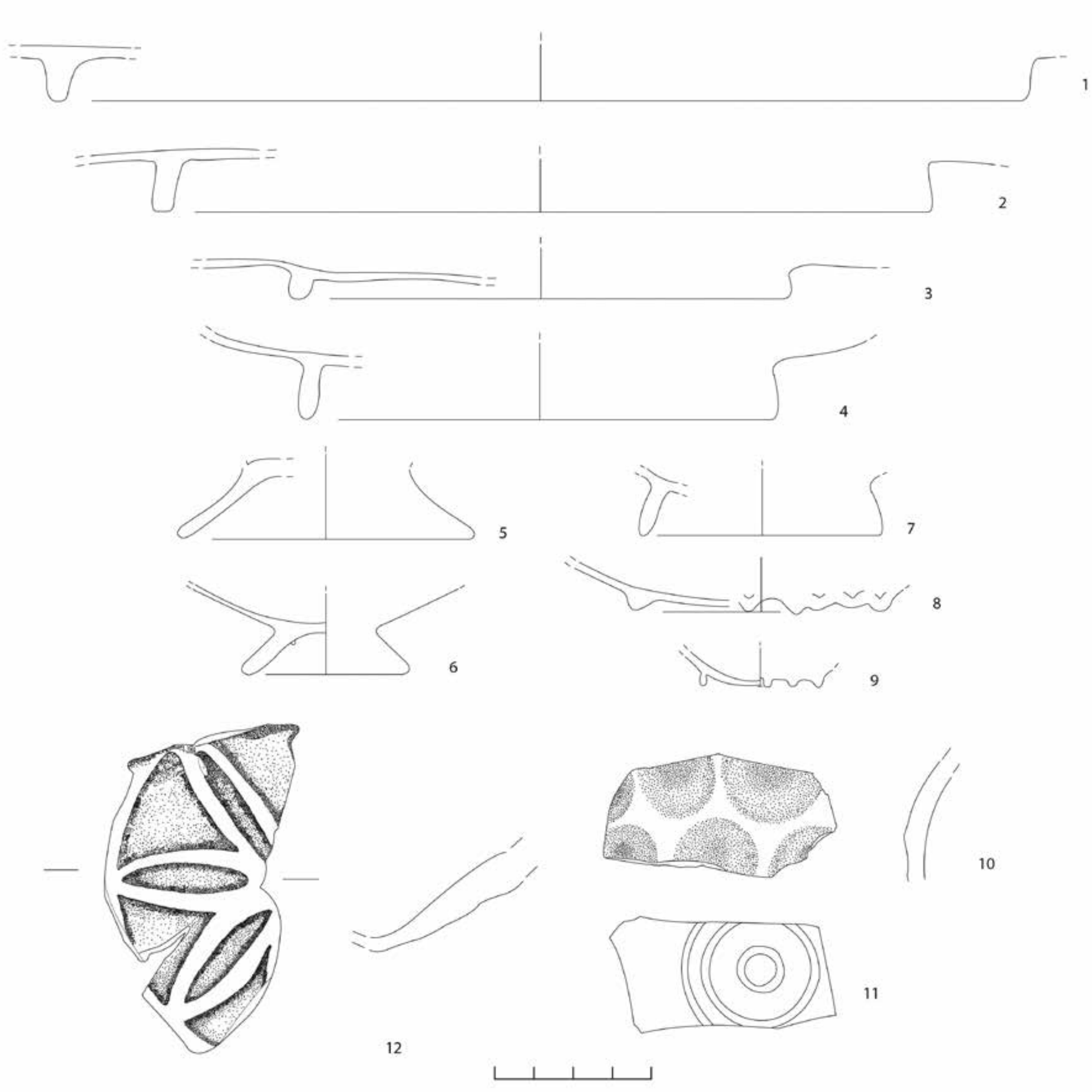

Fig. 2: Middle Roman Imperial glass fragments.

thin-trails below their rims; they also usually have a globular or pyriform body and a flat or concave bottom. Unfortunately, only fragments of the mouth were found preserved among the Zeugma samples. Pottery finds from the same layers suggest a date between the 4th and 5th century (Fig. 3.1-10).

While the production of bottles with funnel-shaped mouths continued as part of Late Roman glass tradition, bottles with vertical mouths were typical forms of Early Byzantine glass (Fig. 3.11-15). The earliest finds of such mouth designs have been dated to the 5th century,[12] but they were especially prevalent during the 7th century.[13]

The two fragments from Villa A are typical examples of sprinkler bottles (Fig. 3.16-

12 Dussart 1995, 347-348, fig.8.1-5 (Jordan and South of Syria, mid 4th-5th cent.); Israeli 2008, 387-388, nos. 223-226 (Caesarea Maritima); Weinberg 1988, 73, fig. 4.3,5, nos. 293-296.

13 Winter 2008, 181, fig. 6.1-3.

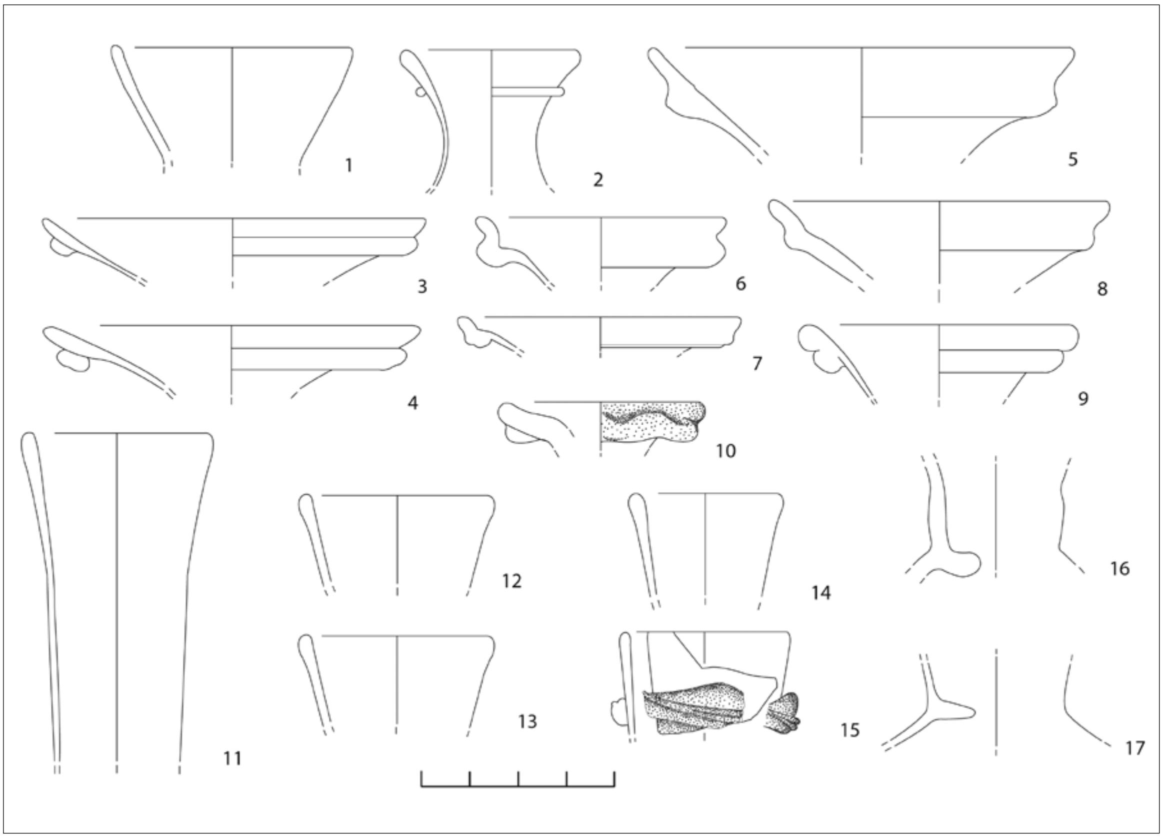

Fig. 3: Late Roman – Early Byzantine bottle and jug fragments.

17). Sprinklers or dropper bottles were distinguished by a narrow diaphragm at their necks that was probably created to permit the outflow of one drop at a time. These bottles had been made and widely used in Syria, Eastern Palestine and Mesopotamia[14] and came in various shapes and decorative patterns. The earliest sprinklers on record are those from Dura Europos, which were dated to a time before AD 256, when the city was abandoned. Zeugma and the neighboring city of Dura Europos exhibit various examples of such sprinkler bottles that possibly indicate local production. However, the fragments can only be identified by their diaphragms: two of the Zeugma Villa A samples were found at levels where the pottery finds were mostly dated to between the 5th and 6th century.[15]

14 Stern 2001, 152-153; Duncan Jones 2003, 137, fig. 3.1; von Saldern 1980, 86-87, no. 643.

15 We would like to thank Zeynep Yılmaz for her support and ceramic information for the levels.

Bowls and beakers

Seventy-eight percent of the finds consist of bowls and beakers. The bowls are characterized by their cut off rims and bodies that can be shallow or deep. It has been assumed that their bottoms were rounded without distinct bases. The best comparable examples of both types of shape come from Jalame.[16]

Shallow bowls with cut off rims can be identified by their plain bodies and are decorated with grooves and abraded lines on their bodies (Fig. 4). These kinds of bowl generally have thick walls. Israeli suggests that these forms seem to have always served both as drinking vessels and as lighting devices.[17] Zeugma sam-

16 Weinberg 1988.

17 The finishing of the rim is used to discern between vessels used for lighting and those used for drinking. When the vessels are intended for drinking, the rim should be smooth in order not to hurt the drinkers' lips (Israeli 2008, 381-382, no. 142). Other paralel samples: Weinberg 1988, 96-98, nos. 483-483.

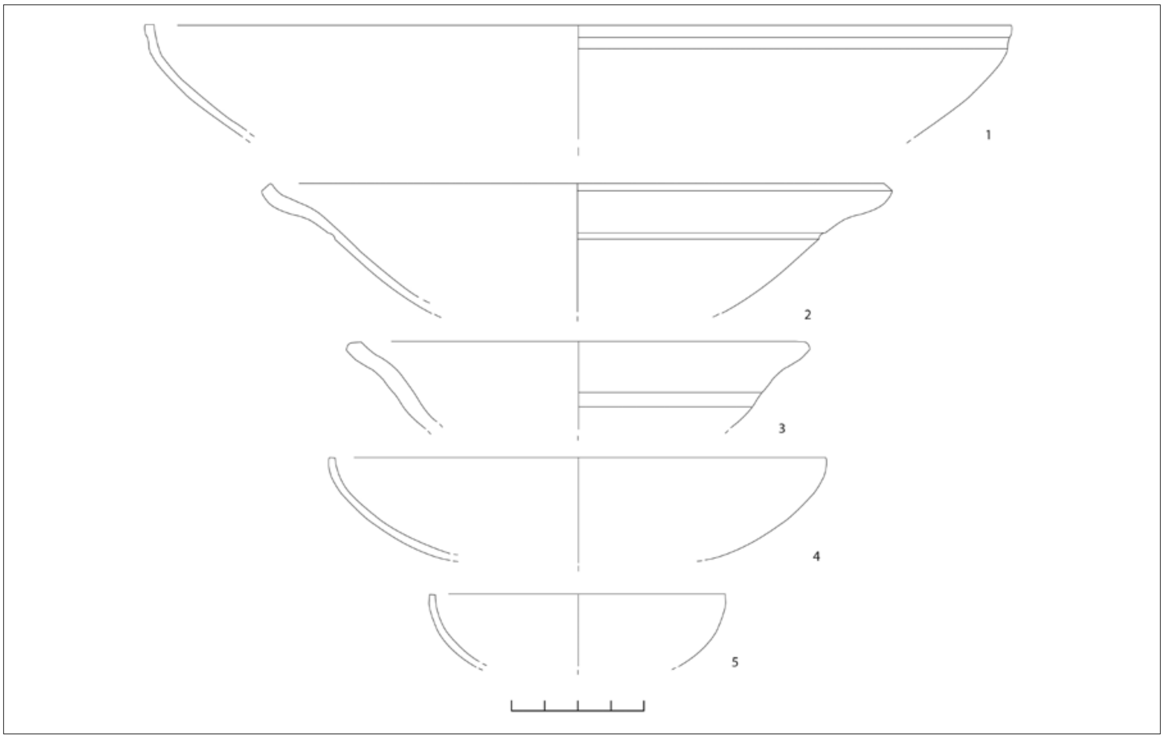

Fig. 4: Late Roman – Early Byzantine bowl fragments.

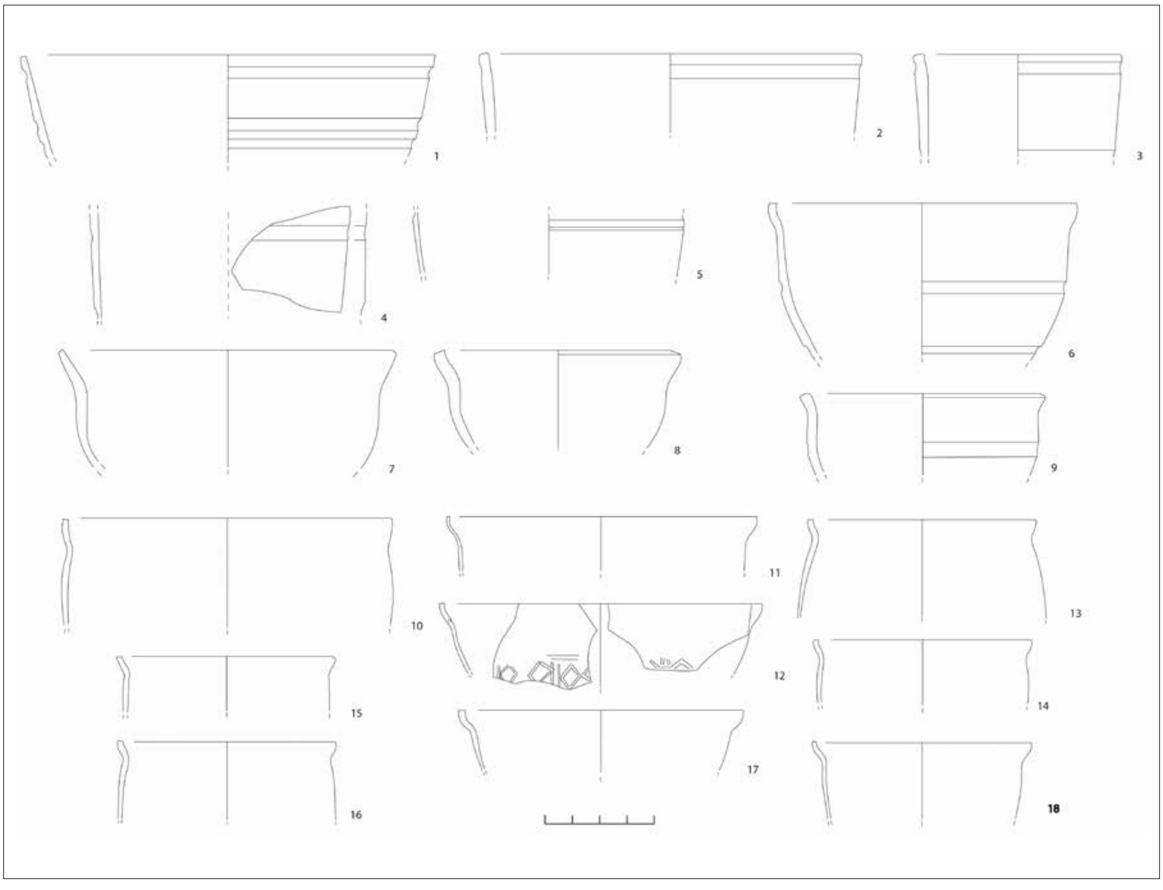

Fig. 5: Late Roman – Early Byzantine bowl and beaker fragments.

ples are derived from levels where the ceramic finds were mostly dated to between the 5th and 6th century.

Deep bowls or beakers with cut off rims can be classified into two groups; one with thick and heavy and the other with thin walls. All are typical for the Late Roman Empire and they were used continuously until around the 5th – 6th century. The first group (Fig. 5) consists of two different forms with both bearing horizontal grooves: cylindrical form (Fig. 5.2-5) and hemispherical form (Fig. 5.6-9). Zeugma samples of this type can be dated to between the 4th and 5th century, which is confirmed by ceramic finds at the relevant level.

Thin-walled bowls or beakers (Fig. 5.10-18) are another typical form of the Late Roman Empire that continued to be used until the 7th century.[18] However, Zeugma samples of this type have been dated to the 4th- 5th century.

Conical vessels

The vessels are shaped as true cones: whereas some forms end in a solid point, others have a flattened base that is too small for the vessel to stand on (Fig. 6.1-6). Conical vessels have been found in both the Eastern and Western Roman Empire.[19] Until now, Jalame is the only place where the production of these forms has been verified.[20] Conical vessels may have been identified either as beakers or lamps. However, in the Eastern part of the Empire, conical vessels were commonly used as oil lamps.[21] The character of the rims is an indicator of how these vessels were used; vessels with fire rounded rims would have been suitable for drinking whereas cut off rims may have been suitable for lighting.[22] Many conical vessels were decorated with grooves and generally with cobalt blue blobs. The blue blobs arranged on the body were inspired by a triangle, a flower or only appeared as a single big blob.[23]

In Zeugma, the vessels decorated with blue blobs were made of light green or colorless glass. This could indicate that some of the cut off rim fragments may belong to conical vessels similar to those discovered in Jalame (Fig. 6.7-11). The fragments from Zeugma come from the late 4th and 5th century levels of Villa A.

Goblets

Goblets are the most popular form from the Early Byzantine period.[24] Grosmann considers goblets to be the most common class of glass vessels at Byzantine Zeugma as fragments of as many as one hundred goblets were discovered during excavation work before 2005.[25] However, during excavation work at Villa A, only 15 folded feet fragments of goblets were found (Fig. 6.12-15).

Conclusion

The detailed work carried out on 160 vessel fragments from Villa A at Zeugma reveals that the majority of glass dates to the Early Byzantine Period while the remainder originates from the Early and the Middle Imperial Period. All these finds share similar typologies with the Eastern Roman glass groups in general.

In addition to the other archaeological data provided by excavation work, the overall study on the glass material from Villa A at Zeugma shows the strong impact of the Roman lifestyle in this relatively remote town in the East. Gradual progress in the tradition of using -and probably producing- glass at the site in the 5th and 6th century was proven by the concentration of finds belonging to this period.

18 These kinds of bowl are dated to the 7th century in Elaiussa Sebaste of Cilicia (Gençler Guray 2012, 295, fig. 3).

19 The differences between Eastern and Western forms are recognizable by the material used and the colour; for example, Syra-Palestinian vessels are generally light green or colourless and usually have a thick wall.

20 Weinberg 1988, 87-94; Weinberg and Stern 2009, 135-136.

21 Grosmann identified them as a beaker (Grosmann 2013, 245, fig. 80).

22 For detailed information see: Weinberg 1988, 87-94 and Weinberg and Stern 2009, 135-136.

23 Sazanov 1995, 335-338.

24 Stern 2001, 270.

25 Grosmann 2013, 239, fig. 58, G59-60.

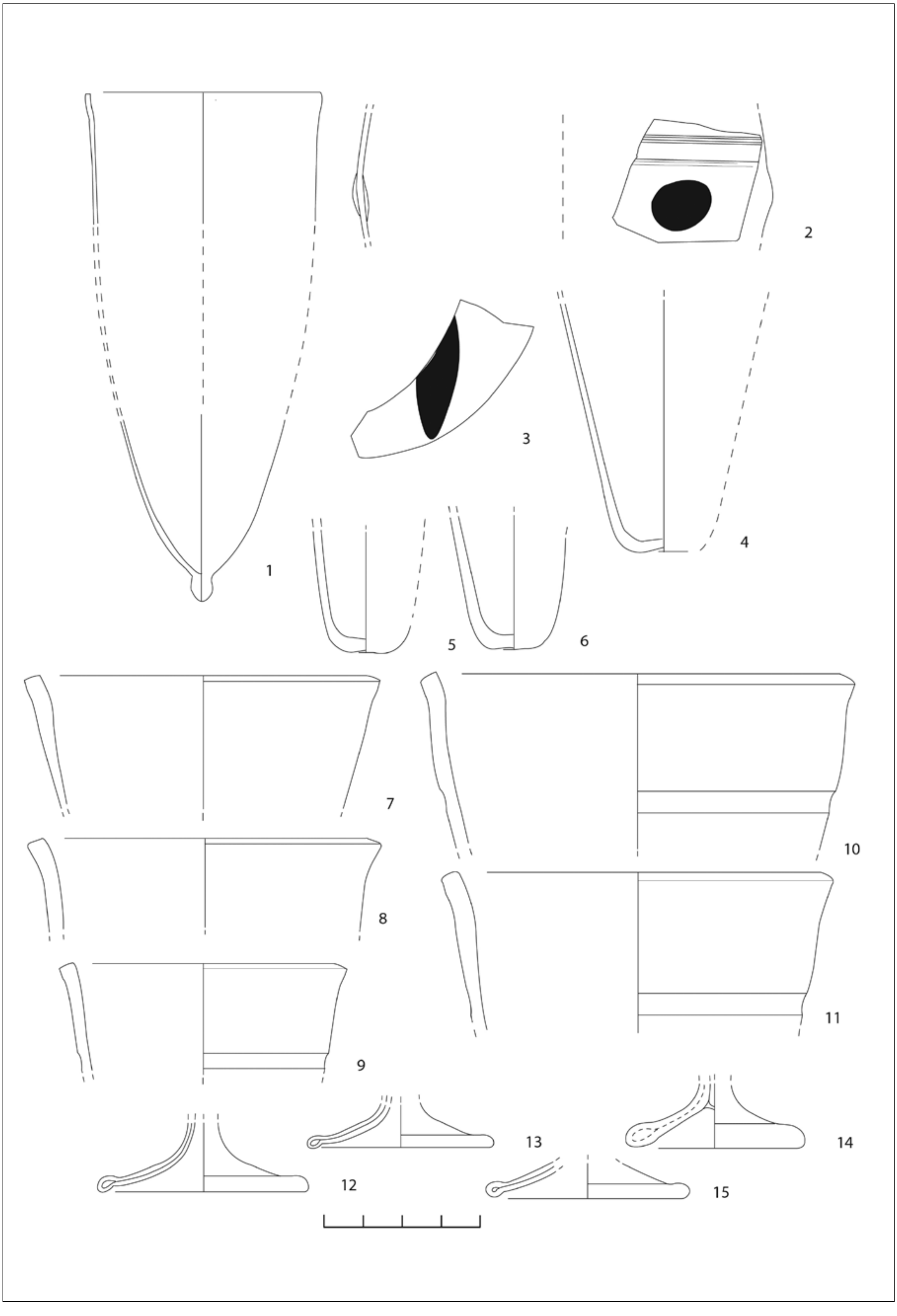

Fig. 6: Late Roman – Early Byzantine conical vessel and goblet fragments.

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SÉPULTURE À INHUMATION AVEC DÉPOSITION DE VERRES DE LAUMELLUM DE L'ANTIQUITÉ TARDIVE (PAVIE – ITALIE DU NORD). FOUILLES 2008

On présente ici une véritable sépulture de l'antiquité tardive, qui a été fouillée en 2008 par la Soprintendenza per i Beni archeologici della Lombardia (Milan) à *Laumellum*, dans l'actuelle province de Pavie (Lombardie, Italie du Nord, près du limite avec le Piedmont).

La localité de *Laumellum* correspond à un site de véritable importance archéologique du territoire de Pavie, qui à l'époque romaine fut une *mansio* tout au long de la rue de *Ticinum* vers la Gallia et acquiert une importance véritable dans l'époque de l'antiquité tardive et du haut moyen âge, quand fut le siège d'un *castrum* fortifié.[1]

Les recherches archéologiques à *Laumellum* par les Universités de Pavie et de Londres (à partir de 1984) et plus récemment par la Soprintendenza per i Beni archeologici de la Lombardie (2007-2008) ont mis à jour une véritable partie des fortifications du *castrum* et une portion des restes de l'ancienne ville.[2]

Le site fouillé (Villa Maria) fut fréquenté à partir de la première âge du fer, jusqu'au bas moyen âge, avec différentes fonctions: habitations, lieu de sépulture, activités artisanales.

Dans la phase de la fouille de la Soprintendenza per i Beni archeologici qui correspond à la tarde époque romaine, on a trouvé quelques sépultures, parmi lesquelles une inhumation intacte, à l'intérieur d'un édifice semi-détruit et abandonné. Il s'agit de deux individus (on croit deux femmes), qui ont été déposés en même temps, dans une structure en briques (Fig. 1) avec le toit plain et, à l'intérieur, deux niches sur les côtés longs : une partie du mobilier se trouvait en effet dans les niches (Fig. 2).

Ce qui est exceptionnel pour cet endroit du territoire est d'abord la présence si abondante de briques, tandis-que les défunts de la Lomellina étaient souvent déposés dans le nu terrain, ou bien avec deux ou quatre briques à former une simple caisse pour protéger les restes.

En plus, la plupart des témoignages funéraires de ce territoire se concentrent dans les deux premiers siècles de l'empire romain. Ici,

1 Maccabruni 1993; Maccabruni 1998, avec bibliographie précedente.

2 Invernizzi 2011; Invernizzi 2012; Muggia 2012.

Figs. 1-2 : La sépulture à inhumation pendant la fouille.

Fig. 3 : Le mobilier de la sépulture.

Fig. 4 : La niche avec la coupe en verre et la lampe.

au contraire, on se trouve évidemment dans un contexte de l'antiquité tardive (IVème siècle après J.-C.), datation qui est confirmée de la monnaie de Constant et du mobilier en céramique et en verre. La typologie de la sépulture, aussi comme la richesse du mobilier, indiquent qu'il s'agit de personnages de haut niveau social, qui appartenaient aux classes privilégiées.

Le mobilier funéraire (Fig. 3) est composé d'un service de table en céramique et en verre : un plat,[3] un gobelet et un pot en céramique commune (le gobelet est cylindrique et le pot est biconique, avec la lèvre évasée), deux coupes et une bouteille en verre.

En plus, on a récupéré un bracelet décoré à incisions circulaires[4] et un petit anneau en bronze, deux lampes en céramique[5] (l'une desquelles présente des évidentes traces

3 Inv. St 166952. Par comparaison voir: Nobile De Agostini 1994-1999, 305, no. 72, pl. VIII,5, plus grand (diam. 25 cm.), tombe 13, datée par une monnaie (*follis* de Constantin I) au deuxième tiers du IVème s.; 330, no. 285, pl. XIX,2 sporadique (plus grand). Caporusso 1991, pl. CI, no. 8.

4 Inv. St 166955. Voir: Nobile De Agostini 1994-1999, 321, no. 227, pl. XVI, 4, tombe 120, datée au IV-Vème s. Portulano et Amigoni 2004, 28, tombe 2: bracelet decoré, deuxième moitié du IV-début Vème s. (avec anneau, autre bracelet et poèle en céramique commune).

5 Lampe petite, inv. St 166953, voir: Portulano et Amigoni 2004, 29, tombe 4, type Buchi X c, daté à partir de la première moitié du IVème s. après J.-Ch.; Massa 1997, tombe 17, no. 58, type Buchi X c, à l'intérieure d'une niche, tombe datée d'un *follis* de Constantin (307-337); 105.
Lampe plus grande**,** inv. St 166954, voir: Lavizzari Pedrazzini 1990, 167, no. 2e3d, de Cremona (L. Passi Pitcher), type Hayes 2B, Vème s.; voir aussi, pour la forme: Deneauve 1974, type VIII d (III-IVème s. après J.-Ch.), pl. XCII.

Fig. 5a : Les trois verres du mobilier funéraire.

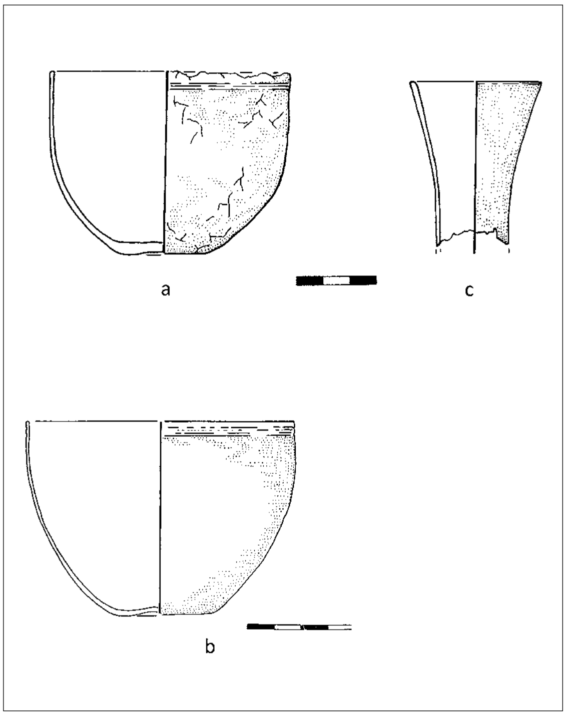

Fig. 5b : Les trois verres du mobilier funéraire (dessins: Eva Reguzzoni, Borgoticino, NO).

d'utilisation) et enfin, une monnaie attribuée à Constant II.[6]

Une coupe en verre se trouvait dans la niche (côté sud), avec la lampe finement décorée (Fig. 4); le bracelet au poigne d'un individu, les autres objets à côté, la lampe avec les traces de feu était en correspondance des jambes d'un des deux défunts.

La vaisselle en céramique est intacte, ainsi que l'une des deux coupes en verre, la deuxième coupe et la bouteille en verre sont cassées : en effet elles sont tombées au-dehors de la niche nord, ou étaient placées en origine.

En particulier pour les verres (Fig. 5), il faut remarquer qu'il s'agit de :

deux bols apodes type Isings 96a[7] (Fig. 5b: a,b) en verre verdâtre, soufflé, avec la lèvre coupée, la panse ovoïde et le fond aplati et légèrement concave. Sur la surface extérieure elles présentent des lignes finement incisées;

une bouteille apode type Isings 104b[8] (Fig. 5b: c) en verre verdâtre aussi, soufflé, avec l'embouchure évasée, tronconique, et la lèvre découpée au ciseau; le corps, maintenant en plusieurs petits fragments, est globulaire, apode, avec le fond aplati.

Le verre n'est pas de haute qualité, il présente la typique couleur verdâtre, qui est due à la présence d'impuretés de fer à cause d'un mauvais procès de décoloration, et plusieurs bulles évidentes, témoignage d'un travail peu raffiné. On doit remarquer qu'il s'agit de la vaisselle de table la plus courante dans le monde romain à l'époque de la fin de l'antiquité.

Pour rester dans la région lombarde, par comparaison on peut mentionner une sépulture fouillée à Milan, dans la nécropole de l'Université Catholique, dont le mobilier présente une coupe et une bouteille du même type et aussi une monnaie : elle est attribuée au III-IVème siècle.[9] En plus, le mobilier d'une autre différente sépulture de la nécropole, datée au IVème siècle.[10]

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6 Inv. St 166959. Roma Imp.; Constant II (avant 350 d.C.); monnaie de Rome (?); AE *Follis*. Bibliographie générale: RIC VIII, 264, no. 188. Merci à Ermanno A. Arslan pour l'interpretation de la monnaie.

7 Inv. St 166957 (tab. 1, a). H cm. 6,9; diam. lèvre cm. 9; diam. fond cm. 4,5; épaiss. cm. 0,18; Inv. St 166949 (tab. 1, c). H cm. 7,2 ; diam. lèvre cm. 10,15; diam. fond cm. 4,25; épaiss. cm. 0,16.

8 Inv. St 166958 (tab. 1, b). H cons. cm. 6,5; diam. lèvre cm. 5,26 ; épaiss. cm. 0,05-0,23

9 Sannazaro *et al.* 1998, 82-86, tombe 3600, à inhumation, avec bouteille déposée dans une niche ; pl. XXII, 1-2.

10 Tombe à inhumation 2136, avec pot en céramique commune, coupes et bouteille en verre (Sannazaro *et al.* 1997, 149, 188-189; Sannazaro *et al.* 1998, 88-93, fig. 30; Sannazaro ed. 2001, 206, pl. 6,3;).

Les mêmes typologies sont attestées à Como, dans les fouilles de via Benzi,[11] à Pioltello, tout près de Milan,[12] à Ostiglia (province de Mantoue, Lombardie orientale),[13] à Brescia et à Verona.[14]

Dans l'Italie nord-orientale, plusieurs exemplaires des mêmes typologies de bouteilles et de coupes se trouvent aussi, par exemple, à Aquilée.[15]

Même dans la partie la plus occidentale de l'Italie du Nord, on trouve ces typologies de verres caractéristiques de l'antiquité tardive.[16]

Pour conclure, l'analyse et l'étude de ce contexte mettent à jour les connaissances sur la Lomellina vers la fin de l'empire romain, car en effet on connaît assez peu de mobiliers funéraires qui datent après le II^{ème} siècle après J.-C. et en particulier - jusqu'à ce moment - on n'a jamais récupéré des sépultures avec des verres de l'antiquité tardive. Le fouilles menées par l'Université de Pavie à *Laumellum*-Villa Maria (1986-1991) ont révélé - dans l'habitat - une faible présence de verres de l'antiquité tardive, avec quelques exemplaires de coupes type Isings 96 et 117 et de gobelets type Isings 106 et plusieurs exemplaires de verres à pied (type Isings 111).[17]

Comme souligne E. Roffia,[18] il faut remarquer que dans la partie centre-occidentale de la Cisalpine, à l'époque romaine tardive, les verres sont assez peu répandus dans les mobiliers funéraires par rapport aux deux premiers siècles de l'empire romain et leur qualité est bien plus courante. Entre la fin du III^{ème} et le début du IV^{ème} siècle apr. J.-C. on note toutefois que les verres reprennent à être diffusés, mais avec un répertoire des formes assez limité et seulement dans les mobiliers les plus riches, comme on peut relever à *Laumellum*.

Dans le cas du mobilier qui fait l'objet de cette recherche, il s'agit de verres communes, mais la structure particulière de la sépulture, aussi comme la générale richesse du mobilier n'ont pas de parallèles, en cette époque, dans la Lomellina et indiquent l'appartenance à personnages d'haut rang.

11 Uboldi 2005, pl. X, 1 ; XI, 1 ; XII, 3.

12 Lavizzari Pedrazzini 1990, 284-286, no. 4e3a (A.Ceresa Mori). Tombe à inhumation 'à sarcophague' de la fin du IV^{ème} s. (avec 21 monnaies datées entre 324 e le dernier quart du IV^{ème} s.); dans le mobilier: plat, amphore, pots et autre vaisselle en céramique commune, coupe type Isings 96 et bouteille type Isings 104.

13 Roffia 1990, 398-400, no. 5d8a, tombe 8, inhumation datée au IV^{ème} s., avec bouteille type Isings 104b, bouteille type Isings 101/133, gobelet en verre et spatule en bronze.

14 Roffia 1996. Par *Brixia* (début IV^{ème} s.) et Verona (V-début VI^{ème} s.) il s'agit de contexts situés près de la zone du *Capitolium* de la ville ancienne.

15 Mandruzzato et Marcante 2005, 79-80, cat. nos. 130, 131, 133; 99, cat. nos. 250-251.

16 Par exemple à *Augusta Praetoria* - Aoste, nécropole de Saint-Martin-de-Corléans, tombe 16, datée à la fin du IV^{ème} s., inhumation avec plat en pierre ollaire, perle en verre et bouteille type Isings 104b. Voir : Lavizzari Pedrazzini 1990, 291, no. 4e.4.e.1b (R.Mollo Mezzena).

17 Diani, à paraître.

18 Roffia 1990. Nouveaux donnés sur la diffusion du verre dans la Cisalpine, à partir du II-III^{ème} s., se trouvent dans Roffia 2002, avec bibliographie précédente. Sur ce thème, voir aussi : Roffia 1996; Roffia 2011.

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PEROVIĆ Šime

PRESENT STATE OF RESEARCH OF THE LATE ROMAN GLASS FINDS IN DALMATIA

A long tradition of study of ancient glass from the Dalmatian region has provided us with an opportunity to create an image about the basic forms of glass artefacts, which appeared during the first centuries of the Empire.[1] Late antique and early medieval glass production in this part of the Croatian coastal area is not well known. In the first place, it is a consequence of poorer distribution and frequency of glass objects at the sites, which was caused by the reduction or complete cessation of local production as well as changes in the funerary rituals starting with the Early Christian period. There are three important components regarding late antique glass production: the first is represented by glass finds excavated at necropolises, which provide continuity from antiquity to the Middle Ages; the second consists of objects from the settlement layers of a significant number of explored early medieval sites, some of which bear features of ancient tradition (Nin, Bribir...);[2] while the third component comprises of finds from the research of early Christian objects or complexes.[3]

This paper will deal with the present state of exploration of glass finds at late antique and early medieval sites in Dalmatia, and the most recent, unpublished material will be presented, supplementing images of late antique glass production and imports to the eastern Adriatic coast (Fig. 1). The general development of glass production on the eastern Adriatic coast seems to have followed that of ancient and early medieval production in Italy and other provinces of the Empire. After exceptional progress and active local production during the imperial period, this line of development was characterized by general economic decline from the first half of the 4th century, which contributed to the cessation of glass production in the region of Dal-

1 Fadić 2009, 405-416.

2 Belošević 1979, 87-132; Delonga 1995, 91-94.

3 We primarily refer to Gata, Srima near Šibenik, Putalj near Kaštel Sućurac, Crkvina in Galovac near Zadar, Jeličić-Radonić 1994; Fadić 1994, 213-226; Gunjača 1985; Fadić 2005, 220-257; Fadić 1993, 61-75; Fisković 1983, 65-80; Belošević 1993, 136-140.

Fig. 1: Map of the sites with late antique glass finds in Dalmatia.

matia, as indicated by the current exploration of late antique and early medieval sites.

Problems affecting glass industry in the final phases of antiquity across the Empire are evident as anti-recession measures are well illustrated by the abolishment of taxes for glassmakers, which was carried out by Constantine (306-337). Owing to this measure, the glassmaking industry survived during the transition from the 3rd to the 4th century.[4] The survival of glassmaking workshops seems to be related to the production of forms based on the precise criterion of functionality as a counterpart to ceramic tableware,[5] and alongside the production of new forms, such as conical lamps and other oil lamps.[6] The 4th and 5th century are characterized by relatively intensive glass production with quite reduced forms and typological similarities, typical of the workshops in northern Italy and Gallic-Rhine workshops in the western part of the Empire as well as centers in Corinth[7] and in the eastern Mediterranean. This production was characterized by the progressive deterioration of the quality of basic raw materials, the coloration of which was poorly controlled, while production was marked by rather sloppy glass objects made of unpurified glass mass, which was often dappled with greenish or yellowish belts, pronounced air bubbles and traces of stretched molten glass. These objects are primarily related to kitchen and tableware that have unworked, poorly smoothed rims and simple undecorated walls; alternatively, they can be decorated with thin lines incised on the wheel.[8] It should be noted that during the transition from the 5th to 6th century, production changes on a technological and typological level took place: more higher quality raw material was used and glass objects from the early Roman period were recycled.[9] Old forms were abandoned and pedestalled beakers (goblets) were promoted as well as bottles with simple globular forms and necks, and with rims that had been rounded and thickened by fire. This change in quality is evident in all European countries in the Mediterranean and further afield, with rare exceptions of regional

4 Harden 1936, 41; Mommsen 1905, Codex Theod. 13, 4, 2.
5 Stiaffini 1994, 207; Sternini 1995, 243-289.
6 Uboldi 1991, 90-91; Uboldi 2001, 153-171.
7 Davidson 1940, 297-326.
8 Stiaffini 1994, 207-219; Uboldi 1993, 271-273.
9 Sagui 1993, 131.

Fig. 2: Glass finds from the Smiljanovac site.

or more elite productions that characterize, for example, Lombardian necropoles and the glass-making style of Merovingians and Franks.[10]

Products from the aforementioned workshops in the eastern Mediterranean and western late antique production centers can be found in certain numbers at late antique sites in Dalmatia. Considering the typology of these artifacts, five groups of objects can be distinguished: bottles, beakers, pedestalled beakers – goblets, oil lamps and window panes (*oculus*).

Images of the finds from late antique graves are considerably improved and illustrated by grave goods recently found in Solin. In particular, during 2011, archaeological excavations of a large Roman cemetery at the site of Smiljanovac in Solin, revealed more than a thousand graves dating from the 1st century BC to the Migration Period i.e. the destruction of ancient Salona. About ten graves could be ascribed to the Germanic (Gepidic) horizon.[11] Finds from the late antique layer of this necropolis are particularly interesting. The assemblage of about sixty glass grave goods stands out among other finds, of which twenty intact examples survive. The typology of these finds is mostly related to beakers (two examples) and standard forms of globular bottles (twenty-two integral examples). This group of late antique bottles is most frequently represented by bottles with characteristic squat bodies and cylindrical necks that end in a funnel (Fig. 2). Fewer examples (approximately a quarter) refer to smaller bottles with thin cylindrical necks and thickened rims. Both groups can be dated to the late 3rd and 4th century. Bottles were mainly made by using the technique of free blowing, and on several examples, mold blowing was combined with free blowing in order to achieve a slightly twisted ribbed ornament on the body. Analogies for these bottles, particularly forms with cylindrical necks and widely everted rims, can be found in the eastern Mediterranean (Syria, Palestine, Egypt, Greece and Cyprus), but similarities can also be drawn with specimens in Italy, Panonnia and Dalmatia.[12] As some authors have already noticed, the abundance of this type with a cylindrical neck and everted rim, and the lack of bottles with funnel-shaped necks that are more frequent in the west, may suggest there were more intensive commercial relations between Dalmatia and the eastern and southern regions of the Empire in late antiquity.[13] The discovery of a small double

10 Uboldi 1993, 272.

11 Uglešić 2011, 183-190.

12 Auth 1976, 123; Calvi 1968, 145-149.

13 Buljević 1994, 259.

Fig. 3: Double glass bottle.

glass bottle at the same site of Smiljanovac is also exceptional. This is a derivative of ancient double glass bottles *dylecythos,*[14] which were not made by the separate production of two bottles that were subsequently joined, but rather were freely blown to form a squat bottle that was then pressed while still hot so that its belly was turned into two chambers (Fig. 3).[15] Accordingly, this object may be called *pseudo-dylecythos,* particularly because this procedure resulted in a double body vessel, not applied to the neck. This vessel is dated to the 4th century and it definitely represents a late antique reminiscence of ancient models.[16] Except for this most important find from Smiljanovac, discoveries of late antique glass from the necropolis of Salona are also very important.

Finds from settlement layers also exhibit a similar typology of globular bottles with tubular necks or squat bottles with funnel-shaped necks. However, these finds are usually exceptionally fragmented and incomplete.

Definitely worth noting are finds from rather old systematic excavations in Nin and Bribir.[17] At these sites are standard late antique forms of beaker and squat bottles with cylindrical necks and everted rims, as well as bottles with funnel-shaped necks. Recent finds are mostly related to intervention research in the old city zones of Nin, Zadar, Solin and Split. According to information from the Archaeological Museum in Zadar, recent research near the Church of St. Dominic in the town unearthed a number of fragmented glass finds in the late antique layer. Similar finds, including a glass oil funnel-shaped lamp, were identified during research of Fort Sokol in Konavle, near Dubrovnik.[18] Interesting finds were also unearthed through recent research of a residential complex in ancient Cissa, known as the present-day settlement of Caska on the island of Pag.[19] Fragments of a glass beaker decorated with a honeycomb ornament are particularly important. This is a very rare type of beaker with a flat base, rounded body and slightly everted rim that was made using a mold-blowing technique. They are often interpreted as a vessel type that is indicative of higher social classes and thus provide information for the site of Caska in a social context. Analogous examples can be found in the western provinces of the Empire[20] that are dated to the 4th century.

Special attention in the study of ancient glass should be paid to finds from the research of early Christian churches. Objects at Gata, Srima near Šibenik, Putalj near Kaštel Sućurac and Crkvina in Galovac, near Zadar have already been systematically excavated. All excavations confirmed that early Christian objects in Dalmatia abound in glass material, particularly typological finds related to the Christian cult, such as conical oil lamps with three handles, pedestalled

14 Morin-Jean 1923, 66; Calvi 1968, 76; Ravagnan 1994, 134.

15 Dimensions of this small bottle are h=14.1 cm, w1=11.1 cm, w2=6.4 cm, rim diameter=5.5 cm.

16 *Dylecytos* with two chambers are usually dated from the 1st to the 3rd century. Isings 1957, 31-32.

17 Belošević 1979; Delonga 1995.

18 Topić and Peković 2012.

19 Kurilić 2011, 405-413.

20 We know of examples from Köln, Trier, Slovenia and Gata, near Omiš in Dalmatia: Isings 1957, 133; Knez 1969, 107; Fadić 1994, 220.

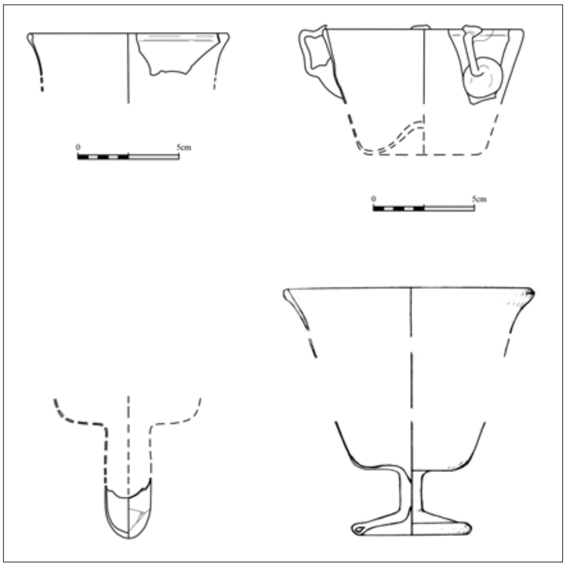

Fig. 4: Drawings of four types of glass vessels from Podvršje: a) undecorated beaker; b) conical oil lamp with three handles, c) footed beaker (goblet), d) funnel-shaped oil lamp (drawing J. Belevski).

beakers (goblets), funnel-shaped oil lamps and undecorated beakers.

An identical typology was also determined at the site of Podvršje, where an early Christian complex of a double basilica from the 5th to the 6th century was found in the period from 2002 to 2006, an undertaking organized by the University of Zadar (Fig. 4).[21] Among more than 700 glass fragments, only 40 represent parts of several types of glass vessel (beakers, oil lamps and goblets), while the rest pertain to fragments of flat window pane made by casting.[22]

The greatest number of finds from Podvršje can be ascribed to non-decorated, more or less conical beakers. Their main characteristics include a distinctly conical concave base and a conical body with thickened rim. They usually have thick walls, and easily recognizable traces of stretched molten glass. They are mostly bluish-greenish, and only rarely do they appear in olive-green and brown.[23] They were used for lighting and for other kinds of everyday use.[24]

Glass lamps in the shape of a cup or small bowl have a concave base, which gradually grows into a rounded or conoidal recipient.[25] They usually have three small handles attached to the walls and fixed on the rim.[26] They were very frequent in the eastern Mediterranean, but can also be found on the Apennine Peninsula and elsewhere in the west. They were found at many early Christian sites in Croatia (Srima near Šibenik, Galovac near Zadar and Putalj near Kaštel-Sućurac).[27] Probably all ten examples of small handles from the site Podvršje – Glavčine belong to this type of glass oil lamp. The first examples of this type of oil lamp are dated to the 4th century (specimens found in Gerasa, at a Mithraeum of St. Prisca in Rome, and Bulgaria), and similar products existed until the 7th century. Oil was poured into a wide vessel into which a floating wick was thrown. They may have been used on a flat surface or they could have been hung on a bronze chain fixed with three handles. The reconstruction of this manner of suspension is well illustrated by the finds of bronze elements for suspension from Crkvina in Galovac[28] and at a church in Gata.[29]

One fragment belongs to a funnel-shaped glass lamp with a wide body (beaker-shaped) and a narrow hollow cylindrical ending. This type of glass lamp may have functioned as an independent lighting object with accompanying suspension or was part of a hanging metal lamp (*polycandelon*). The first appearance of such lamps is related to Palestine i.e. the church of St. John the Baptist in Samara, whose examples were dated to the 5th and 6th century. Similar dating (from the 5th to the 7th century) was attributed to examples from Palestine, Gerasa and Bulgaria.[30] This type of oil lamp was used for a long time up until the 14th century. Like the previous example, it was based on burning oil through a wick in a wide recipient. Funnel-shaped oil lamps were found in Croatia; specifically on Crkvina in Galovac, at the church of

21 Uglešić 2009, 139-148.
22 Perović 2012; Cagnana and Zucchiatti 2004.
23 Calvi 1968, 170-171; Fadić 1994, 217.
24 Fadić 1994, 217.

25 Isings 1957, forma 134, 162.
26 Duval and Jeremić 1984, 131.
27 Fadić 1994, 217-218; Belošević 1993, 121-142; Fadić 2005, 222.
28 Belošević 1993, 138.
29 Fadić 1994, 218-219.
30 Fadić 1994, 215.

Fig. 5: Biconical oil lamp with three handles from Podvršje.

Fig. 6: Glass oil lamp from the site of St. Martin in Pridraga.

St. Juraj in Putalj, in Lovrečina on the island of Brač, and in St. Ivan, Zadar.[31]

Two fragments of a foot of a glass pedestalled beaker – goblet were also found in Podvršje. They usually consisted of a round foot, cylindrical stem and conical or rounded recipient. On the basis of more recent research, these are common finds at early Christian sites in Croatia (Srima near Šibenik, Galovac near Zadar and Putalj near Kaštel-Sućurac).[32] They were used as votive lights or perhaps as goblets in the liturgical ritual.[33] They are considered a Mediterranean type of glassware and originate from the 3rd to the 4th century onwards.[34] They continued to be used throughout late antiquity until the early Middle Ages.

A quite exceptional and rare example of a glass product was found in Podvršje in addition to the finds described: an oil lamp with a biconical body and three (broken) handles placed above the vessel rim (Fig. 5). The example from Podvršje does not have preserved handles, but impressions on the rim are easily recognizable at the points where the handles were fixed. This type of oil lamp may have been suspended on bronze chains or simply laid on a flat surface. It is probable that the development of this type of lamp took place under the direct influence of small models of conical lamps with handles that reached from the lateral walls to the rim (earlier described as type b). Despite this fact, it seems that oil lamps of this type were not present at the sites in the eastern Mediterranean. Similar examples were found at the site of San Vincenzo in Volturno,[35] at the site of Luni within the layers of the 6th century[36] while one specimen of unknown provenance is kept in Milano (Civiche Raccolte Archeologiche e Numismatiche),[37] dated to the period between the 5th and the 6th century. Presently, it seems that the dominant distribution of this type of glass artifact took place in the wider region of central and southern Italy. This fact indicates that the find from Podvršje should be interpreted as a product of Italic, not eastern workshops.

Apart from a complex in Podvršje, several more early Christian churches were explored in the broader Zadar region. The churches of St. George in Kruševo, St. Martin in Pridraga and Sukošan, and St.Victor in Telašćica were explored in collaboration with the Archaeological Museum in Zadar.[38] All sites revealed mostly fragmented glass finds, such as pedes-

31 Belošević 1993, 122; Fadić 1993, 136; Fadić 1994, 216-217.

32 Fisković 1983, 65-80; Fadić 2005, 228-229; Fadić 1993, 61-71; Belošević 1993, 121-142.

33 Fadić 1994, 213.

34 Turno 1989.

35 Stevenson 1988, 198-209; Stiaffini, 1991, 182-183.

36 Roffia 1981-83, 214-215.

37 Roffia 1993, 182.

38 For information about these recent excavations, I am grateful to Jakov Vučić, curator at the Archeological Museum in Zadar.

talled beakers and oil lamps. The discovery of a fragment of an oil lamp that was unearthed during excavations at the church of St. Martin in Pridraga is particularly precious. It was reconstructed for a renewed permanent display at the Archaeological Museum in Zadar (Fig. 6).

Generally, new research is supplementing the interpretation of late antique glass finds in Dalmatia. The development of glass production on the eastern Adriatic coast in light of the existence of local production since the imperial period as well as exceptional additional progress, is characterized by a general decline of the economy from the first half of the 4th century. Thereafter, glass production was reduced and was terminated in many ancient centres, including those on the eastern Adriatic coast. However the need for glassware, utensils in churches and so forth was not completely neglected. Rather, it was substituted with imports from surviving late antique glassmaking centres located from workshops in northern Italy, Gallic-Rhine workshops in the west of the Empire, as well as centres in Corinth and the eastern Mediterranean.

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GLASS IN MILAN FROM ROMAN TIMES TO LATE ANTIQUITY

The picture of Roman Milan and its social history is becoming increasingly detailed, pieced together from the finds of a recent archaeological excavation and fresh analysis of older records. The material drawn from more recent excavations, as well as older discoveries that have since been packed away in warehouses, helps patch together a collage of the major urban centre of Milan. Its central position on the river plain to the north of the Po made it the focus of important events and intense industrial activity, thereby attracting people of different cultures as well as resources.

Glass from burial sites

Glass finds from Milanese contexts come from both burial grounds and settlement sites (Fig. 1).

The Milanese burial sites were the first focus of attention and the analysis of its known finds was published thanks to M. Bolla's work in 1988.[1] Back then, most of the identified finds were dated to a period between the 1st and 2nd century AD (Fig. 2) while there was an almost total lack of evidence for the later Roman period.[2]

Subsequent excavations managed to fill in the gaps. The excavations in the courtyards of the Catholic University (1986-2004), close to the Basilica Ambrosiana ad Martyres, uncovered several hundred graves. These were distributed in two chronological phases: a lesser group originating from a period between the end of the 1st and 2nd century,[3] and a larger burial area dated to a period between the 3rd and 5th century.[4] The presence of glass containers at several late Roman burial sites confirmed that in Milan too, as in virtually all of the Roman Empire and especially in the 4th century, there was a tendency to include glass vessels among grave goods, at times even replacing pottery vessels (Fig. 3).

1 Bolla 1988.

2 Bolla 1988, 170 ss.

3 Airoldi 2003.

4 Sannazaro 2001; Paternoster 1999; Paternoster 2001; Uboldi 2011a; Uboldi 2011b.

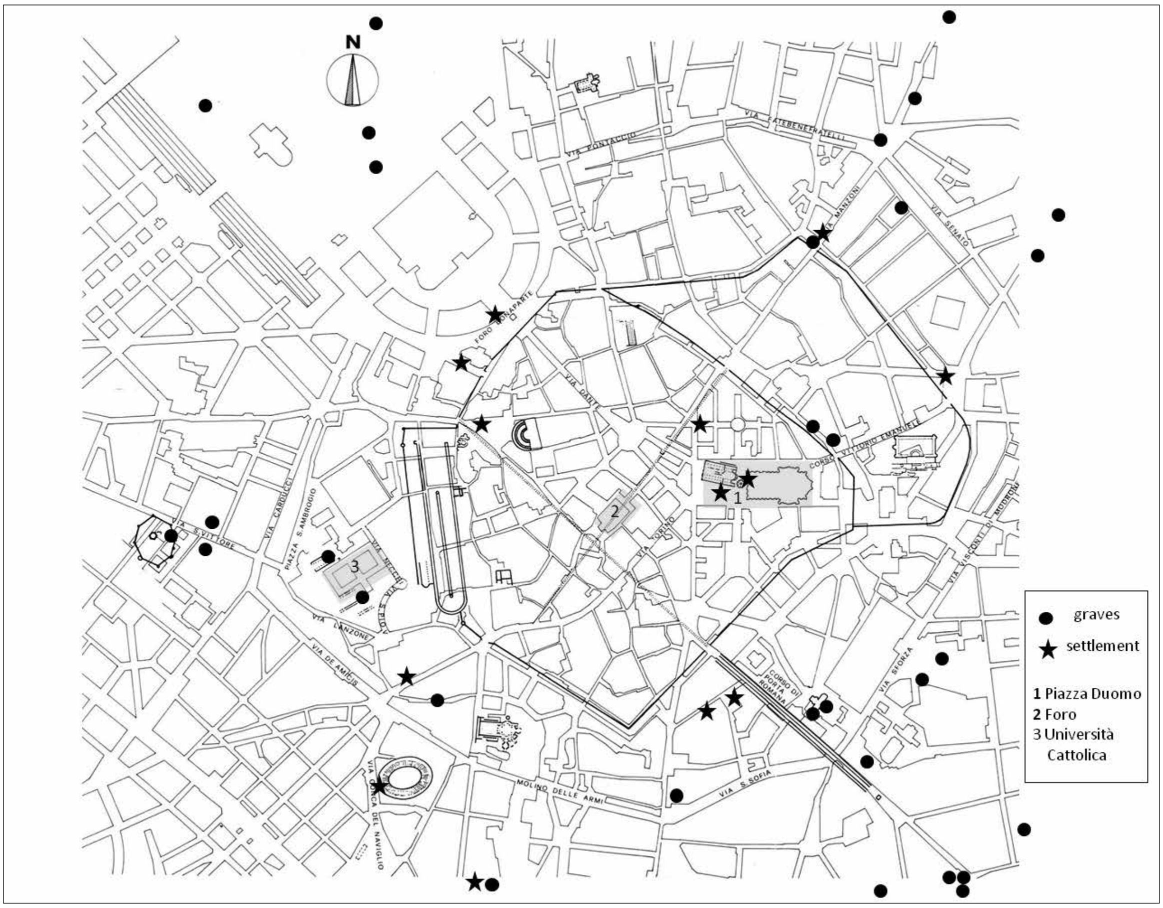

Fig. 1: Map of Roman glass finds in Milan.

More recent excavations have focused on other burial sites,[5] with various study projects still underway. The finds from the burial grounds identified in Corso di Porta Romana 47[6] are currently being investigated (A. Marensi). These can be tied to the burial ground of the Policlinico Hospital, which already appeared in archaeological documents by the end of the 19th century[7] and was again, subject to excavation from 2007-2008. I am currently studying glass finds discovered in a group of graves, following the excavation of a block between Via Madre Cabrini and Corso di Porta Romana[8] as well as the glass balsamaries from graves excavated in Corso Venezia 37.[9] This is an area of the city already rich in burial finds.

In relation to graves from the 1st and 2nd century AD, the plethora of documents reflects the prevalence of balsamaries, followed by bottles, both Isings 50 and Isings 55a. Sometimes more than one Isings 55a conical jug is placed in the same burial: for example, four samples were found in a cremation burial excavated at the end of the 18th century in the area of Parco Sempione,[10] four in the Via Madre Cabrini Grave 8, three in Grave 60 and two in Grave 21 at the Policlinico burial site.[11] It would appear, in fact, that this represents the most typical vessel found among grave goods from the second half of the 1st to the be-

5 *Soprintendenza per i Beni Archeologici della Lombardia. Notiziario* and unpublished data from the Soprintendenza Archeologica della Lombardia.

6 *Soprintendenza per i Beni Archeologici della Lombardia. Notiziario* 1999-2000, 177-179

7 Bolla 1988, 73-100.

8 *Soprintendenza per i Beni Archeologici della Lombardia. Notiziario* 2008-2009, 163-170.

9 *Soprintendenza per i Beni Archeologici della Lombardia. Notiziario* 2007, 145-150.

10 Bolla 1988, 155-157.

11 A. Marensi, pers. comm.

Fig. 153. Disegno di sepoltura a incinerazione in cassetta di serizzo rinvenuta nel 1894 a Milano, in piazza Duca d'Aosta, e oggi perduta (fine del I secolo d.C.) (da G. CAROTTI, *Relazione sulle antichità entrate nel Museo Patrio di Archeologia in Milano (Palazzo di Brera) nel 1894*, in "Archivio Storico Lombardo", XXII, 1895, p. 468).

Fig. 2: Drawing of cremation burial with glass vessels as grave goods. From Milan, Piazza Duca d'Aosta, 1894 (After Bolla 1988, pl. XXXII).

ginning of the 2nd century AD. The same importance can be attributed to the purple glass jug with white spots and globular body from the Via Manin burial ground (unfortunately lost)[12] and the small jug with a spouted rim Isings 56b from Grave US 8323 at the Catholic University site.[13]

It has been documented that only a few burials, dated to between the second half of the 1st and the first half of the 2nd century AD, have the practice of using a glass jar of Isings form 67a as a cinerary urn: an example found in via Buonarroti[14] was covered by the bottom of a dish Isings 48 used as a lid with its sides deliberately removed; a second example, from via Lorenteggio, has now been lost and is of dubious identification;[15] and a third example is now known from via Calatafimi.[16] Various glass accessories include some cups Isings 17 (Zarte Rippenschalen),[17] beakers Isings 32,[18] Isings 12[19] and Isings 35,[20] a type of beaker Isings 33,[21] other cups Isings 41/42,[22] and the small jar Isings 68.[23]

The finds - thought to originate from the middle to late Roman period - were previously represented by just two bottles Isings 104 and

12 Bolla 1988, 49, pl. XVI.
13 Airoldi 2003, fig. 11, 2.
14 Bolla 1988, 153, cat. 57/2.
15 Bolla 1988, 152.
16 Unedited. *Soprintendenza per i Beni Archeologici della Lombardia. Notiziario* 2007, 111-119.

17 Apart from UC, an Is. 17 complete from Via Manin (Bolla 1988, cat. 7/92, pl. XVI) and another from Via Croce Rossa (Bolla 1988, 35).
18 The specimen from the S. Vittore enclosure, "beneath" Grave 47 (Bolla 1988, cat.55/5, pl. CVIII-CIX).
19 Policlinico grave 186 (A. Marensi, pers. comm.). It looks like an Is. 12/29 as does the beaker in the drawing of the grave in Piazza Duca d'Aosta (Bolla 1988, R10, pl. XXXII).
20 Pl. 51 Policlinico (A. Marensi, pers. comm.)
21 Cemetery of Via Madre Cabrini, see Uboldi, in this book.
22 Via Madre Cabrini, see Uboldi, in this book.
23 From Via Manin, Bolla 1988, cat. 7/86, tav.XIV, and from Via Commenda, "Amphora grave", Bolla 1988, cat. 25/31, pl. LXVIII.

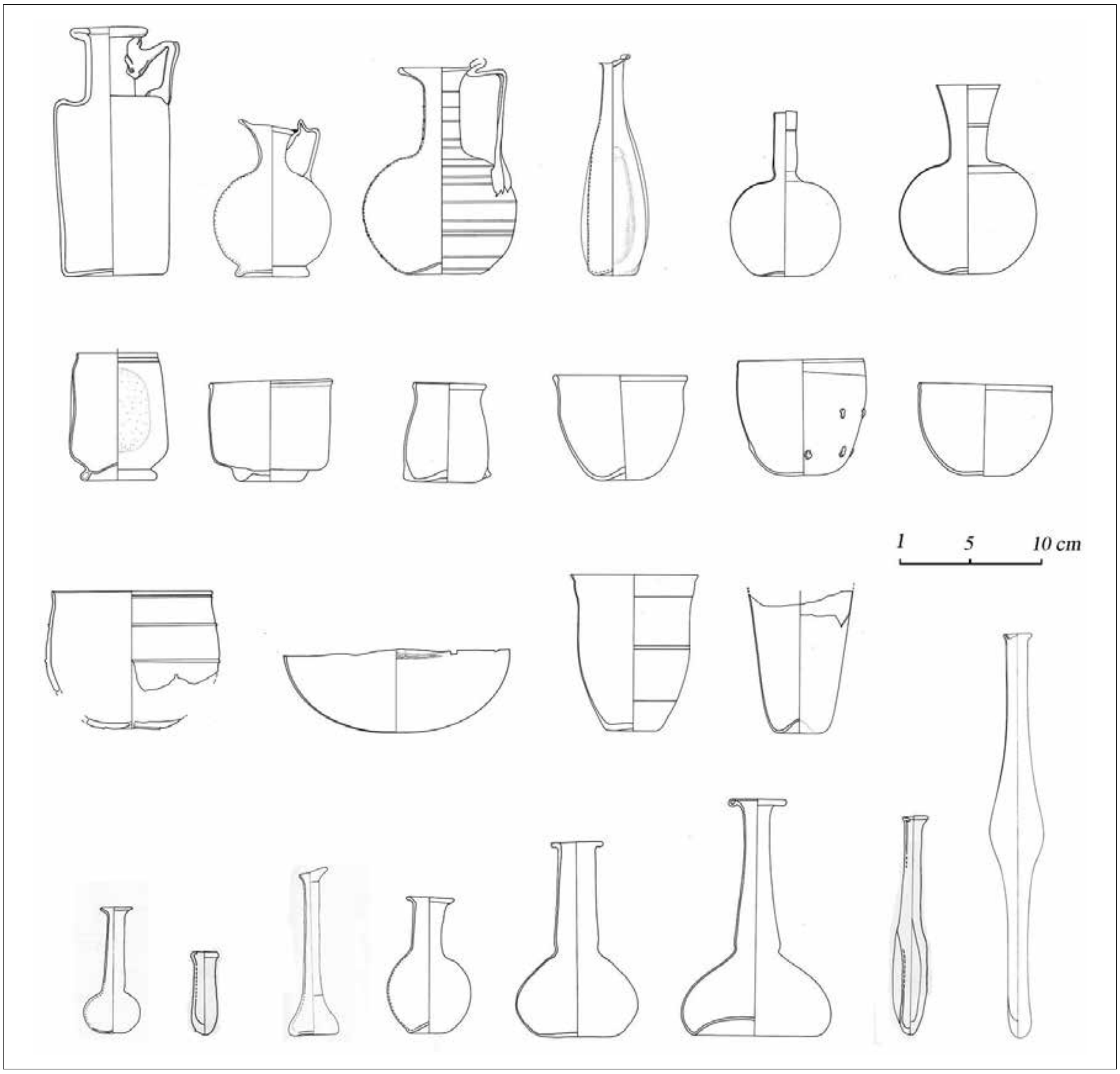

Fig. 3: Glass vessels from the graves of the burial ground excavated in the courtyard of Catholic University of Milan.

a jug with a handle Isings 126[24] from earlier excavations. However, finds from the Catholic University site have provided new information. Thanks to the dating of grave goods and the recovery of various coins from the layers associated with the first systemization of the area, the original layout of the burial ground can be dated to between the end of the 2nd and the first decades of the 3rd century AD. Grave finds from this period include a glass beaker Isings 35 with vertical sides that has been impressed with four depressions sitting on a ring base (Grave 3161); balsamaries with a crushed body and long necks, three of which are stamped on the bottom; and square bodied bottles. Of particular interest is the beaker Isings 85b, present in five sets of grave goods, and two probable votive deposits (Graves 1739, 2008, 5734, 7174, 7295; US 3214 and US 1614).[25] During the most intense period of use of the burial ground, from the first decades of the 4th century, glass vessels were almost exclusively designed to contain liquids probably associated with the rites of libation dur-

24 Bolla 1988, 174; Bolla 1992-93, 251-252.

25 It is almost certainly an Is.85b, and not an Is. 44, the fragment from Grave 47 in the S. Vittore enclosure (Bolla 1988, cat.55/6, pl. CIX).

ing the funeral ceremony: apart from a few balsamaries, there are also Isings 103 and 104 bottles as well as Isings 106, 96 and 116 beakers and cups. There are four large examples of spindle-shaped Isings 105-De Tommaso 57 vials, found almost exclusively in female graves. This vessel, believed to have contained essence, wine or liquefied food, is found fairly frequently throughout Northern Italy, including the Lombardy region.[26]

The equivalent of some of these finds can only be found in the central-European area or in the ancient Roman province of Pannonia. This could suggest that their origin lies in these regions of the Empire, from where they would have reached Milan through commerce or with their owners. These include a beaker/cup similar in shape to an Isings 96, but with a pinched decoration on the body (Grave 1545); a hemispherical cup embellished with a refined horizontal engraved ribbed decoration (Grave 3600); and an oval bowl from a child's grave with four feet attached when the glass was still hot (Grave 3587).[27] A long necked pear -shaped bottle almost certainly originated from the Rhine area. It is decorated with four depressions (Grave 5804) and finds its equivalent in examples from Cologne and Trier.[28]

Glass vessels from settlement

Though there are numerous excavations that have investigated the heart of the Milanese settlement and that have focused on some of the most important parts of the Roman city (for example, the forum),[29] most of the results are as yet unpublished. Material that has been published is derived from excavations carried out during the construction of some underground stations of Line 3 (Piazza Duomo, Via Tommaso Grossi, Via Crocerossa, Via Rugabella);[30] from excavations of the Church of S. Maria alla Porta, which uncovered the remains of Roman townhouses along the Decumanus Maximus;[31] and of those in Via Puccini,[32] the cloisters of the Monastery of S. Eustorgio,[33] Via Cesare Correnti and Via Conca del Naviglio.[34] The finds of M. Mirabella Roberti's excavations from 1962-63 around the cathedral and the ancient Baptistery are currently being studied. These will integrate data from the finds of the 1996 excavations around the Baptistery of

Fig. 4: Fragments of ribbed hemispherical cups (Is. 17), found in a dump layer on the Catholic University excavation.

Fig. 5: Mosaic glass foot of a ribbed bowl (variant of Is. 3), from the Catholic University excavation.

26 Uboldi 2011, 116-117.
27 Paternoster 2001.
28 Sannazaro *et al.* 1998, pl. XXII, 3.
29 *Soprintendenza per i Beni Archeologici della Lombardia. Notiziario* 1991, 114-117.
30 Uboldi 1991.
31 Uboldi 1986.
32 Ceresa Mori 1997.
33 Uboldi 2007.
34 Ceresa Mori 2004.

Santo Stefano, put on display during the exhibition "The city and its memory. Milan and the tradition of Sant'Ambrogio".[35]

Analysis is underway of glass finds from the 1992 excavation in Piazza Erculea.[36] The area in question lies immediately outside the Roman walls close to Corso di Porta Romana. The remains of a suburban district were uncovered, which, as it predates its construction, does not follow the orientation of the Roman road for Rome. This location was inhabited between the 1st and 3rd century and is distinguished by the presence of a residential area and a metallurgical industrial zone for processing bronze and iron.

Nevertheless, it is interesting how the Catholic University excavation has yielded the most abundant and interesting data. The excavation lay outside the walls of the Roman city. Prior to its transformation into a burial ground, the area was occupied by houses lying along the roads leading out of the city.

The finds from these deposits are mostly open forms of tableware, followed by containers (bottles, jugs and jars). As well as wares for everyday use, probably locally produced, there is a constant presence of superior wares, mosaic glass, moulded cups finished on a grindstone and engraved glass, all of which provide evidence of the flourishing commerce and wealth of Mediolanum in the imperial age.

The earliest forms, produced between the last decade of the 1st century BC and the beginning of the 2nd, are hemispherical cups, either smooth or with a flat ridged rim (forms Isings 1, 18, 2) in both monochromatic and mosaic glass. Typical for the 1st century AD are the Isings 3 cups (also in the footed variant, Fig. 4) as well as frequent examples of thinly ribbed Isings 17 hemispherical cups. One example was particularly interesting, found discarded almost intact in a dump layer at the Catholic University excavation site (Fig. 5).[37] There are several fragments of free-blown glass bowls and plates (forms Isings 41-49), the more refined of which are coloured cobalt blue or green sapphire glass. Analysis has also identified a number of fragments of a glass Isings 85b beaker or cup, typical for the 3rd century. This form spread rapidly from the Gallic and Rhine regions, where it seems to have been manufactured, into Northern Italy. During the same period, a similar type of glass was used to produce various broad-mouthed cups on an upright foot with a hemispherical body and flat edged rim, often engraved with a series of rice grain lozenges (type AR 82-84).[38] The frequency of these examples in our region[39] would imply that they were manufactured locally.

Engraved decoration, in the early and middle imperial period, tends to consist of parallel lines on the sides of beakers and cups or appears as a series of rice grain lozenges. However, the excavations at the Catholic University and Piazza Duomo have also brought to light some interesting decorated fragments depicting people that were probably imported.[40]

Closed vessels are mainly represented by bottles, both square and cylindrical (Isings 50 and 51); from the mid-1st century up until at least the 3rd century AD with the form Isings 103-104 and from the late 3rd to 4th century with Isings 120. The elegant single handled jugs were probably kept as refined tableware or fineware, some appearing in naturally coloured blue or green glass as well as finer deep blue or purple with streaks or spots, while some specimens were coloured yellow amber with white filaments to create a marble effect. These were probably manufactured in the Ticino or Po plains.

35 Lusuardi Siena *et al.* 1997, 48, fig. 15.

36 *Soprintendenza per i Beni Archeologici della Lombardia. Notiziario* 1992-93, 121-123.

37 US 4241, see Bordigone 2004-2005

38 Uboldi 1999.

39 Numerous examples are now known from Verona, Brescia, Angera, Calvatone, Como, Cividate Camuno and Trezzo d'Adda, just to mention those from Lombardy, see Uboldi 2006, 223-224 (form AR 82-84), 225-226 (form Is. 85b), with the bibliography of the finds referred to.

40 The engraved glass from the Catholic University excavation was studied for a university thesis: Carrabino 2008-2009.

Truncated cone-shaped glasses and cups (Isings 106, Isings 96, Isings 116) are present throughout the layers that can be dated to a period between the 4th and 5th century as well as bottles produced with the same yellowish green naturally coloured glass.

The glass finds also include numerous fragments of window panes, in use since the 1st century AD (given the evidence from Pompeii), and various mosaic tesserae. The twisted glass rod Isings 79 constitute a separate category, as well as glass ornaments, necklace beads and bracelets, of which numerous examples have finished in our hands either having been broken or mislaid.

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KRIŽANAC Milica

5^{TH}-6^{TH} CENTURY GLASS IN SERBIA AND TERRITORY OF KOSOVO

The territory of the central part of Serbia and Kosovo was a part of the Prefecture Illyricum, the Dacian diocese and the provinces: Moesia Prima, Dacia Ripensis and Dacia Mediterranea, Dardania and Praevalitanae during the Late Roman and the Early Byzantine period. Up to 396, it formed a central part of the Roman Empire, but following the division of the latter, it became part of the border area of the East Empire. After the Huns invaded the territory of Serbia in 441/442, the Early Byzantine period began before ending with the penetration of Slavs and Avars in the late 6^{th} or the early 7^{th} century.

Although the use of glass in the central part of the Balkans was still extensive during this period, a few simple forms were still used. At approximately twenty published sites[1] explored so far, different types of goblets, beakers and oil lamps have been found, while bowls and bottles have been less common. The glass vessels were found in the ancient towns of Prahovo/Aquae,[2] Caričin grad/Iustiniana Prima,[3] Beograd/Singidunum[4] and Gračanica/Ulpiana,[5] at the border military fortifications on the river Danube (Karataš/Diana,[6] Kostol/Pontes,[7] Gra-

1 At some sites, only window glass was found, which is not covered in this paper.

2 In the Roman period, from the 2nd to the 4^{th} century Aquae was only a station along the way. In the 6th century, it is mentioned as a town and episcopal center. It was restored during Iustinian I.

3 The city and the seat of the Archbishop of Illyricum established at the time of Iustinian I.

4 The site is a multi-layered archaeological location: a Celtic fort, mentioned in the 2^{nd} century, was a military castrum and civilian settlement, restored in the time of Iustinian I, Serbian medieval city, Turkish and Austrian fort.

5 In the 2^{nd} century, it had the status of Municipium ad later became an episcopal center. It was restored in Iustinian's I time, when it was also renamed Iustiniana Secunda.

6 In the 1^{st} century, it was an earthen build and at the end of the 1^{st} and the beginning of the 2^{nd} century, a stone fortification. It was renewed several times from the 3^{rd}-6^{th} century.

7 The Roman castrum was built in the 1^{st} or 2^{nd} century. It was renovated in the mid-5^{th} and in the 6^{th} century, in Iustinian's I time.

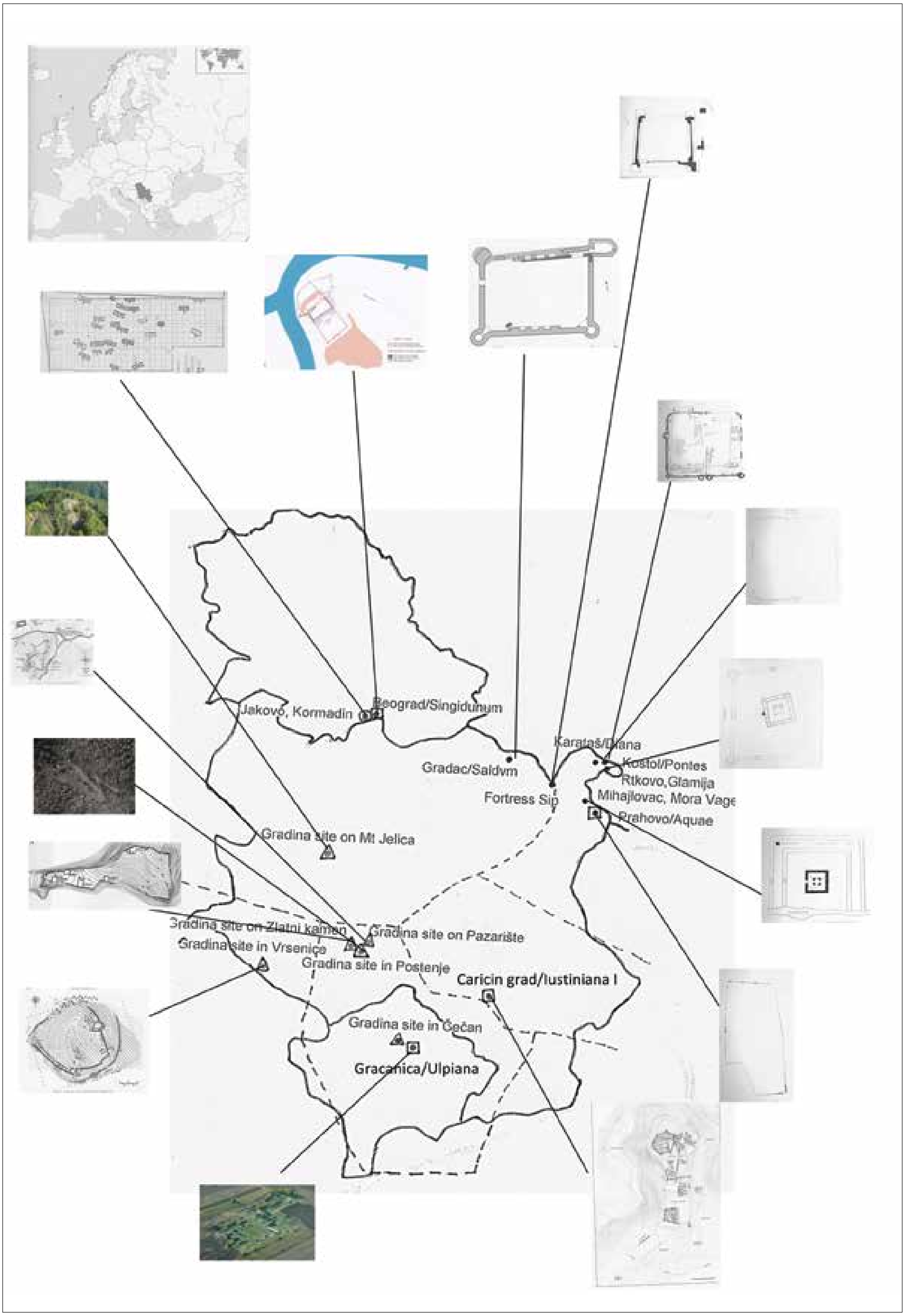

Fig. 1: 5th to 6th century sites with glass finds from Serbia and territory of Kosovo.

dac/Saldvm,[8] Fortress Sip,[9] Rtkovo-Glamija,[10] Mihajlovac-Mora Vagei[11]) and on hilltop settlements (the Gradina site on Mt. Jelica,[12] the Gradina site in Pazariste,[13] the Gradina site on Zlatni kamen,[14] the Gradina site in Vrsenice,[15] the Gradina site in Postenje,[16] the Gradina site in Čečan.[17]

In the territory of Serbia and Kosovo, glass fragments are quite common during the second half of the 5th and the 6th centuries, but from the vessels mainly smaller, mostly individual fragments were discovered. The vessels were mainly made of greenish, yellowish and colourless glass. The glass was free blown and only in a few cases decorated by blowing into the mold. Therefore, when decorated patterns exist, it is in the form of grooves and applied threads or drops.

Bowls

During the Early Byzantine period, bowls were rarely found in Serbia, in contrast to the 4th and the first half of the 5th century, when they were more frequent. They are present at a few sites and only in layers of the 6th century. The early Byzantine bowls appear in two basic forms, hemispherical and conical.

Shallow hemispherical bowls

These bowls, made of green and colorless glass (diameter of rim 13-15.5 cm), are present in two varieties. The first have cut-off, thickened rims, a calotte-shaped body and slightly concave base. At the Gradina site on Mt. Jelica (Fig. 2. 1,3), these bowls have been dated to the 6th and the beginning of the 7th century,[18] and at the Gradina site in Postenje (Fig. 2.2), they could have been in use during the Early Byzantine period – or possibly earlier during the Late Roman period.[19] The main characteristics of the second variety are funnel-shaped rims, a calotte-shaped shallow body and flat or concave base. In Serbia, these bowls are only found at the site of Gradac/Saldvm (Fig. 2.4), dated to the middle and second half of the 6th century.[20]

These types of bowl, typical for the Late Roman period, do not appear at other Early Byzantine sites in Serbia. However, in nearby areas, similar shallow hemispherical bowls were found. Among the glass tableware of the 5th and 6th century discovered in Thessaloniki, both varieties of shallow hemispherical bowls were identified.[21] In North Bulgaria, at Dichin, frag-

8 The site is a multi-layered archaeological location where layers of the Early Iron Age have been registered as well as signs of a settlement from the Roman period and Early Byzantine castellum.

9 A smaller fort from the 6th century.

10 A smaller fort from the 4th century that was extended in the time of Anastasius I and Iustinian I.

11 Two towns or smaller forts from the Roman and Early Byzantine periods.

12 The site, in the vicinity of Čačak town, is a multi-layered archaeological location (846 m altitude), where layers of the late Eneolithic and the Iron Age have been registered as well as those dated to the Early Byzantine and early Middle Ages (smaller, fortified, Slavonic settlement dated to 7th-10th centuries).

13 In the vicinity of Novi Pazar town (1079 m altitude), there was a station in Roman times and in the Late Roman period, a large fort that was in use until the 6th century.

14 The fortification in the vicinity of Novi Pazar town (1055 m altitude) was built in the Late Roman period (4th century) and was renewed in the 6th century.

15 Late Roman fort, rebuilt during the time of Iustinian I, was built in the Sjenica valley at about 1330 m above the sea. Later became a Serbian Early Medieval Fortress.

16 The site in the vicinity of Novi Pazar town is a multi-layered archaeological location (780 m altitude), where prehistoric layers (Eneolithic and the Early and the Elder Iron Age) have been registered, as well as those from Late Roman, Early Byzantine (Iustinian I) and Late Byzantine (Komnenos Dynasty) periods.

17 The site in the vicinity of Vučitrn town in Kosovo is a multi-layered archaeological location (473 m altitude), where prehistoric layers (Early and Late Iron Age) have been registered, as well as as well as those from Late Roman, Early Byzantine (Iustinian I) and Late Byzantine (10th -14th centuries) periods.

18 Gavrilović 1989, 89, pl. 1/6; Križanac 2010, 267-268, fig. 2: 1, 2.

19 Križanac and Mrkobrad 2012, 32, fig. 2: 1, 2.

20 Jeremić 2009, 143, cat. no. 413.

21 Antonaras 2010, 307, fig. 7.

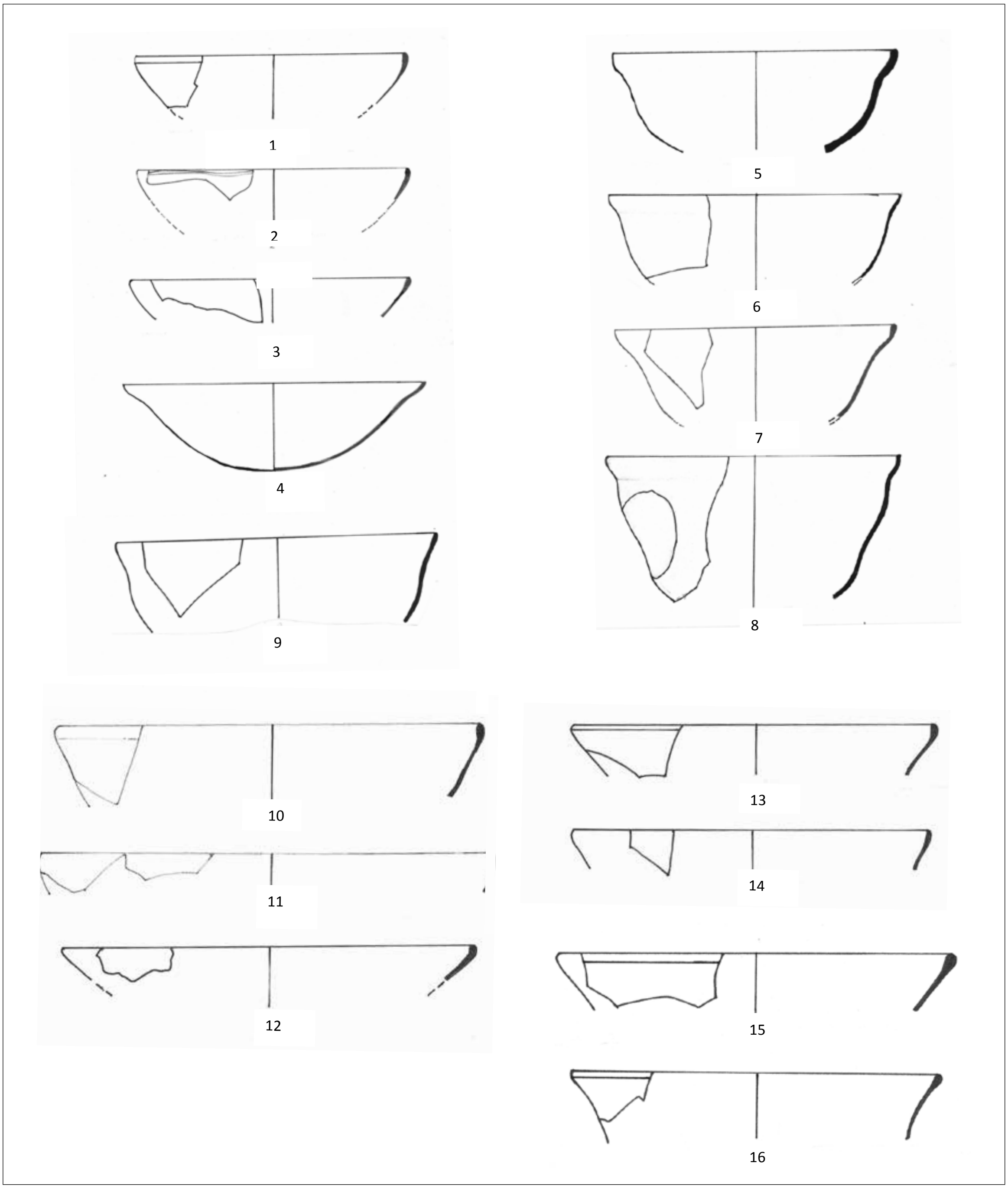

Fig. 2: Hemispherical and conical bowls.

ments of similar bowls are dated to the 5th century.[22] In Turkey (Elaiussa Sebaste), in the layer belonging to the middle and the second half of the 5th century,[23] specimens like those from Saldvm were also discovered.

22 Cholakova 2010, pl. VIII/2, pl. II/3; Rehren and Cholakova 2010, 82, 83, fig. 2:2.
23 Gençler Güray 2009, 292, fig. 1.1.

Deep hemispherical bowls

In the territory of Serbia, hemispherical deep bowls were very common during the 4th and the beginning of the 5th centuries. These bowls, made of green and colorless glass (diameter of rim 12-14 cm), have funnel-shaped rim, deeper body and a flat or concave base. Like the previous types of bowl, hemispherical bowls with a

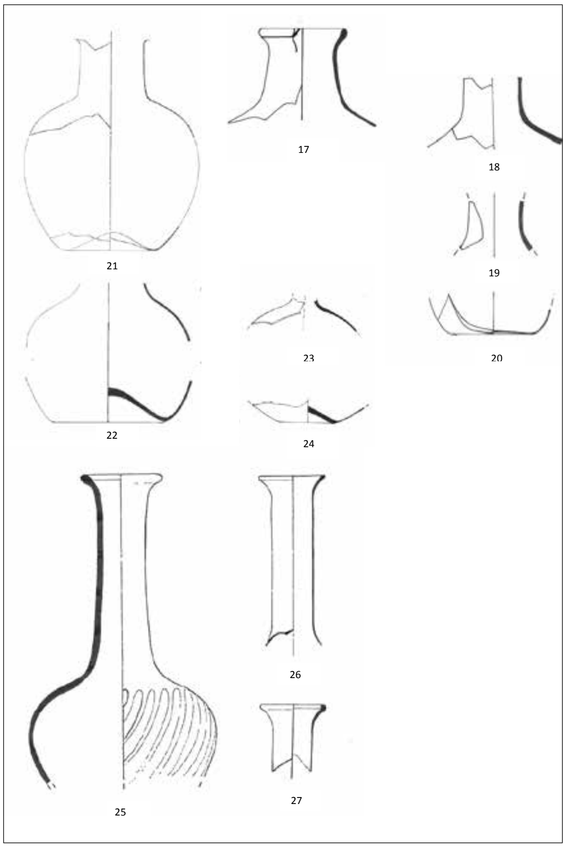

Fig. 3: Bottles.

deeper receptacle appear during the early Byzantine period in the layer of the 6^{th} century: in Karataš/Diana (Fig. 2. 5) from the beginning of the century[24] and in Gradac/Saldvm (Fig. 2. 6,8) from the middle and second half of the 6^{th} century,[25] except at the Gradina site in Postenje (Fig. 2. 7,9), where thay can be dated to the 6^{th} century and even earlier, to the Late Roman period.[26] Only example from the site Gradac/Saldvm (Fig. 2. 8) is decorated with ovoid indentations.[27]

Conical bowls

This type of bowl, made of green and colorless glass (diameter of rim 12-14 cm), are not common findings in Serbia. They have cut-off, thickened rims and no decoration. The fragments of conical bowls found at the Gradina site on Mt Jelica (Fig. 3. 10,11,13,14,16) from the 6^{th} and the beginning of the 7^{th} centuries[28] were relatively numerous, while at the Gradina site in Postenje are rare and dated to the 6^{th} century and also earlier[29] (Fig. 3. 12,15).

Vessels of a similar shape were found in Dičin in the north of Bulgaria, where they have been dated to the second half of the 5^{th} century.[30]

Bottles

Although findings of bottles are rare in the layers of the 5^{th} and 6^{th} century in Serbia, parts of them are preserved that can completely define their forms. They are made of green, colorless, yelowish and olive green glass. At several sites in the inventory of Early Byzantine glass, only spherical bottles were found.

The bottles with a shorter and wider cylindrical neck (diameter of rim 4.6 cm), a funnel-shaped rim and larger spherical body can be smaller, as is the case with bottles from Gradac/Saldvm,[31] the Gradina site on Mt. Jelica,[32] Kostol/Pontes,[33] the Gradina site in Vrsenice.[34] However, they can also be larger, such as the item from Caričin grad/Iustiniana Prima,[35] whose reconstructed height is 28.2 cm (diameter of rim 8.2 cm). All these bottles are dated to the 6^{th} and the beginning of the 7^{th} century, except a bottle from the Gradina site in Vrsenice, which is dated from the second half of the 4^{th} to the 6^{th} century. Among the 5^{th} and 6^{th} century glass from the hilltop setlement of Tonovcov Grad, in Slovenia, bottles of this type were also found.[36]

The bottles with a long, narrow neck and funnel shaped rim have a smaller spherical body decorated with relief ribs (diameter of rim 3.8-4.4 cm). The parts of the bottle with a

24 Ružić 1994, 39, cat. no. 566-567
25 Jeremić 2009, 143, cat. no. 414; Ružić 1994, 39, кат.бр. 563-565.
26 Križanac and Mrkobrad 2012, 32, Fig. 2: 3, 4.
27 Jeremić 2009, 143-144, cat. no. 416.
28 Križanac 2010, figs. 2:3,4; 3:1-3.
29 Križanac and Mrkobrad 2012, fig. 2: 2, 5.
30 Cholakova 2010, 264; Cholakova 2009, 8:3.
31 Fig. 3:17; Jeremić 2009, 153, cat. no. 448.
32 Fig. 3:18-20; Križanac 2010, figs. 4: 1, 2.
33 Fig. 3: 22, Špehar 2010, cat. no. 40.
34 Fig. 3: 23, Popović and Bikić 2009, 146, cat. no. 121, fig. 52/9.
35 Fig. 3: 21; Bavant 1990, pl. XXXIII: 123.
36 Milavec 2010, pl. 2/4, 5.

long neck have been determined with certainty only in Caričin grad/Iustiniana Prima[37], while the individual parts decorated with ribs, which could belong to this type of bottle, were found at several sites in Serbia. The bottles from Caričin grad/Iustiniana Prima originated from the 6th and the beginning of the 7th century. In the second half of the 6th to the beginning of the 7th century layer, spherical bottles with an elongated neck were found on the Romanian Black Sea coast, during the excavation of an episcopal basilica in Istria/Istros.[38] Spherical bottles are characteristic of Late Roman tableware, so they were very common in the territory of Serbia from the second half of the 3rd to the 5th century.

Beakers and goblets

Hemispherical beakers

In the territory of Serbia, hemispherical beakers were still relatively frequent during the second half of the 4th and the first half of the 5th century. During the Early Byzantine period, hemispherical beakers with a funnel-shaped rim, hemispherical body and slightly concave base remained in use among settlements in Central Serbia, although not often. They are made of olive green and whitish glass (diameter of rim 8.8-10 cm). Beakers of this type were found in the layer of the 6th century in Caričin grad/Iustiniana Prima[39] and Gradac/Saldvm.[40] The beakers from the Gradina site in Postenje[41] and at the Gradina site in Vrsenice[42] are dated from the second half of the 4th to the 6th century. Beakers of a similar shape were found in Istria/Istros on the Romanian Black Sea coast, where they were dated to the period from the second half of the 6th to the early 7th century.[43]

Conical beakers

At Early Byzantine sites in Serbia mostly small fragments of rims and bases of conical beakers were preserved, so their form cannot be determined with certainty. Therefore, some parts of rims may belong to conical stemmed goblets or possibly oil lamps. They are made of green, olive green, colorless, yelowish and bluish glass (diameter of rim 6.75-10 cm). At the Gradina site in Vrsenice,[44] one type of beaker with a funnel rim and concave bottom (Fig. 4. 32) has been reconstructed, which were present at this site during the Late Roman and the Early Byzantine period. In Gradac/Saldvm,[45] within the layer of the mid-late 6th century, appears the type of deep conical beaker with a cracked-off and outsplayed rim (Fig. 4. 33). Very similar items have been found in Bulgaria, in Nicopolis ad Istrum,[46] where they were dated from the 4th to the 6th centuries and in Dičin, within the layer of the 5th century.[47] In Elaiussa Sebaste, Turkey,[48] the same specimens as in Saldvm were found in the layers of the 6th and 7th century.

Other fragments found are part of the conical beakers that were typical of the Late Roman period and were very common in Serbia. This type of beaker has flat sloping sides and a flat or slightly concave base. It seems they were widely used and massively produced. The figural representations show they were used as drinking vessels while floor mosaics and oil residue in some of the beakers indicate they were also used as lamps.[49] At the Gradina site on Mt. Jelica (Fig. 4. 34-37), a larger number of conical beaker fragments were preserved. One fragment (Fig. 4. 35) is decorated with the ornament of parallel thin threads and ellipsoidal drops.[50] Another

37 Fig. 3: 25-27; Bavant 1990, pl. XXXIII: 120-122.

38 Băjenaru and Bâltâc 2000-2001, 483-484, pl. XI/3.

39 Fig. 4: 31; Bavant 1990, 211, cat. no. 113.

40 Fig. 4: 28; Jeremić 2009, 153, cat. no. 420.

41 Fig. 4: 29; Križanac and Mrkobrad 2012, fig. 3:2.

42 Fig. 4: 30; Popović and Bikić 2009, 146, cat. no. 117, fig. 52/8.

43 Băjenaru and Bâltâc 2000-2001, 478-482, pl. X/1.

44 Popović and Bikić 2009, 145, cat. no. 112, fig. 52/4.

45 Jeremić 2009, 149, cat. no. 437.

46 Shepherd 1999, cat. nos. 548, 550.

47 Cholakova 2010, pl. III/1, 3.

48 Gençler Güray 2009, 294, Fig. 3.1.

49 Gorin-Rosen and Katsnelson 2007, fig. 5. 20.

50 Križanac 2010, fig. 7:1.

fragment is decorated with applied threads (Fig. 4. 38) while some have decoration in the form of grooves.[51] In addition, at the Gradina site in Vrsenice (Fig. 4. 41), undecorated fragments of conical beakers were found in the layer of the 6th century.[52] At the Gradina site in Postenje (Fig.4. 43), similar fragments can be dated to the Late Roman and Early Byzantine periods.[53] Among the glass tableware of the 5th and the 6th century discovered in Thessaloniki also appears conical beakers of this type.[54]

Stemmed goblets

Among the stemmed goblets or lamps discovered at Early Byzantine sites in Serbia, a large number of foot have been noted, although they are difficult to determine with certainty.[55] However, in the literature, some items are marked as stemmed goblets. Stemmed goblets are made of green, colorless, yelowish and olive green glass (diameter of rim 4-7 cm). The only complete stemmed goblet in Serbia was discovered at the Gepids necropolis in Kormadin by Jakovo (Fig. 4. 46) near Belgrade.[56] This conical goblet, most likely a Byzantine product, is dated to the end of the 5th and the beginning of the 6th century. Deep conical stemmed goblets appear among the glass tableware of the 5th and the 6th century and were discovered in Thessaloniki[57] and in Nicopolis ad Istrum[58] in north-central Bulgaria, where they are dated to between the 4th and the 6th century.

Part of the rim of a deeper hemisperical body of the stemmed goblet and two feet were discovered in Gradac/Saldum (Fig. 4. 47-49) in the layer of the middle and second half of the 6th century.[59] Only the upper part of the shallow hemisperical body of a goblet of this type and several circular feet (Fig. 4. 50-52), dated from the Late Roman to the Early Byzantine periods, have survived at the Gradina site in Postenje.[60] In Kostol/Pontes (Fig. 4. 53), besides numberous circular feet, the lower part of a hemisperical body and foot decorated with incisions have also been preserved.[61] At the Gradina site on Mt. Jelica (Fig. 4. 54), one footed base with a preserved part of the hemisperical body was found and has been dated to the 6th and beginning of the 7th century.[62] A deeper goblet from Lezha in Albania has a similar foot and has been dated to between the 6th and 7th century.[63]

Oil lamps

Stemmed lamps

Two types of stemmed lamps were reconstructed in Caričin grad/Iustiniana Prima (Fig. 4. 55,56). One type has the form of a deeper beaker[64] and the other is hemisperical with three handles.[65] The hemisperical stemmed oil lamps with three handles appeared at several sites in nearby areas: in Thessaloniki during the 5th century,[66] in Istria/Istros[67] on the Romanian Black Sea coast, where they were dated to the period of the second half of the 6th to the early 7th century, and in Nicopolis ad Istrum[68] in north-central Bulgaria, where they were dated to between the 4th and 6th century.

Conical or hemispherical oil lamps with three handles

The oil lamps with three handles, in a conical or spherical form and without decoration, were excavated in the 6th century layers in the

51 Fig. 4: 36, 37; Križanac 2010, fig. 6:4, 6:5, 7:2.
52 Popović and Bikić 2009, cat. no. 116, fig. 52/14, 13.
53 Križanac and Mrkobrad 2012, fig. 3:5.
54 Antonaras 2010, 307, fig. 7.
55 Duval and Jeremić 1984, 149/a,b; Bavant 1990, pl. XXXII/90-105; Janković 1981, pl. XII/8-11; Ivanišević and Špehar 2005, fig. 4:12-15; Popović 1999, fig. 57-14; Špehar 2010, 49-53.
56 Dimitrijevic 1960, 30-31, pl. I: 14.
57 Antonaras 2010, 307, fig. 7.
58 Shepherd 1999, 339, cat. no. 274.
59 Jeremić 2009, 151, cat. no. 440, 442, 443.
60 Križanac and Mrkobrad 2012, fig. 3:6-8.
61 Ružić 1994, cat. no. 1118.
62 Križanac 2010, Fig. 8:3.
63 Prendi 1980, pl. I-IV; Janković 2007, 20, fig. 1.
64 Duval and Jeremić 1984, fig. 149 a.
65 Duval and Jeremić 1984, fig. 149 b.
66 Antonaras 2010, 307, fig. 7.
67 Băjenaru and Bâltâc 2000-2001, pl. VI-VIII.
68 Shepherd 1999, 339-340, cat. nos. 284, 285, 287.

territory of Serbia. They are made of green and olive green glass (diameter of rim 8.5-9 cm). Conical lamps with a rather shallow receptacle and with smaller and rounded handles applied below the rim were found in Caričin Grad,[69] at the Gradina site on Pazarište[70] and at the Gradina site on Zlatni Kamen.[71] At the Gradina site on Mt. Jelica,[72] the Gradina site in Vrsenice[73] and Caričin grad[74] the items with handles applied at the very rim were found. The glass finds, which were dated to between the 6th and the beginning of the 7th century, in Budva, Montenegro,[75] as well as the 5th-6th century glass finds from the hilltop setlement of Tonovcov Grad, in Slovenia,[76] contained conical oil lamps with deeper receptacles. Among the 5th and 6th century glass from the hilltop setlement of Tonovcov Grad, in Slovenia, there are the conical lamps with three handles which run from the edge of the rim.[77] Only one fragment of a hemispherical body with one handle (Fig. 5. 64) that may belong to this type of lamp derives from the Gradina site on Mt. Jelica.[78] Hemispherical lamps with three handles, similar to hemispherical beakers, appear in Istria/Istros[79] on the Romanian Black Sea coast, where they are dated to a period between the second half of the 6th to the early 7th century as are those from the site Novae in Bulgaria.[80] Analogies with the conical and hemispherical lamps from the Gradina site on Mt. Jelica can be found in Elaiussa Sebaste, Turkey, in the layer of the 7th century.[81]

69 Fig. 5: 57; Duval and Jeremić 1984, fig. 149: c; Bavant 1990, pl. XXXII/110-111.
70 Fig. 5: 58; Popović 1999, 108, fig. 57:13.
71 Fig. 5: 59, 60; Ivanišević 1990, 13, fig. 4:b.c.
72 Fig. 5: 61; Križanac 2012, fig. .9:1.
73 Fig. 5: 62; Popović and Bikić 2009, 77, сл. 52:18.
74 Fig. 5: 63; Duval and Jeremić 1984, fig. 145:1, 2.
75 Janković 2007, 26, fig. 3-5.
76 Milavec 2010, pl. 2/6.
77 Milavec 2010, pl. 2/6, 7, 9, 10.
78 Križanac 2010, fig. 11:3.
79 Băjenaru and Bâltâc 2000-2001, pl. X:8-10.
80 Olczak 1995, 32.
81 Gençler Güray 2009, 296, fig. 4.1, 3.

Oil lamps with hollow stem

There are two types of lamp with a hollow stem and conical or bowl-shaped receptacle. They are made of green, colorless, yelowish, olive green and bluish glass (diameter of rim 9-10 cm). The reconstructed lamps with a conical receptacle and a hollow stem were found in the 6th century layer in Caričin Grad,[82] at the Gradina site on Pazarište[83] and at the Gradina site on Zlatni Kamen.[84] This type of lamp appeared in Thessaloniki[85] and at the Novae site in Bulgaria[86] during the Early Byzantine period. The lamps,[87] similar to those from the Gradina site on Pazarište and on Zlatni Kamen, were found in Elaiussa Sebaste, Turkey, in the layer of the 7th century.

Oil lamps with a hollow stem from Serbia could also have bowl-shaped receptacles as did the items from Caričin Grad[88] and Gradina site in Postenje.[89] During the excavation of the episcopal basilica in Istria/Istros on the Romanian Black Sea coast,[90] numerous lamps with a hemispherical body and hollow stem were found and subsequently dated to the period between the second half of the 6th to the early 7th century. The fragments of hollow stems without parts of the bodies were found at several sites in Serbia and Kosovo in the layer of the 6th century: in fortress Sip,[91] Čecan in Kosovo,[92] Caričin grad[93] and the Gradina site on Mt. Jelica.[94] At the Gra-

82 Fig. 5: 65; Duval and Jeremić 1984, fig. 145:6, 7; 249e.
83 Fig. 5: 66; Popović 1990, 108, fig. 57:12.
84 Fig. 5: 67; Ivanišević, 1990, 13, fig. 4:a.
85 Antonaras 2010, 307, fig. 7.
86 Olczak 1995, 32.
87 Gençler Güray 2009, 296, Fig. 4.4.
88 Fig. 5: 78-79; Duval and Jeremić 1984, sl. 149:d,f.
89 Fig. 5: 80-81; Križanac and Mrkobrad 2012, fig. 5:2,3.
90 Băjenaru and Bâltâc 2000-2001, 471-474, pl. I, II.
91 Fig. 5: 68; Špehar 2010, cat. no. 352.
92 Fig. 5: 69; Ivanišević and Špehar 2005, fig. 4:16.
93 Fig. 5: 70-74; Bavant 1990, XXXII:110-112; Duval and Jeremić 1984, fig. 145:6,7; 142, a:1, b:10.
94 Fig. 5: 76-77; Križanac 2010, fig. 9:4-5.

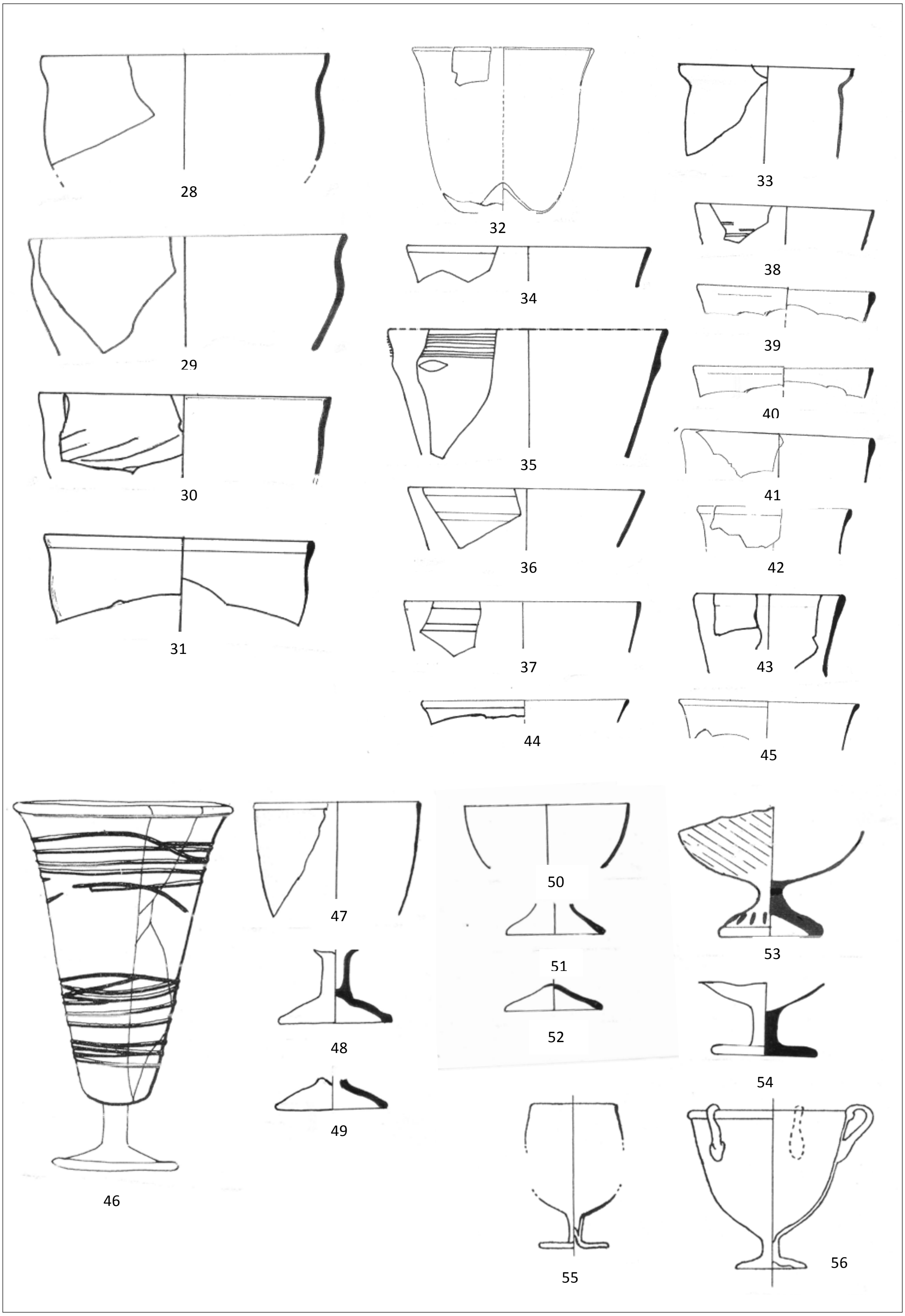

Fig. 4: Beakers and goblets.

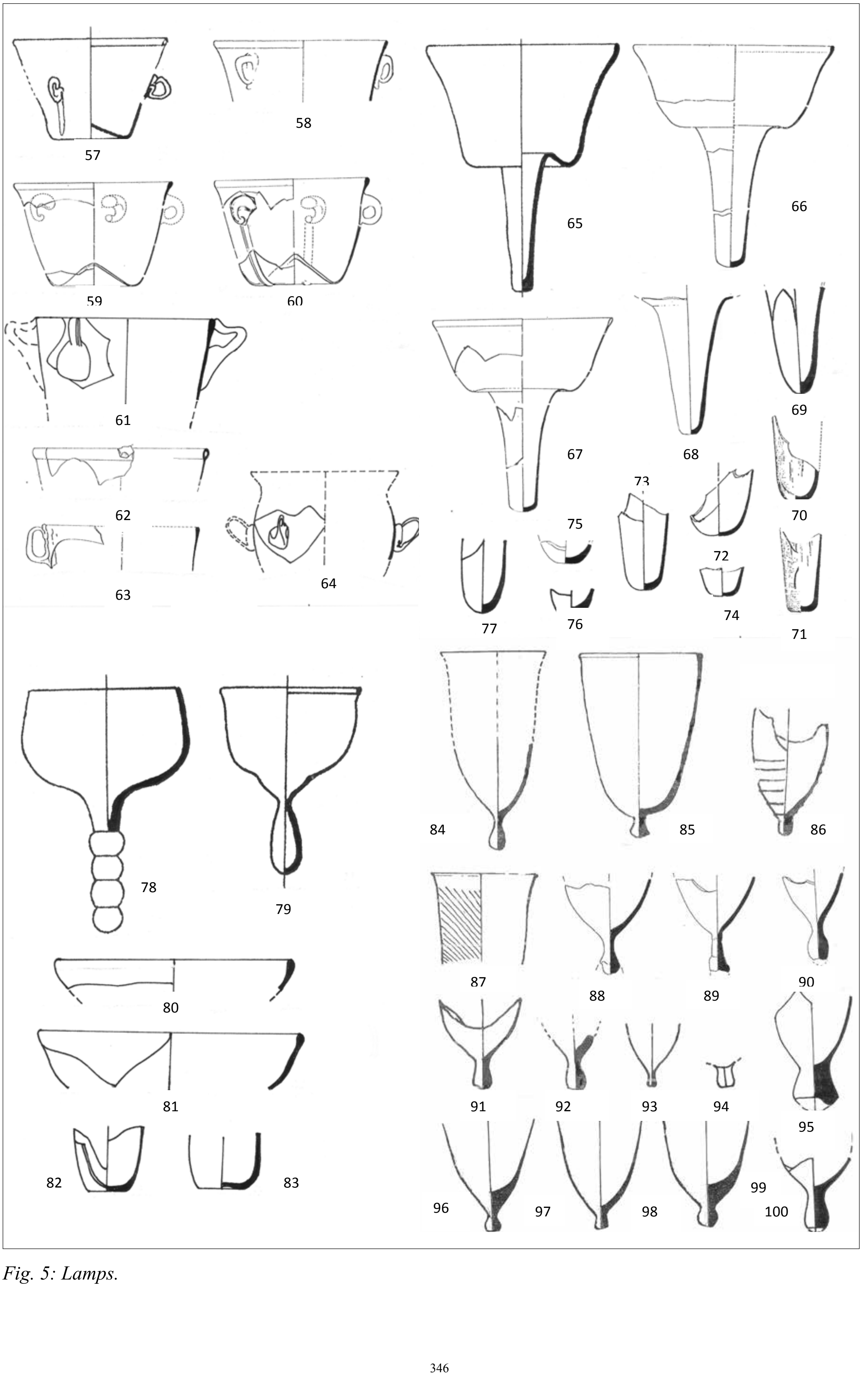
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Fig. 5: Lamps.

dina site in Postenje[95] and at the Gradina site in Vrsenice,[96] the items have been dated to between the 4th and 6th century.

Oil lamps with pointed base

Lamps with a pointed base, made of green and colorless glass (diameter of rim 4-6.4 cm) were found at several sites in Serbia and Kosovo. The lamps found in Rtkovo-Glamija (Fig. 5. 84), Karatas/Diana (Fig. 5. 93), Kostol/Pontes (Fig. 5. 87-90) and Mihajlovac-Mora Vagei (Fig. 5. 91-92) were dated to between the 6th and the beginning of the 7th century[97] as well as lamps of this type from Prahovo/Aquae[98] and the Gradina site on Mt. Jelica.[99] The lamps from Belgrade/Singidunum,[100] Gračanica/ Ulpiana[101] and the Gradina site in Postenje[102] are dated to between the 4th and 6th century. The body of the lamp from Kostola/Pontes[103] is decorated with sloping, shallow grooves while the lamp from Gračanica/Ulpiana is decorated with applied threads. Oil lamps with a pointed base appear in Istria/Istros[104] on the Romanian Black Sea coast and have been dated to the beginning of the 7th century while in Thessaloniki[105] similar finds originate from the Iustinian period until the 7th century.

95 Fig. 5: 82-83; Križanac and Mrkobrad 2012, fig. 5:4,5.
96 Fig. 5: 75; Popović and Bikić 2009, 77, cat. no. 123, fig.52:15.
97 Špehar 2010, 90.
98 Fig. 5: 96-99; Janković 1981, pl. XII/12-14.
99 Fig. 5: 97, 102; Križanac 2010, fig. 11:1, 2.
100 Fig. 5: 85; Pop-Lazić 2002, fig. 14/2.
101 Fig. 5: 86; Ružić 1994, 55-56, cat. no. 1149, 1180, 1188.
102 Fig. 5: 100; Križanac and Mrkobrad 2012, fig. 5: 6.
103 Fig. 5: 90; Ružić 1994, 56, cat. no. 1170-1171.
104 Băjenaru and Bâltâc 2000-2001, 483, pl. XI/2, fig.4/4.
105 Antonaras 2010, 307, fig. 7.

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RECENT GLASS FINDS FROM PANTOCRATOR CHURCH IN ISTANBUL

Pantocrator Monastery, now known as Molla Zeyrek Mosque, is one of the most important structures from the Middle Byzantine Period in Istanbul. The ongoing restoration work on the monastery started in 1997 and was interrupted for several reasons before it commenced again in 2009.[1]

The structure's history dates back to the time of John II Comnenus and his wife, Eirene, circa 1118-1136. Pantocrator complex consisted of various structures, such as monasteries, churches, an imperial mausoleum, an almshouse, a hospital and a pharmacy. The current structure consists of three buildings: the Church of Pantocrator Christ to the south, the Imperial Mausoleum dedicated to Archangel Michael in the centre and the Church of Eleusa Mary to the north.

The monastery was used as a residence for Latin administrators in the 13th century during the 4th Crusade Occupation (1204-1261) and was converted to a madrasah in the time of Mehmet the Conqueror following the conquest of Istanbul. The first professor of this institution was Zeyrek Molla Mehmet Efendi. The mosque, converted from a church, was named Molla Zeyrek Mosque. It is also called Zeyrek Mosque or Zeyrek Church Mosque. It was restored in the time of Mustafa III in the 18th century and Abdulhamid II in the 19th century. Wall paintings from both periods can be observed inside the structure. Old photographs meticulously provide an impression of the changing windows.

The monastery was restored in the 20th century at least three times; the aim of the current restoration is to correct the mistakes of the previous attempts. Meanwhile, excavation work has been performed in and around the structure under the supervision of the Directorate of Istanbul Archaeology Museums. Numerous glass pieces were found during the excavation work and cleaning of the structure.

The most exciting finds are the *crown glass* pieces, discovered in the drum of the western dome of the Central Building (Fig. 1, below

1 Ousterhout and Ahunbay 2000.

Fig. 1: Cast glass, crown glass.

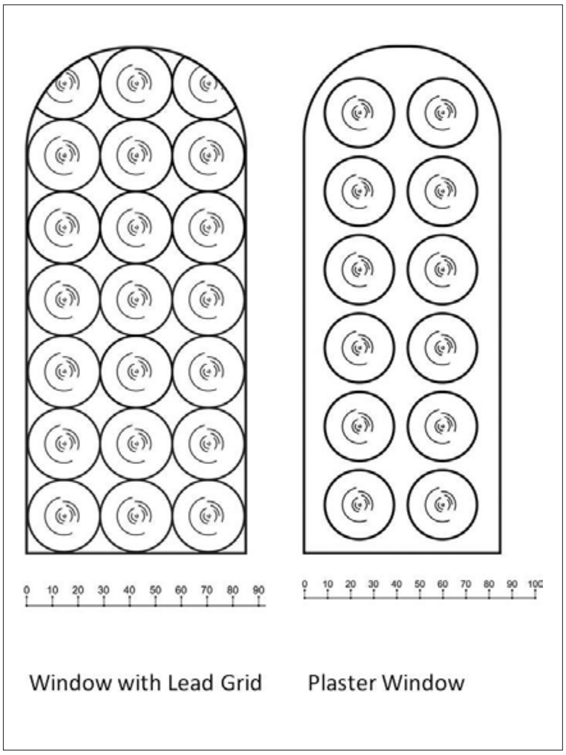

Fig. 2: Windows.

right)[2] during the cleaning of the wooden beam openings located in the drum. These pieces have an average diameter of 28-30 cm and must have been swept aside during the Ottoman restoration. Similar examples were also found during the cleaning of the structure (Fig. 1, below left). The crown glass examples are generally greenish and yellowish in colour with distinguishable pontil marks and folded rims. One purple piece and a few cobalt blue examples with clearly visible rotation marks were found. The coloured glass also reveals weathering marks. We may have suggestions on what kind of frames these glass panes were placed in. It is known that frames of various materials were used during the Byzantine period. Stone frames can be observed at Lips Monastery in İstanbul, Athens Little Metropolis Church and Thessaloniki Panagia Chalkeon Church. Lead grids with small diameters were very popular among Byzantine buildings, such as Byzantine shops in Sardis, Pammakaristos Monastery in İstanbul and Torcello.[3] The crown glass pieces found in a Middle Byzantine church during Nif Olympus excavation work are approximately the same size as our examples and have plaster frames. It is highly unlikely that there were stone frames in the drum of Pantocrator as they would have weighed heavily. Most of the models would have been made with plaster or lead grids. Although not equal in entirety, drum windows have the average height of 220 cm and a width of 85 cm. The upper sections of the windows are curved. If lead grids were used, each window should have 19 complete and 2 half-crown glass panes, considering the window width and glass diameters, with holes consisting of 7 rows for 3 adjacent panes (Fig. 2, left). If plaster frames were used, each window should have 12 complete crown glass pieces with holes consisting of 6 rows for 2 adjacent panes (Fig. 2, right).

Cast glass pieces were also found during cleaning and are small in general. One piece is considerably large. The height of a green-blue and probably rectangular cast glass is 31 cm and

2 For the parallels Gill 2002, 102-103, 226-228; Saldern 1980, 101; Kanyak 2009, 33-38; Canav Özgümüş and Kanyak 2012, 299.

3 Ousterhout 1999, 153; Saldern 1980, 92.

Fig. 3: Colored window glass

Fig. 5: Pharmaceutical objects, alembic sherds.

the width is 25.5 cm (Fig. 1, top). The thickness varies from 0.3-0.7 cm while one border is folded.

There is an addition to a corner, which was mistakenly cut when hot and was later reattached. There are very large and very small bubbles found together as well as marks from the mould and tools used on the reverse. Remains of a mortar of red and white soil are seen on the borders. Similar examples are known among contemporary Islamic glass in

Fig. 4: Mosaics and chunks.

Fig. 6: Ottoman plaster windows.

the Middle East. Examples from Fustat are the closest in terms of both their colours, technical attributes and the mortar remains.[4] This type of glass may have been used for Meteora - styled or plaster window, such as those used in Sina at St. Catherine Monastery. Smaller cast glass pieces were also found, generally in shades of green and are translucent due to bubbles and sand particles. They may have been used in plaster frames with small openings, as was

4 Foy 2005, fig. 147, 149.

the case with finds from the Islamic period, or for any of the forms designed for Byzantine window frames.[5]

Among the surprising results of our study is a case of broken glasses left by Megaw. The prothesis of the South Building (Pantocrator Church) was used as a store room for the material left by his works,[6] which we named the "Megaw Room" and was listed as such in inventories. We were the first to break the lock and enter the room following Megaw's work. Inside were several shelves, upon which were various pieces that had not been taken to the museum. Among the pieces were stone, ceramic, bone and glass finds. The glass pieces had been placed inside a wooden case. These glass specimens are a bonus for the study. We cleaned and classified them. There are coloured glass pieces as well as colourless specimens (Fig. 3). There is a decorated and plain glass piece for each colour with an overall smaller number of decorated glass pieces. The colours varies from shades of green, cobalt blue, purple, red, pink, yellow and to a lesser extent, dark red. The glass produced by the casting method ranges between 0.1 cm and 0.5 cm. The borders have the following shapes: arcs, triangles, polygons and rectangles (shaped by grozing). Nevertheless, the pieces are heavily weathered. A dense, thick and tar-like dye was used for the decorated glass pieces. Translucent brown is present in a few examples, which seems to be an accidental colour. The analyses of the glass pieces and dyes will be performed and published by experts at Ankara University.[7]

Decorative motifs consist of rows of pearls, passionflowers, ivies, rosettes, polygons, spirals and crosses inside diamonds. There are also Greek letters, one of which is Epsilon, the other possibly Theta. The motifs present on these pieces were prevalent in the Byzantine world. Mosaics and frescoes also complement one another with Pantocrator and Chora glass appearing to have been incorporated into this pattern. Wall paintings, tiling and the coloured compositions of the windows would also have complemented each other within Ottoman structures - a style presumably imposed by the Byzantine decoration program.

The style of the Byzantine world was commonplace and can be observed in the following: frescoes and mosaics inside the window arches at Pantocrator; frescoes inside the window arches of Cosmosotiria Church in Pheres from the same period; silver-stain patterns on Middle Byzantine period bracelets; and enamel decorative features on the purple bowl taken by the Venetians to the treasury of Saint Marco.

These motifs also have a strict stylization. This excessive stylization is the most important feature that distinguishes these motifs from decorative elements on Western stained glass, which are distinctive due to their extremely naturalist style.[8]

Kilograms of mosaic tesserae were retrieved during the cleaning of the church. They were then separated according to their colours, affording us the opportunity to work on all this material before they were taken to the Museum. It is possible to calculate where parts of these mosaics fell off. Opaque red mosaic cubes are still present inside arches in combination with gold-foiled mosaics (Fig. 4 below right). Close observation of the red mosaics reveal that they were not refined. Opaque blue mosaic cubes are also still present on the interior of the arches. These cubes seem to be porous and not very refined. There are mosaics inside the mortar. The paint on the mortar indicates that the patterns were first drawn with paint and then covered with mosaics.[9]

Small chunks and glass cakes were found during excavation work around the church in the colour of gold-foiled mosaics; however, opaque green mosaics as well as window glass pieces were also discovered (Fig. 4). It is apparent that there was a glass workshop where

5 Gill 2002, 236; Foy 2005, fig. 131-141, 159-162.

6 Megaw 1963; for Byzantine window glass Dell'Acqua 2005; Dell'Acqua 2006.

7 For earlier studies Brill 2005.

8 Peters 1958; Brisac 1984; Lagabrielle 2006; Raguin 2008.

9 For Byzantine mosaics see James 2006.

mosaics and window glass were produced by melting chunks, possibly using a temporary furnace, near the structure. The workshop must have been set up in order to supply the glass material used in the church otherwise these chunks and glass cakes could not have been present.

The Pantocrator complex had the most advanced medical buildings at the time and the hospital was famous for its ophthalmology service. Some glass objects, which we believe belong to the hospital, were found during excavation work around the structure. Small bowls, small bottles, jars, pharmaceutical objects and alembic shards may have been tools that were used to prepare drugs or to perform analyses (Fig. 5).[10] In addition, sections of oil lamps and pieces of goblets that were necessary for daily life were found and were made of ordinary glass.

Other glass finds discovered during archaeological work are Venetian and Ottoman in origin. Ottoman glass pieces have been dated to the 16th century and later. Similar examples were found during excavation work at Marmaray and Bursa Castle, but were heavily weathered. Kicked bases in shades of amber, green, yellow and blue and spiral-ribbed bottle pieces are typical Ottoman finds. Furthermore, oil lamp bases from the Late Ottoman Period were also found and are similar to the material discovered at Tekfur Palace, the data for which was published by Ömür Bakirer.[11] Pontil - marked colourless pad-bases made of refined glass were also discovered and bear the typical Beykoz–ware features dated to the 19th century. The team also found a large number of curved handles, some of which are faceted. All these pieces must belong to spouted ewers and analyses of these pieces are underway. It is likely the results will reveal that this is potash glass, similar to the compositions of Beykoz glass.

Additionally, a few typical examples of Venetian filigree glass from the 16th century were found and were decorated on a colourless background with opaque white stripes. Comparisons are knwon among the finds of the Gnalić Wreck and Marmaray[12] and were also heavily weathered. A few interesting pieces are colourless or are greenish mould-blown window glass with diamond embossments.

When examining the western dome of the Central Building, the Chapel of Michael, it can be observed that the window openings became shorter in the course of time as they were filled from the bottom.

Windows were gradually walled up at various times throughout history. However, while the windows were filled, bricks were put on top of old wooden frames. As Khorasan mortar (brick dust mortar) was used for filling, this must have been done during Ottoman restorations and during the Republican Period. Instead, cement and marble powder were used for restorations during this time, after 1923.

The Ottomans used much shorter windows than the Byzantines. Three periods have been identified in the structure and comprise of the following: a Byzantine window opening at the bottom, an Ottoman frame in the middle with a filling on the frame and new frame on the filling are seen. When the filling and the bricks were removed, the frame in the central layer was uncovered. Unfortunately, the wooden material of the frame had crumbled and instead, revealed part of a plaster window inside. We removed the plaster window piece by supporting it with wooden boards and wrapping it in cotton. There was a triangular groove inside the wooden frame under the plaster. The triangular groove was intended to grip onto the triangular-profiled plaster frame.

Similar triangle-grooved wooden frames were found inside the northern vault windows of the South Building of the Pantocrator Church. These windows were changed and the wooden frames found intact. They were short windows with a height of 150 cm and were used as vault windows. The wood was 6 cm thick and was shaped by a wood fitting technique. A plaster frame was placed inside the window. There were round holes pierced into the upper part

10 For alembic shards Calvi 1969, pl. 15:1.

11 Bakırer 2001.

12 Lazar and Wilmott 2006, 40, fig. 41; Charleston 1975.

of the window. Liquid plaster was poured into the groove of the frame and inside the holes to make the window stronger.

The liquid plaster remains can be seen on the triangular groove of the window. These wooden windows must have been installed through restoration work during the Late Ottoman Period, because they have not been observed in 16th - 17th century Ottoman plaster windows.

There are three styles of Ottoman plaster frames. Plaster frame pieces with round openings (Fig. 6, upper left) were found on a shelf inside the Megaw room. They have been dated to an earlier period, because frames with round openings were used in 16th and 17th century Ottoman structures. Glass from earlier periods is crown, in other words, bullseye glass (*elephant's eye* in Turkish), which has folded edge and pontil marks.

Another frame form used on outer windows during Ottoman restorations is a model with lozenge-shaped openings. The plaster piece taken from the dome of the Central Building belongs to this model (Fig. 6, below left), where cast glass had been inserted into the frame. There were also other pieces of such frames. They are visible in old photos of the South Building.

Windows with oval openings were present after the 18th century and were influenced by the Western Baroque style. Pantocrator examples confirm this observation (Fig. 6, below right). Cast glass was used for these windows. The old photos exhibiting windows with oval openings permitted a better understanding of some of the plaster frame pieces. Such pieces with cast glass fragments inside were found during excavation work. These windows must have been made after those with lozenge-shaped openings and were found above the aforementioned fillings. The ongoing restoration assumes that these frames with oval openings were used as a base model to establish a norm while the type of frame grid was used for the renewed windows.

We have presented the glass finds obtained at the Pantocrator complex so far. Excavation work is due to continue for a longer period of time. We hope to procure results that will inform us further on this matter.

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A STUDY OF PROTO-BYZANTINE GLASS FRAGMENTS FROM PHILIPPI, NORTHERN GREECE, USING ATOMIC SPECTROSCOPY

Introduction

This study presents the chemical analysis of twenty-eight samples belonging to an equal number of archaeological glass finds. Found during excavations in Philippi, Central Macedonia, these glass finds date back to between the 4th and 6th century AD, and can be divided into three types: a) Plate glass b) Vessels c) Small glass. The samples are kept in the storerooms of the Archaeological Museum of Philippi.

The methodology used for the analysis of the samples was the following a) Atomic Emission Spectrometry Inductively Coupled Plasma (ICP - AES) for the quantitative determination of the elements Ca, Al, Mg, Fe, Mn, Co, Cr, Cu, In, Pb, Zn, B, Ba, Ag and Ga b) Flame Atomic Absorption Spectrometry (F.A.A.S.) for the elements Na and K in order to ensure the presence of Na and K due to its low energy excitation and c) X-ray Fluorescence Analysis (XRF) for the quality analysis of elements Sn, Sb and As.

The results of the analyses provide initial information about Proto-Byzantine glass from Macedonia and its manufacturing technology. All the objects studied are made of soda -lime -silica glass as is the case with the majority of ancient glass. Glassmakers used natural soda as alkaline raw material. Its origin cannot be accurately determined.

Analytical methods

The microanalysis of the twenty-eight samples was carried out using the analytical techniques of Inductively Coupled Plasma Atomic Emission Spectroscopy (Perkin-Elmer 3100 XL) and Flame Atomic Emission Spectroscopy FAAS (Perkin-Elmer 5100). For the quality analysis of elements Sn, Sb and As, X-ray Fluorescence Analysis (ARTAX 400) was used.

Sample preparation

Samples were located within groups of glass fragments collected during the excavations. If several fragments were thought to belong to the same object, then the smallest specimen was kept aside for analysis. The samples we had were all in fair condition although some were deformed by the heat. First, a light surface cleaning of the samples was carried out with a soft brush in order to remove any corrosion products. Samples were photographed under a Carl Zeiss stereomicroscope with a magnification of 10 X. Next, they were grounded in an agate mortar to a grain size of less than 60 mesh and dried at 105°C for one hour. The grounded samples were stored in glass vials with a plastic lid and placed in a desiccator to prevent moisture uptake. They were then precisely weighed and dissolved in order to be analysed by ICP-AES and FAAS.

Dissolution

The dissolution method selected has been used in the analysis of ancient glass and recommended as appropriate for the analysis of silicate materials, which includes glass. The method is based on the action of hydrofluoric acid on silicate glass. The dissolution method was accomplished in the following steps:

approximately 0.5 g of the sample was weighed in a Teflon melting pot. 5ml of hydrochloric acid (HCl 37%), 5 ml of hydrofluoric acid (HF 40%) and 1ml of chemically pure methanol were added. The solution was heated until dry (for approximately three hours). 5ml of concentrated hydrochloric acid was added and the solution heated again until dry (for approximately one hour). This procedure was repeated twice. The residue was taken out with 50ml 1.2 M of hot hydrochloric acid. The solutions were transferred to polypropylene bottles and deionized water was added up to a final volume of 100 ml.

ICP-AES measurements

All the measurements were carried out with a Perkin-Elmer OPTIMA 3100 XL Inductively Coupled Plasma Atomic Emission Spectrometer by axial viewing of plasma emission. Multi-element working standard solutions were prepared for the calibration of the instrument from a 1000 mg L^{-1} multi-element stock solution. Fifteen elements were determined (Ag, Al, B, Ba, Ca, Co, Cr, Cu, Fe, Ga, In, Mg, Mn, Pb and Zn). A pneumatic nebulizer was used as well as a Scott-type double-pass spray-chamber. A segmented CCD detector employed. The fluid sample was pumped into the nebulizer via the peristaltic pump. The nebulizer generated an aerosol mist and injected humidified Ar gas into the chamber along with the sample. Each element was measured in two different spectral emission lines; the range was determined according to their sensitivity. Finally, the most suitable was chosen. Wavelength (nm): Ag: 328.068, Al: 308.215, B: 249,772, Ba: 233.527, Ca: 317.933, Co: 228.616, Cr: 283.563, Cu: 324.752, Fe: 238.204, Ga: 294.364, In: 325.609, Mg: 280.271, Mn: 259.372, Pb: 220.353 and Zn: 213.857.

FAAS measurements

Flame Atomic Absorption Spectrometry was applied to all samples to determine sodium (Na) and potassium (K) levels. FAAS was used to ensure the presence of Na and K due to its low energy excitation. A Perkin-Elmer 5100 PC atomic absorption spectrometer was also used. An oxidant flame of air-C_2H_2 was employed for the determination of Na and K at a temperature of 2400-2700K. During combustion, the atoms are excited and when in a basic state, they emit characteristic radiation. To provide specific wavelengths, a light beam from a lamp, whose cathode is made of the element being determined, is passed through the flame. A device such as a photomultiplier can detect the amount of reduction of light intensity due to absorption by the analyzer, and this can be directly related to the amount of the element in the sample. Single-element matrix matched standard solution was prepared for the calibration of the instrument from 1000 mg L^{-1} Merck standard solutions. An excess of Na was added to this solution in a ratio similar to that expected in the unknown samples.

Most of the measurements of elements Ag and Ga are under the detection limits of ICP-AES device and for this reason are not included in the Pl. 1.

X-ray fluorescence analysis

It is worth repeating that for the quality analysis of elements Sn, Sb and As, X-ray Flu-

samples	CaO % w/w	Na_2O % w/w	K_2O % w/w	Al_2O_3 % w/w	MgO % w/w	MnO % w/w	Fe_2O_3 % w/w	B ppm	Ba ppm	Co ppm	Cr ppm	Cu ppm	In ppm	Pb ppm	Zn ppm
1	4,6	14,9	0,9	1,8	0,7	1,1	0,8	2028	314	3	19	64	429	209	-
2	5,4	15,0	0,6	1,8	0,8	0,7	1,1	162	215	10	18	142	242	349	178
3	5,1	13,7	0,8	2,1	0,9	0,5	1,1	1291	193	4	18	37	194	157	1130
4	4,2	13,2	0,3	1,1	0,5	0,9	0,5	444	221	-	10	34	317	96	150
5	5,2	14,4	0,6	1,8	0,7	0,7	1,0	1075	243	6	18	119	265	333	199
6	4,1	13,2	0,2	1,4	0,4	0,7	0,9	652	878	1	26	49	304	228	247
7	4,7	9,8	0,2	1,8	0,9	0,7	1,1	248	310	10	18	62	282	111	205
8	4,9	6,6	0,1	1,6	0,7	0,6	1,0	387	201	5	17	56	226	182	208
9	4,0	8,7	0,4	1,3	0,4	0,8	0,7	420	628	4	20	49	256	217	288
10	6,1	7,3	0,2	2,4	0,6	1,2	0,4	877	428	2	13	23	506	101	43
11	5,8	7,5	0,2	2,6	0,5	1,0	0,4	2557	457	2	15	20	376	125	68
12	4,2	10,0	0,1	1,3	0,6	0,8	1,1	215	237	16	17	140	310	626	-
13	5,1	15,8	0,3	1,4	0,6	0,3	1,0	640	193	3	18	40	121	246	215
14	5,5	15,7	0,2	1,7	0,6	0,7	1,1	625	243	10	19	114	271	349	545
15	6,9	9,8	0,2	1,9	0,7	0,9	1,4	233	341	17	23	149	348	409	53
16	8,0	8,0	0,2	2,3	0,5	1,4	1,0	392	578	7	23	69	558	266	2
17	7,6	9,2	0,1	2,0	0,8	1,4	1,1	626	362	13	19	108	521	356	-
18	5,9	10,1	0,2	1,4	0,6	1,2	0,7	262	336	8	16	70	481	334	157
19	6,0	8,4	0,1	2,0	1,0	1,4	0,9	271	410	7	18	71	607	166	157
20	4,6	15,2	0,3	1,4	0,7	0,9	0,6	612	733	1	14	85	366	108	-
21	3,9	16,4	0,2	1,6	0,8	0,8	0,7	318	411	5	13	51	324	170	-
22	5,7	15,7	0,7	2,0	0,9	1,5	0,8	683	411	7	17	107	579	1470	-
23	5,1	12,2	0,6	0,9	0,6	1,1	0,7	464	572	6	13	48	337	162	337
24	4,6	14,0	0,6	1,4	0,6	0,9	0,7	477	201	4	15	76	380	269	153
25	4,5	9,4	0,2	1,8	0,4	0,4	0,4	716	746	-	11	16	134	185	-
26	4,4	13,2	0,3	1,0	0,5	0,9	0,9	499	221	10	15	112	273	395	145
27	4,3	8,4	0,2	1,6	0,4	0,0	0,3	1125	159	-	9	10	11	70	-
28	4,9	10,7	0,2	1,7	0,7	1,1	0,7	1157	328	4	17	67	472	165	-

Plate 1: ICP-AES and FAAS measurements.

orescence Analysis (ARTAX 400) was used. The measurement conditions of the μ-XRF were 0.9 mA, 35 kV and 200 s for all samples. The detector was SDD cooled by peltier (window Be, 10 mm² active area) and the nominal beam diameter was 1.6 mm at the position of the sample. The elements were identified based on the characteristic X-ray peaks in the range of 0-50 keV.

Results and discussion

According to the results of the analysis, the high percentage of Na_2O (6.6 - 16.4 %), and CaO (3.9 - 8.0 %) leads to the conclusion that all the specimens belong to the category of soda-lime glass. The detection of K_2O (0.1 - 0.9 %) and MgO (0.36 - 0.95 %) favors the possibility that natural soda was used as an alkali source. Its origins cannot be determined precisely; perhaps it is natron from Egypt it may be from the region of Macedonia. PbO exhibits a very low rate in the samples (up to 1470 ppm) and testifies to the fact that the specimens are not lead-type fragments. Cobalt oxide (CoO) and Chromium oxide (Cr_2O_3) are at very low percentages and do not affect the color in any sample.

The samples generally show a high rate of Fe_2O_3 and are decolorized by MnO. The coloring property of iron is neutralized by the presence of manganese at a rate of 0.33 - 1.46 % of MnO, a rate that is too high to be considered random and suggests the deliberate addition of manganese to the molten material as decolorizer.

The samples 4, 7, 11, 18, 19, 20, 21, 22, 23, 25, and 28 are not green and were decolorized by adding Mn.

The white opacity of Sample 27 is due to the dispersion of tin (Sn), as indicated by the quality analysis (XRF).

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THE GLASS OF TERME MILANO AT GORTYNA (CRETE)

Glass remains from Terme Milano at Gortyna (Crete) were found during the excavations that were carried out from 2003 to 2010 under the direction of Prof. G. Bejor as a part of a project promoted by the S.A.I.A. (Italian School of Archaeology at Athens) in collaboration with the University of Milan.[1] Diggings were concentrated in the southern part of the city, the so called Pretorio's quarter, and they have brought to light a bath whose different monumental phases can be dated to between the middle of the 4th and 7th centuries AD.[2] The total glass fragments found are 997: the majority of 542 are composed of windowpanes, while the remainder is divided into 450 vessel pieces and 5 slags. 2374 mosaic glass *tesserae* were also found. The highly fragmented conditions have not permitted the reconstruction of whole shapes, except for a lamp with a globular bowl and three small handles. All the material was covered by a thick dark brown film formed as a result of continued exposure to external agents. In particular, many fragments have deteriorated, because the action of water corrosion has made the surfaces very microporous.[3] The colour range is dominated by blues and greens but there are also colourless or transparent specimens and the presence of bubbles in the material of almost all of the fragments found is a clear indication of the blowing process. Most of the glass can be dated to the Late Roman and Byzantine period, but a few post-antique vessels have also been found in some of the upper layers.

In this paper I will not present a complete study of all glass materials coming from the bath - which can be instead found in a forthcoming work[4] - but rather a selection so that

1 I thank Prof. G. Bejor for having given me the possibility to take part to this important research project and for welcoming me in his *equipe*.

2 For a complete description of Terme Milano refer to: Bejor and Sena Chiesa 2003; Bejor *et al*. 2004; Bejor 2011a; Bejor 2011b. For a summary about materials from the excavations refer to: Panero 2009; Panero 2011.

3 Bandini 2012, 87-89.

4 For a comprehensive study of the whole class refer to: Belgiovine forthcoming.

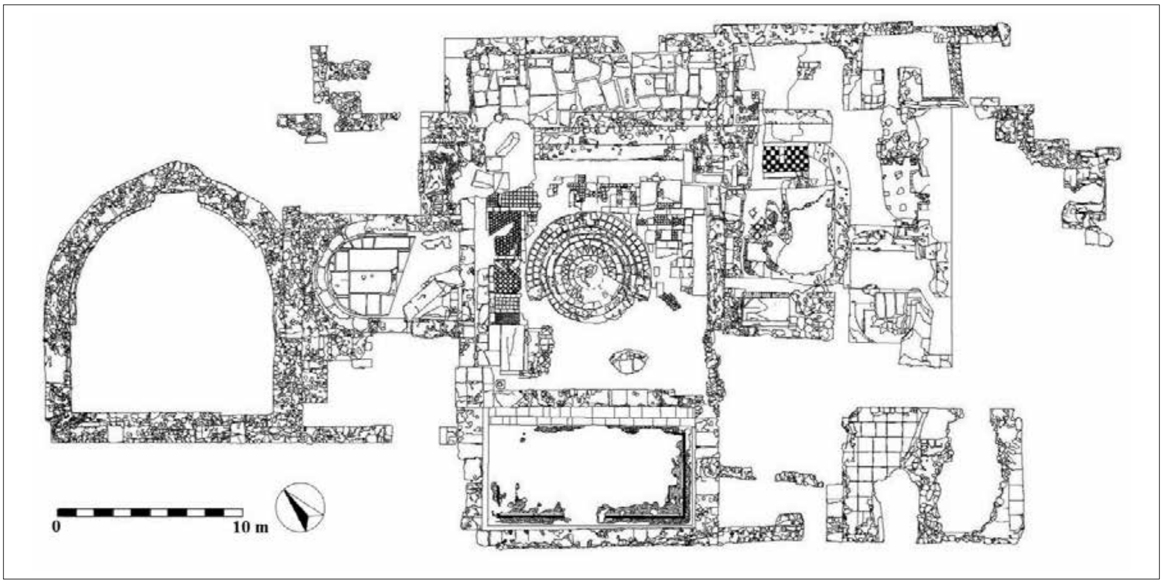

Fig. 1: Gortyna, Terme Milano. Plan of the bath (Archive of the Archaeological Mission of Gortyna of the University of Milan. Department of Cultural Heritage, Sector of Archaeology).

the most significant characteristics can be identified and attention given to the archaeological context.

The windowpanes, in accordance with the thermal purpose of the building, are one of the best represented categories: they constitute more than a half the total of glass fragments found. A high concentration of these windowpane fragments – 384 – was found all in US 413, which constitutes the first filling layer of the collapsed pool of the bath that, later, was obliterated by a paving in *opus sectile* (Fig. 1). Consequently, the materials contained in US 413 provide important chronological information, which allow us to date the transformation of the pool to the 5th-6th century AD, when extensive reconstruction works took place in the majority of the building.[5] In the same layer, besides the many fragments of windowpanes, the rim of a beaker-shaped lamp, with flaring mouth in green, Isings type 106c[6] (Fig. 3.9), and dated from the late 4th-5th centuries AD,[7] has been also found. The windowpane fragments, even if they hardly fit together and belong to different specimens, have made possible the reconstruction of the profile of some panes: the best preserved example has a rectangular shape and two surviving corners that reach a maximum height of about 20 cm (Fig. 2). Finding complete panes is very rare and the only ones preserved usually have dimensions within 23 and 35 cm, but in some cases they could reach the length of 1 m.[8] Finally, inside the filling layer, some remains of plaster, where windows were probably housed in, have also been found. The panes found in Terme Milano are characterized by a general thickness extending to 0.2-0.4 cm, but in some cases there are fragments which can reach even 0.5-0.6 cm or, on the contrary, can be very thin – for example, only 0.1 cm thick. As far as the colour is concerned, it is possible to observe the presence of different shades of green with the prevalence of yellow-green and light-green, and in some cases, as in the best preserved pane, the glass is translucent with concentrations of a dark green pigment where the batch has not fused well[9]. Fragments are also full of air bubbles that are often elongated in the same direction, testifying to the use of the cylinder-blown glass.[10] Windowpanes belonging to the Early Byzantine

5 Bejor 2011b, 16-17.

6 Isings 1957, 129.

7 For comparison see also: Sternini 1977, no. 5, pl. 48; Crowfoot and Harden 1939, 198, no. 4-5, pl. 28; Dussart1998, 80, no. 7-9, pl. 13.

8 Czurda-Ruth 1979, 222-223.

9 Stern 1983, 48.

10 Kaynak 2009, 38-42.

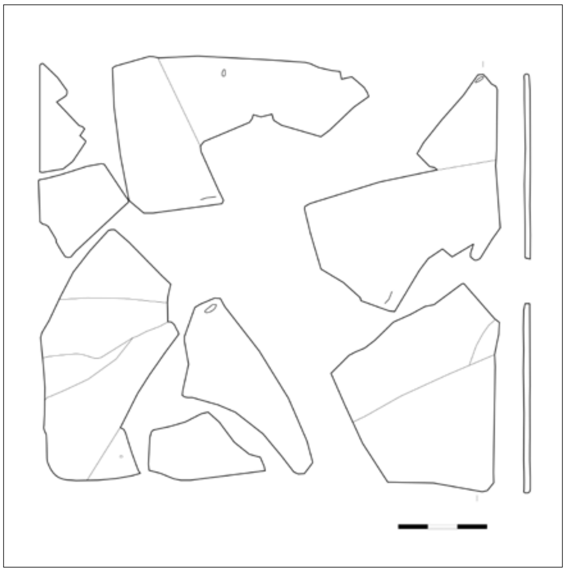

Fig. 2: Gortyna, Terme Milano. Windowpanes, the best preserved pane (Archive of the Archaeological Mission of Gortyna of the University of Milan. Department of Cultural Heritage, Sector of Archaeology. Drawing of the author).

period have been also found in Sardis, where all the fragments were made by blowing a cylinder; the majority belonging to the double-glossy type, however a few cases can be considered of glossy-mat type.[11] This coexistence has also been found in the excavation of the Roman Theater of Nicea.[12] In Gortyna, many fragments present both glossy surfaces and for this reason they can be attributed to the double-glossy type, but there are some pieces where the level of deterioration of the glass does not permit an assessment of the typology. Interestingly, a lack of crown glass,[13] whose production was only introduced in the 6th century AD, has been demonstrated by the excavations in Jerash.[14] In general, the progressive development of technologies for the manufacture of windowpanes experienced a quick growth thanks to their application in the large baths of the imperial age, where the adoption of increasingly large openings can be seen, with the former examples being smaller and rectangular in shape. These large windows were usually placed in the facades of buildings with vaulted roofs and, consequently, they adopted a semicircular profile.[15] For this reason, it was hypothesized that large semicircular windows were inserted in the facades of the vaulted *frigidarium* in the Terme Milano and this hypothesis could also be confirmed by the comparison with the Hunting Baths in Leptis Magna, which are the best preserved and chronologically contemporary example.

Also in accordance with the thermal purpose of the building, is the finding of a substantial amount of glass mosaic *tesserae* that were assembled within a rubble layer, US 015, and in some cases, were still housed in the plaster. In the same layer, besides numerous pieces of plaster, there were also some white limestone *tesserae* and various fragments of stemmed goblets. The discovery of more than 2,000 glass pieces indicates that one or more rooms of the complex should have been decorated with magnificent mosaic floors or wall coverings;[16] the only evidence of the use of such material is now represented by some green glass *tesserae* that are still *in situ* in the mosaic of *natatio*. The *tesserae* found in US 015 have dimensions between 1 and 1.5 cm and cover a wide range of colours with a predominance of blue and various shades of green; there are also some yellow, gray and white examples, and only a few red versions. They seem to be similar to those found in the room 110 of the Pretorio, where a mosaic workshop was installed in the 5th century AD.[17] Glassware was also active[18] in the same quarter in Late Antiquity, from which other *tesserae* are derived from. L. De Matteis and G. De Tommaso have already pointed out the close link between glassware production and the needs of monumental complexes in the area[19] and now these new findings from Terme Milano show the same relation.

The layers of the 6th-7th centuries AD are characterized by the prevalence of goblets, present in both shapes with a solid stem and a hol-

11 Saldern 1980, 91-92.

12 Özgümüş 1993, 39.

13 Kaynak 2009, 33-38.

14 Mayer 1989, 207-209.

15 Vistoli 2005, 257-259.

16 James 2006, 29-30.

17 Di Vita 2010, 225.

18 Di Vita 2010, 169.

19 De Matteis and De Tommaso 2001, 253.

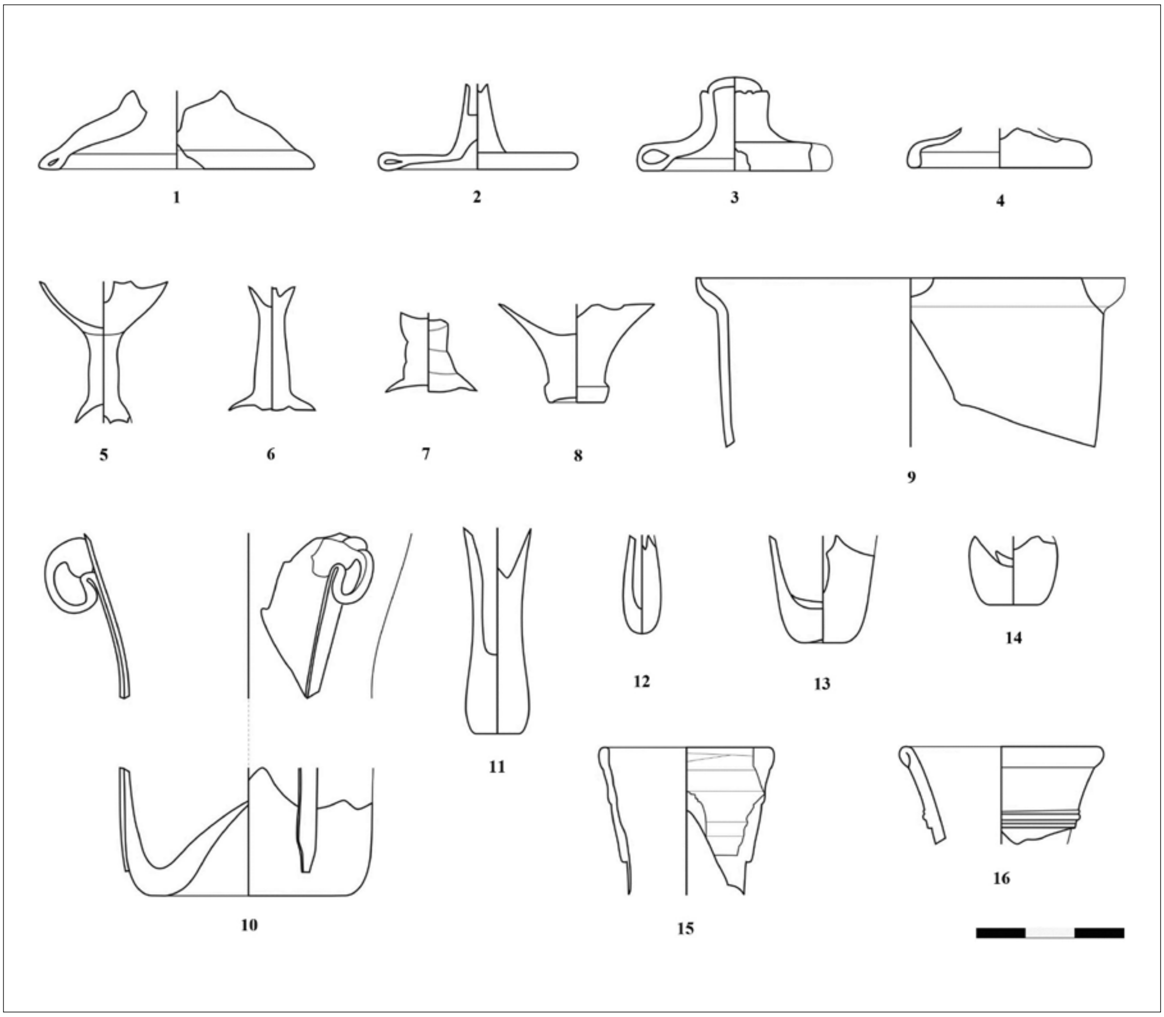

Fig. 3: Gortyna, Terme Milano. Glass fragments: 1-8, goblets; 9, beaker; 10-14, lamps; 15-16, flasks (Archive of the Archaeological Mission of Gortyna of the University of Milan. Department of Cultural Heritage, Sector of Archaeology. Drawings of the author).

low stem that completely belong to the Isings form 111.[20] Commonly found on late antique Mediterranean sites, these goblets are dated between the 5th and 7th centuries AD. In Gortyna, several stems and bases have survived and are the most resistant parts of the goblets, but it was not possible to reconstruct whole shapes. In relation to the different methods of manufacture, it is possible to distinguish between goblets with folded bases and hollow stems, and applied-bases goblets with flat bases and solid stems.[21] However, vessels belonging to the solid stem type, characterized by stems pulled out of the body, are missing: this kind of goblet usually presents a highly irregular base, with evident tooling marks, and is particularly widespread in Late Roman-Early Byzantine Anatolian settlements.[22] Its absence has already been noted in the excavations of the Pretorio[23] and therefore, this particular type seems to be completely missing in Gortyna. Among the fragments found there is a predominance of folded bases, of which few stems survive. The bases have a diameter between 3.4 and 5.6 cm and different shades of blue and green (Fig. 3.1-4). As far as the preserved stems are concerned, they all belong to

20 Isings 1957, 141-142.

21 For an accurate typological study of goblets see: Jennings 2005, 124-131; Çakmakçı 2009.

22 Hayes 1992, 406.

23 Sternini 1998, 233; De Matteis and De Tommaso 2001, 199-201.

goblets with a solid stem applied separately (Fig. 3.5-8). The goblets often had shapes very similar to glass lamps and, being contemporary to them, it was difficult to determine with certainly what was their function. The use of glass as a lighting object goes back to the first half of the 4th century AD in Syria and Palestine and since then it spread everywhere; the reason for this is connected to the fact that the glass lamps allowed a longer illumination time, contrary to terracotta lamps, because they were filled with water in addition to oil.[24]

In Terme Milano different glass lamps have been also attested; among them there were some lamps with globular bowls and three small handles, of the latter it has been possible to reconstruct the whole shape, which was characterized by a concave base and loop handles[25] (Fig. 3.10). Others were reconstructed with a hollow stem (Fig. 3.11-12), that in two cases present a glass wick holder welded on the bottom (Fig. 3.13-14). This particular type, dated to the 6th-7th centuries AD and documented only in Gortyna so far, is attributed to local production.[26]

Notably, the discovery of two flask rims with trailed decoration that probably do not belong to local production can be compared with some findings in Beirut that date back to the Early Byzantine period; interestingly, they show trade relations with the East Mediterranean area. The first fragment, pale green with slightly in-turned fire-rounded rim, has a trail decoration in the same colour glass as the body[27] (Fig. 3.15) while the second belongs to the blue trail group[28] (Fig. 3.16); the bodies of these flasks can be globular or cylindrical and are very thin.

In conclusion, the glass material from Terme Milano can generally be compared with the one found in the excavations of the Pretorio's quarter and show a substantial uniformity with the city's glass production in the Late Roman and Early Byzantine periods. Instead, looking at the glass and its archaeological context, this material appears strongly related to the thermal purpose of the building; in fact, windowpanes and glass mosaic *tesserae* are quantitatively the best represented typologies. In particular, the fragments of panes found, made with the technique of the cylinder glass, probably belong to the first structural phase of the complex; moreover, the absence of crown glass that did not come into use before the 6th century AD, seems to confirm this interpretation. The glass mosaic *tesserae*, instead, give an idea of how sumptuous and richly decorated the building must have been.

24 Çakmakçı 2009, 51.
25 Uboldi 1995, no. 2, pl. 1.
26 Sternini 1998, 232-233.
27 Jennings 2005, 167-168, no. 5, pl. 7.14.
28 Jennings 2005, 154-159, pl. 7.4; Foy 2000, 263-265, pl. 18.

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LATE ROMAN AND BYZANTINE GLASS FROM HADRIANOPOLIS (SOUTHERN ALBANIA)

Introduction

Since 2005, the University of Macerata and the Archaeological Institute of Tirana have been conducting archaeological investigations at the Roman site of Hadrianopolis (Fig. 1) near the modern village of Sofratikë in Southern Albania.[1] The town lies in the broadest section of the Drinos valley in Chaonia in the Northern Epirus.

Recent investigations have demonstrated that this Roman town was based on an ancient settlement. The site was frequented from at least the 4th century BC through the discovery of a fragment of painted architectural cornice and by the presence of black glazed pottery,[2] which is so far, the main marker of human presence at the site. Some tiles with the mark $$ have also been dated to a later phase of the Hellenistic age up to the Roman era. These finds provide proof of the monumental development of the settlement (Fig. 2), which is evident from the construction of public buildings and the discovery of abundant pottery and findings from archaeological excavations. This growth is certainly linked with the geographic location of the site, which lies along a secondary byway of the *via Egnatia*, going from Apollonia to Nikopolis. The main phase of development of Hadrianopolis dates to Hadrian's time as the toponym – or sign of a (re)foundation - suggests. The town made remarkable economic and monumental progress from this period at least up until the mid 4th century AD, after which data from the archaeological investigations – which are still in progress – testify to a period of crisis that continued at least until the end of the 5th century AD.

From this period onwards, our investigations seem to testify to a temporary revival of the urban centre, which might have reached its peak in the Justinian period when the town assumed, but only for a short period, the name of Justianoupolis.
(R.P.)

1 See, in general: Perna and Çondi 2012.
2 Cingolani 2012a, 148; Cingolani and Perna forthcoming.

Fig. 1: Map of the main sites in Chaonia and in the neighbouring regions.

The Glass

The glass finds from Hadrianopolis belong to phases dating from between the Early Imperial period and Late Antiquity.[3] As for the later phases on which this paper focuses, the evidence confirms that after the economically lively phase between the 2nd and 3rd century AD due to imports from the Aegean and Eastern Mediterranean, the 4th century AD was characterized by a progressive stasis of trade with a decrease of imports. Among the finds there is evidence that a form (Pl. 1. 1,2) produced already in the 2nd century (to whose a wall decorated in facet technique (Pl. 1. 3) should also be related), appears frequently even during the 4th century. A cylindrical blue-green glass with rounded rim and concave bottom, dated to between the 3rd and the end of the 4th or beginning of the 5th century AD, comes from the necropolis of Sofratikë (Pl. 1. 4; Fig. 3). The following discoveries have also been dated to the 4th century AD: a fragment of stemmed goblet with a carinated wall, decorated with horizontal incised lines[4] (Pl. 1. 5); two bases with a shallow splayed foot-ring[5] (Pl. 1. 6); and two jug fragments Is. 120 with a hot applied coiled thread under the rim[6] (Pl. 1. 7).

A significant change was evident in Hadrianopolis between the end of the 4th and 5th/6th century AD: the glass might reflect the definitive decline of former long-range trade and a significant decrease of imports. Only two types of drinking vessels are widely documented in this period: the conic or tronco-conic glass and the goblet. The first group (conic or tronco-conic glass) consisted of the large series of rounded and enlarged rims (Pl. 1. 8-17) and some concave bases with a sort of false foot[7] (Pl. 1. 18-20) relating - with several variants -

3 This paper concerns some of the glass found during the excavation from 2006-2010 (see also Cingolani 2012b, 201-207) while the study of the finds of 2011 and 2012 is still in progress. I wish to express my gratitude to Prof. Roberto Perna, the Director of the Italian archaeological mission of Hadrianopolis, for grantng me permission to study and publish the material discussed.

4 See also Perna, Capponi, Cingolani *et al.* 2012, 139-142. The type is the most known in the Eastern Mediterranean. Close to our fragment for the stem and the base, see: von Saldern 1980, 61, pl. 24.

5 See also Perna, Capponi, Cingolani and Tubaldi 2012, 139-142. This type of base is a typical feature of Late Antique productions of the 4th-5th century CE both in the Eastern (Harden 1936, pl. XIV, 221; von Saldern 1980, nos. 444, 465; Hayes 1975, no. 473; Gençler 2003, 722, pl. 38) and in Western Mediterranean (see Whitehouse, Costantini, Guidobaldi *et al.* 1985, fig. 5, 51 and Sternini 2001, 71, fig. 21).

6 The shape was widespread in the 4th and 5th century CE in the entire basin of the Mediterranean and in Albania, where is attested in Butrint, Durrës and Qerret (near Kavajë): Tartari 2005, 133, pl. XVI, 244, 245, 247, 249. Considering the large number of variants in the entire Mediterranean basin, however, the typological classification of C. Isings seems to be morphologically and chronologically restricted (see also Sternini 2001, 29).

7 Sternini 1995, fig. 13, 167-168; Foy 1995, 200, pl. 9, 80-83; Tartari 1996, pl. XV, 236; Sternini 2001, 31, fig. 17.

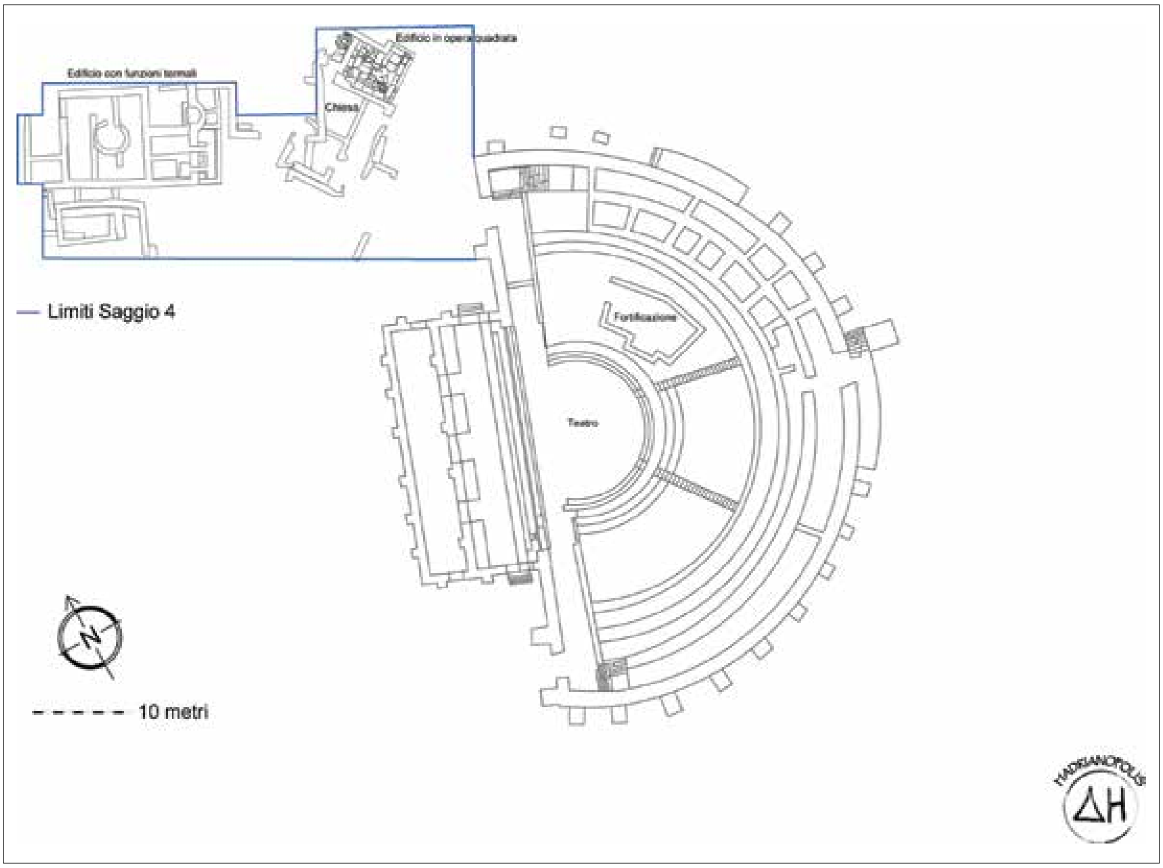


Fig. 2: Hadrianopolis (Sofratikë). Planimetry of the area of archaeologial investigation.

to the type of conical beaker or lamp[8] Is. 106. However, it should be pointed out, that it is difficult to precisely define the shape and the relative chronology of the type of rims, which relate to several different shapes between the 4th and 5th century AD.

The stemmed goblets belong to a more advanced phase, which are dated to the second half/end of the 5th century AD. The shape was widespread in the entire Mediterranean basin with a particular concentration in the Central and Eastern regions and was still largely produced from the 7th to the 8th century AD. The goblet, known in a large range of variants, is easily recognizable because of its very characteristic base, which is also the most reliable feature of this shape. As for its use, it was primarily, but not exclusively, intended for the table: the frequent discovery of numerous specimens in Early Christian churches on many Mediterranean sites suggests that it was also used as lighting devices.[9]

At the same time, our items represent the later more widely disseminated shapes in Hadrianopolis. Most of the specimens have a base and an incomplete goblet: thanks to the match between some of these bases with rounded rims found in the same stratigraphic layers, three recurrent types - whose reconstruction of the complete profile is possible – have been identified. The first type has a straight rim featuring an enlarged

8 Several variants of lamps are attested in Late Antique contexts in Epirus (between the 4th and 8th century CE) in Arapaj (Hidri 1991, pl. IX, 4-5, 11-14), Onhezmit (Lako 1984, pl. XI, 1-2), Paleokastër (Baçe 1981, pl. X, 18 to which an unpublished fragment of hollow stem preserved in storage at the Archaeological Museum of Tirana and classified by me should be added), Mesaplikut (Komata 1984, 1-9). In Hadrianopolis a sole specimen is currently known. As for the survey on Late Antique and Early Medieval glass lamps, see in general Uboldi 1995, 93-145 with previous bibliography.

9 Lamps in the form of a wineglass are still in use today (see Yelda Olcay 2001, 86-87).

border with tronco-conic goblet (Fig. 4.1); the second has an everted rim and rounded goblet (Fig. 4.2); finally, a third has an inward rim with tronco-conic goblet (Fig. 4.3).

Three recurrent types of bases, all created with the one-time technique, have also been identified: the first type with tubular rim and cylindric stem; the second with tubular rim and hollow stem with a bulging knot; the last type with concave base and solid tronco-conic stem (Fig. 4.1-3).

The quantity of the specimens, the high repetition and the homogeneity of the two shapes might suggest that local glass production started along with the brief economic revival of the centre following the Justinian re-foundation. Poor quality and the workmanship of the examined fragments indicate that they may have come from the same workshop: clear indicators are, in particular, the typological and technological uniformity and homogeneity of the chromatic range (greenish/brownish-colourless/greyish), maybe due to the repeated recycling of cullet. So far, no specific evidence, such as kilns, confirms this assumption; however, glassworking waste, lumps and pieces of raw glass (Fig. 5) are found too often to discard this hypothesis. Only further studies will permit a more accurate assessment of this evidence within the productive and economic system of the late antique settlement.
(S.C.)

Conclusions

The spread of conical beakers and goblets in Hadrianopolis is dated to a phase of economic upturn following the crisis that began at the end of the 4th century AD, an observation supported both by new commercial dealings, trade of the city and by building activities in the urban area.[10] Fragments of African Red Slip Ware D2,[11] dated to between the end of the 5th and the 7th centuries AD, *spatheia* and Keay 34[12] amphorae suggest a resumption of

Fig. 3: Hadrianopolis (Sofratikë, Necropolis). Cylindrical glass.

connections with the African world. It is worth noting, however, that there is little evidence of D2 production of African Red Slip Ware is in Hadrianopolis, especially when compared with finds from other coastal areas and the rest of the Albania.[13] This is an indication that in the 6th century AD, the commercial trade of the city was still active through the roadway Apollonia – Nikopolis, which still maintained its fundamental role, despite the fact that the liveliest coastal markets were more connected to Tunisian productions.[14]

The few imports of Aegean amphorae common in Butrint[15] and Durrës[16] and the presence of a type of local amphora known as "Epirote

10 Perna 2012b, 251-254.

11 See Tubaldi 2012a, 166-167.

12 Lahi and Shkodra 2012, 188.

13 E.g. in Dürres, Butrint and Shkodra: Shkodra 2005b, 132-136; Reynolds 2004, 228; Hoxha 1995, 253-259.

14 For what concerns these commercial trends see: Reynolds 2004, 239-240.

15 Reynolds 2004, 229, 241-242. On the contrary, African amphorae are common in Skutari where in a smaller quantity seem to be attested the Aegean types: Hoxha 1992, 209-243.

16 Shkodra 2005a, 224-238.

amphora"[17] suggest a sort of regionalization of the commercial circuits. This trend seems to be confirmed by the coarse ware[18] and cooking ware,[19] which is now only locally produced.[20]

The assumption of local glass production fits well with the picture of a new economic order connected to narrower trade and markets and therefore, to the predominance of local and regional production.

Regarding the use of goblets as stemmed lamps in ecclesiastical buildings, is important to highlight that, from the end of the 5th century AD, the town was involved in a process of urban reorganization, which also consisted of the construction of cult buildings. Besides the structure to which the impost block found in the theatre[21] belonged, other important elements that can be connected to a cult building have also been found. This structure with worship functions might date to the end of the 5th century AD although it is more likely to originate from the 6th century AD, when during the Justinian period, it was reorganized into three aisles with a narthex and probably an atrium.[22]
(R.P.)

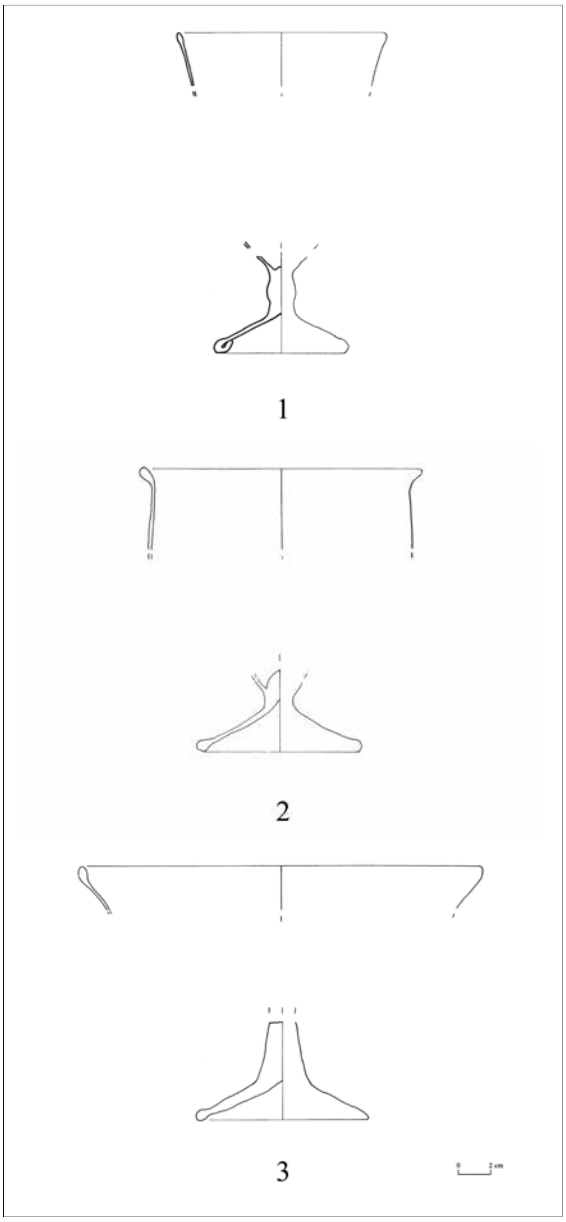
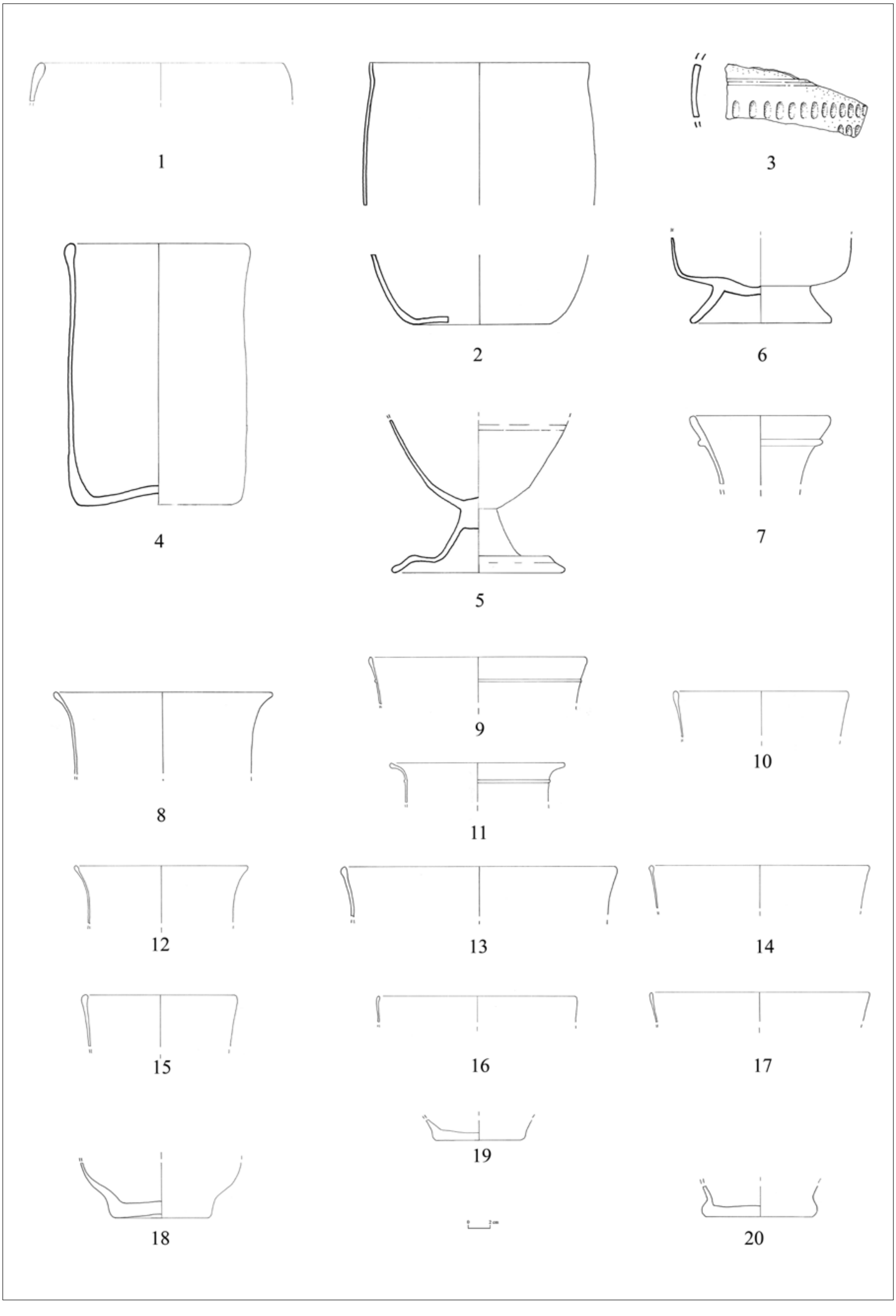


Fig. 4: Types of goblets from Hadrianopolis (drawings S. Cingolani).

Fig. 5: Glass-working waste and lumps from Hadrianopolis.

17 Lahi and Shkodra 2012,190.
18 Capponi 2012, 171-174.
19 Tubaldi 2012b, 177-181.
20 In Butrint the range of imports reflect the importance of active commercial trade, which is very complex and articulated in Reynolds 2004, 234-236.
21 Montali 2012, 218-221.
22 Perna 2012a, 126-134.



Pl. 1: Glass from Hadrianopolis (drawings S. Cingolani).

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THE DISCOVERY OF COBALT COLOURANT RAW MATERIALS AS INCLUSIONS WITHIN ANGLO-SAXON GLASS BEADS

Introduction

Cobalt is one of the earliest colourants used in ancient vitreous material production. Many analytical studies of cobalt-blue glasses have used the presence of minor or trace elements, or increased levels of major elements, to suggest the raw materials that may have been used. These suggested sources range from minerals associated with silver ores found in Central Europe to the use of cobalt-rich alums in New Kingdom Egypt.[1]

Where cobalt-containing inclusions have actually been found within glass objects it has occasionally been possible to suggest the sources of raw materials used to produce them.[2] Further discoveries of cobalt-rich raw materials in similar primary contexts that directly link them to glass production are therefore of great importance to the study of ancient glasses.

1 Dayton 1993; Tite 2003.

2 Freestone 1988.

Fig. 1: Photograph of mottled blue beads from Ringlemere: left: grave 8, bead f, diameter 15 mm; right: grave 8, bead g, diameter 18 mm.

In the course of the British Museum-led research excavations at a prehistoric site at Ringlemere, Kent, 51 Anglo-Saxon burials clustered in groups were also discovered. They contained surprisingly rich grave goods and stray finds consistently compatible with a fifth or early sixth-century date. The objects recovered come from a diverse cultural background. The people from Ringlemere had far-reaching connections and seemed to be rather well-off.[3]

3 Marzinzik 2011.

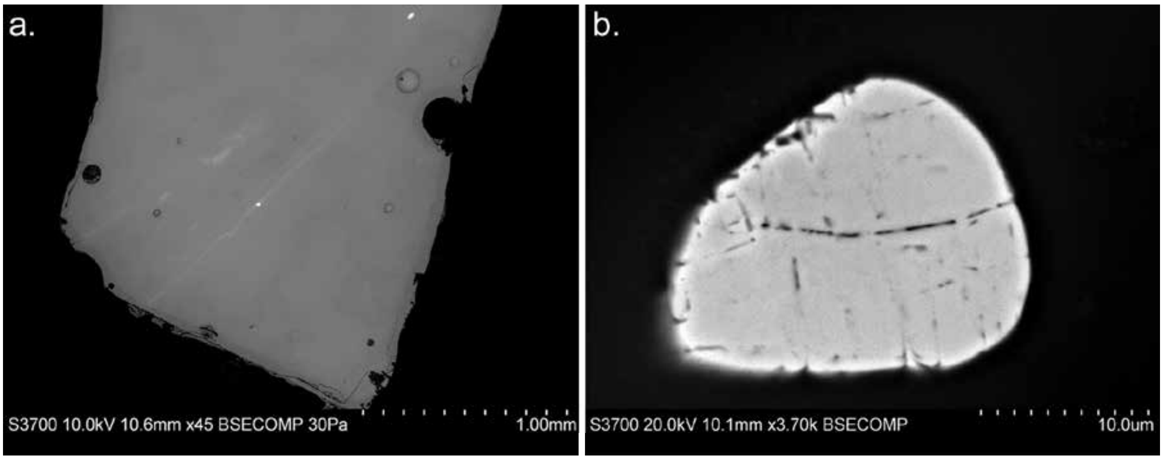

Fig. 2: SEM images of the mounted glass fragment in backscattered mode (a) Note the bright streaks of high-cobalt glass extending from the site of the cobalt-rich inclusion 2, visible as a white spot in the centre of the figure; (b) High magnification image of cobalt-rich inclusion 2.

Among these varied grave goods were hundreds of glass beads of a wide variety of forms and colours. Particularly common were opaque red and yellow, with opaque blue, black, white and green also occurring regularly. Among the translucent shades, blue and green tones are predominant.[4] The chemical composition and design of these beads can be used to suggest that some are reused Roman beads and that the remainder are contemporary with other grave goods and have a continental or Anglo-Saxon origin.

One highly fragmented bead in particular has provided some of the most interesting analytical results; a mottled blue bead from grave 36 (from here on described as bead 36a). This bead is made from blue glass with small flecks of red decoration; Guido[5] type 6xi. It was highly fragmented when found, however similar, almost complete mottled blue beads from Ringlemere, can be seen in Figure 1. The distribution of these beads includes Anglo-Saxon England, Ireland and continental row-grave cemeteries.[6] An origin in Sweden or the Low Countries has been suggested for this type of bead by Guido.[7] Scientific analysis has been able to shed some light on the raw materials used to produce this bead.

4 cf. Guido 1999 and Brugmann 2004
5 Guido 1999.
6 Brugmann 2004.
7 Guido 1999.

Research questions

- Is it possible to identify any unmelted inclusions in the cobalt-blue glass beads and can any of these inclusions be linked to specific raw materials?
- What can this information tell us about the provenance of the raw materials or the beads themselves?

Methodology

Scanning electron microscopy with energy dispersive X-ray spectrometry (SEM-EDX)

A Hitachi S3700 variable pressure (VP) SEM was used in high vacuum and variable pressure modes. Analysis was carried out with a 20 kV accelerating voltage, 0-10 keV spectral range, 2.30 nA current and 150 seconds live time. Calibration was carried out using metal and mineral standards. Corning A glass standard was analysed to verify that this calibration was producing accurate results. This analytical method resulted in detection limits for most metal oxides of around 0.1%. Some fragments were qualitatively analysed unprepared under low vacuum and one fragment was mounted in epoxy resin, polished to a 1 µm diamond paste finish and carbon coated for quantitative analysis.

The SEM can also be used to image the sample in various ways. One of the most useful in terms of this project was backscattered electron (BSE) imaging. This technique provides a black and white image which reveals differences in composition by differences in brightness. The higher the atomic mass of an element the brighter the image is.

Raman spectroscopy

A Horiba Infinity with a green (532 nm) laser was used. Measurements were made in-situ on the surface of the polished section with no additional sample preparation. Spectra produced were compared with reference spectra from an in-house database and published data.

Results

SEM Imaging

Using BSE imaging it was possible to produce a visual representation of compositional differences across the prepared samples. Qualitative compositional analysis was carried out on any inclusions using EDX.

Many inclusions rich in copper could be found on the unprepared fragments of the bead analysed under low vacuum. Investigation of the mounted and polished fragment at high magnification could also identify various inclusions related to the basic raw materials used in the production of these beads. These inclusions were high in aluminium, iron and titanium and are believed to result from the incomplete melting of impurities in the raw materials used in the preparation of the glass. It was also possible to identify cobalt-rich inclusions in the prepared fragment of bead 36a (Figs. 2 and 3). These inclusions were studied further using quantitative SEM-EDX and Raman spectroscopy.

SEM-EDX

The results of quantitative SEM-EDX analysis showed that the three inclusions in the bead contained high levels of iron, cobalt and aluminium (Table 1). Inclusion 3 also contains significant copper levels. These inclusions are clearly the cobalt-rich raw material used to colour this bead blue. However, from the major and minor chemical

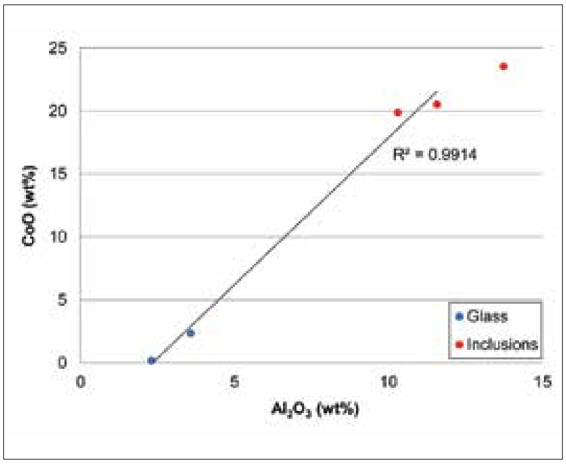

Fig. 3: Cobalt oxide (wt.%) vs. aluminium oxide (wt.%). The trendline is based on both glass samples and inclusions 1 and 2.

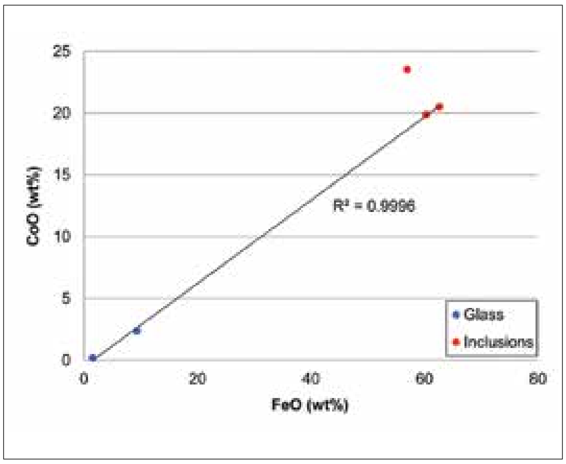

Fig. 4: Cobalt oxide (wt.%) vs. iron oxide (wt.%). The trendline is based on both glass samples and inclusions 1 and 2.

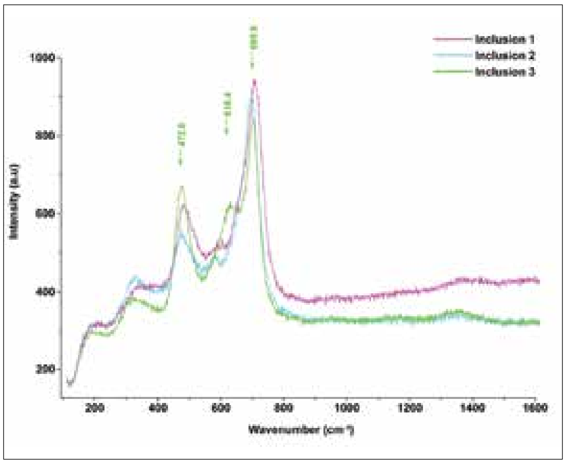

Fig. 5: Raman spectra for the three cobalt-rich inclusions.

	Na_2O	MgO	Al_2O_3	SiO_2	FeO	CoO	NiO	CuO
Inclusion 1	1.07	1.83	11.57	0.93	62.64	20.51	1.37	0.09
Inclusion 2	2.19	1.87	10.3	3.79	60.32	19.88	1.57	0.06
Inclusion 3	0.61	1.76	13.74	0.71	56.94	23.53	1.88	0.82
Glass near inclusion 2	22.45	1.02	3.57	61.18	9.29	2.34	nd	0.14
Bulk bead glass	24.02	0.68	2.29	71.12	1.47	0.19	nd	0.23

Table 1: SEM-EDX normalised quantitative major and minor chemical composition of cobalt-rich minerals and glass of bead 36a (nd=not detected).

composition data alone, it was not possible to identify their origin.

Analysis of the glass surrounding cobalt-rich inclusion 2 showed elevated levels of cobalt, iron and aluminium compared to the bulk glass of the bead (Table 1 and Fig. 2a). It was possible to observe that the cobalt-rich inclusions have a direct effect on the composition of the glass surrounding them. How the cobalt and other components are incorporated into the glass can be investigated by plotting the cobalt content of the glass and inclusions against other major components (Figs. 3 and 4).

Raman spectroscopy

Using Raman spectroscopy it is possible to suggest the mineral form in which the various elements detected by SEM-EDX are present. The Raman spectra for the inclusions show a series of peaks (Fig. 5). Two main peaks can be seen in all three spectra and one further peak in the analysis of inclusion 3. These peaks are at approximately 470, 700 and 620 cm^{-1} respectively. The peak at 700 cm^{-1} is tentatively interpreted as magnetite (iron oxide, Fe_3O_4), shifted slightly due to the presence of other compounds. The peaks at 470 and 620 cm^{-1} may be related to an aluminium-cobalt-rich phase of the inclusions. It has not been possible to fully characterise the inclusions by comparison with existing datasets. However, it is likely they are not naturally occurring minerals.

Discussion and conclusions

The discovery and investigation of the inclusions found within a glass artefact provides a way of identifying raw materials used in early medieval cobalt-blue glass production. Both copper and a cobalt-rich material appear to have been used to colour the glass of bead 36a blue.

The results of this study show that the cobalt-rich inclusions in this glass bead are characterised by high iron (probably magnetite) and aluminium levels. It is therefore suggested that the raw material used as the colourant in this bead contained a mixture (likely unintentional) of a cobalt-aluminium-rich mineral with magnetite which, following high temperature processing, has formed the inclusions within the glass. Geologically, magnetite is found together with cobalt-rich minerals and similar mineral combinations and therefore sources have been suggested for the colorants in medieval Islamic blue glass production.[8]

It may be possible to identify more archaeological examples of the use of this type of colourant by comparing the results obtained from previously analysed blue glasses with the chemical composition of the glass and inclusions in this bead (Figs. 3 and 4).

Experimentation with possible cobalt-rich raw materials and further scientific investigation may be able to define the mineral used and suggest potential locations for its provenance.

Acknowledgements

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8 Allan 1973.

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LES RÉCIPIENTS EN VERRE DES INHUMATIONS DE L'ANTIQUITÉ TARDIVE ET DU HAUT MOYEN AGE EN PICARDIE (FRANCE)

Introduction

L'archéologie funéraire s'attèle à comprendre la place qu'occupent les morts dans les sociétés anciennes par le biais des rituels, comme les modes de traitement du défunt, la structuration de la sépulture ou le dépôt de mobiliers. Les pratiques funéraires modèlent ainsi des assemblages de vaisselle, issus de contextes clos et bien datés. Les séries de récipients ainsi constituées permettent de travailler sur la représentation numérique des différents vaisseliers en céramique, en verre ou en métal, sur la fonction des récipients et sur leur évolution chrono-typologique.

Il nous a semblé intéressant d'appliquer ces problématiques aux verres des sépultures datées de la fin de l'Antiquité et du premier haut Moyen Age en Picardie (France; Fig. 1). Le choix de cette région est motivé par la pluralité des connaissances sur les pratiques funéraires et sur l'histoire politique locale. Les données proviennent des fouilles conduites sur un nombre important de nécropoles tardives, des études faites sur les pratiques funéraires et des travaux menés sur l'organisation administrative de la région. L'aire géographique, définie par les limites administratives actuelles, regroupe quatre cités de tradition gallo-romaine, situées au carrefour entre la Gaule Belgique, la Gaule Lyonnaise et la Bretagne.

Les résultats présentés dans cet article sont tirés d'un travail de doctorat reposant sur un corpus de 215 sites funéraires datés entre la fin du III^e^ siècle et la fin du VII^e^ siècle dont 90 ont livré des sépultures contenant de la vaisselle en verre. Ne sont présentés ici que les 19 sites les plus représentatifs, pour un nombre minimum de 247 tombes et 267 objets (Fig. 2).

Les récipients ont été classés par forme, par groupe de pâte et par technique de fabrication. Les catégories obtenues ont ensuite été confrontées aux datations de leur contexte de découverte, établis à partir des objets présents dans la tombe, définissant quatre horizons chronologiques : l'horizon 1 compris entre le dernier tiers du III^{e} et le milieu du IV^{e} siècle, l'horizon 2 compris entre le milieu du IV^{e} et le milieu du V^{e}

siècle, l'horizon 3 compris entre le milieu du Ve et le dernier tiers du VIe siècle et enfin l'horizon 4 compris entre le dernier tiers du VIe et le dernier tiers du VIIe siècle.

Dernier tiers du IIIe-mi IVe

La vaisselle de l'horizon 1 compte 82 récipients, répartis en quatre catégories fonctionnelles. La vaisselle à verser (regroupant les formes hautes fermées telles que les cruches, les flacons, les bouteilles et les barillets) est la mieux représentée avec 29 individus. Vient ensuite la vaisselle à boire (regroupant les formes basses à embouchure moyenne tels que les gobelets et les vases à boire) avec 26 individus. La vaisselle de présentation (regroupant les formes basses largement ouvertes comme les coupes à pied ou apodes) avec seulement 6 individus. Enfin, seuls 7 contenants à soins du corps sont recensés.

Deux groupes de pâtes sont identifiés pour l'horizon 1. Les pâtes dites naturelles couvrent environ 60% du lot. La teinte vert clair est prépondérante. Les teintes bleuté et bleu-vert sont présentes mais de manière anecdotique. Les pâtes incolores représentent un peu moins de la moitié de l'ensemble. Nous supposons que ces pâtes sont majoritairement décolorées à l'antimoine car l'observation macroscopique de la surface des récipients montre une altération de teinte jaune à jaunâtre sur la quasi-totalité des individus.

Les assemblages de formes et de décors de l'horizon 1 rompent assez nettement avec les ensembles des périodes précédentes (Fig. 3). Au IIIe siècle, les récipients sont variés et regroupent différentes formes aux caractéristiques morphologiques et décoratives diversifiées. Dès le dernier tiers du IIIe siècle, le répertoire de formes entame une mutation et évolue vers une standardisation et une réduction du nombre de types. Cette standardisation entraîne la modernisation des techniques de façonnage et la modification des caractères morphologiques. Ainsi, les attributs du IIe-IIIe siècle comme les bases annulaires rapportées, les lèvres ourlées par repli vers l'extérieur, les bords à marli horizontal ou les panses cylindriques tendent à disparaître. Ils sont remplacés par des fonds apodes, par des pieds discoïdes repliés, par des lèvres meulées, par des bords en esse, par des embouchures en entonnoir et par des panses ovoïdes. Les décors sont épurés et certainement plus rapidement exécutés, c'est pourquoi, la technique de l'application est préférée à la gravure qui disparaît complètement. Les figures complexes géométriques ou vermiformes, ainsi que les résilles et les dépressions sont remplacées par des motifs simples comme des lignes parallèles appliquées sur le pourtour du récipient, sous la lèvre ou sur le bas de la panse. Les décors serpentiformes sont réservés aux rares pièces d'exception.

Fig. 1 : Localisation de la région d'étude.

La vaisselle à boire de l'horizon 1 est constituée au trois quart de gobelets hémisphériques apodes (type Isings 96), de gobelets tronconiques apodes et de hauts gobelets ovoïdes à pied refoulé (type Isings 109). Ces trois types constituent les deux tiers des récipients destinés à la boisson. Quelques formes anecdotiques complètent l'ensemble comme les gobelets bulbeux à pied pincé (type Trèves 62a) et les gobelets ovoïdes à pied annulaire rapporté (type Trèves 64). Au sein de la vaisselle à verser, quelques formes anciennes perdurent mais la quasi-totalité des formes de cette catégorie est renouvelée au début du IVe siècle. Ainsi, les flacons sphériques (type Isings 101 et Isings 133) sont toujours utilisés à la fin du IIIe siècle mais dans des proportions bien moindres qu'au début du siècle. De la même manière, quelques bouteilles cylindriques (type Trèves 140/108) sont découvertes dans

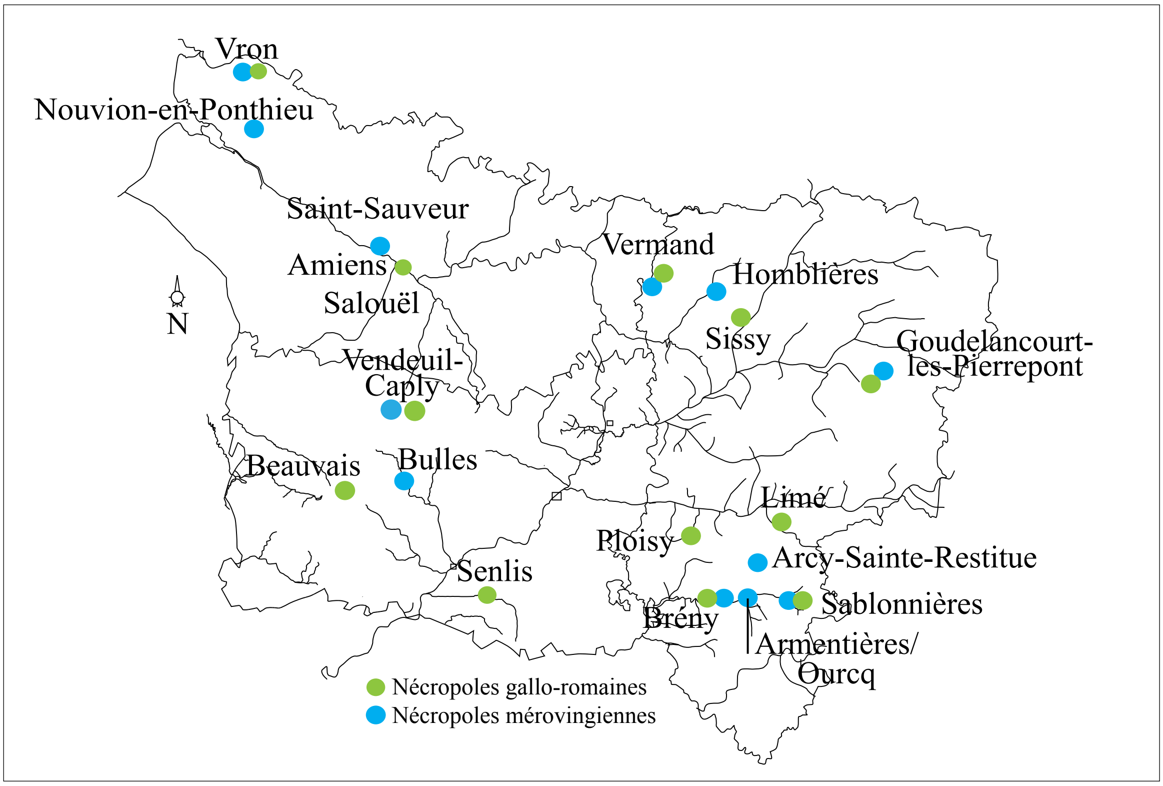

Fig. 2 : Carte de répartition des sites.

des contextes jusqu'au milieu du IVe siècle. Les cruches à bec tubulaire de type "biberon" qui apparaissent vers la fin du IIe siècle sont utilisés jusqu'au milieu du IVe siècle mais leur aspect général est modifié. Ainsi, les exemplaires produits au cours du IIIe siècle présentent une panse sphérique, un col droit et une anse en ruban de section ovale. Le bec verseur est court et relevé. En revanche, au début du IVe siècle, la panse du biberon s'allonge, l'anse est moins développée et décorées d'arrêtes vives. Le bec verseur tend vers le bas.[1] Ce type de biberon est associé dans la nécropole d'Amiens Citadelle, à des pots bilobés en céramique noire, bien connu dans la zone comprise entre l'Escaut et la Somme dans des contextes compris entre 320 et 360 ap. J.-C. La vaisselle à verser compte également des formes nouvelles, essentiellement des cruches à panse ovoïde (type Isings 120) et des flacons à panse sphérique (type Isings 104). Quelques exemples de diotas sont recensés. Enfin, les contenants à soins du corps évoluent peu avec une unique nouvelle forme : les bouteilles cylindriques à anses delphiniformes (type Isings 100a). Les aryballes et les flacons cylindriques à col en entonnoir (type Isings 82) persistent. Le flacon fusiforme (type Isings 105) est apparu sporadiquement dans des tombes d'Amiens et de Beauvais.

Les bouleversements les plus importants concernent la vaisselle de présentation et les contenants de transport des denrées liquides pour lesquels le nombre de types chute au début du IVe siècle. La vaisselle de stockage des liquides opère un changement drastique avec la disparition brutale des bouteilles prismatiques, phénomène visible aussi en Champagne-Ardenne.[2] Les barillets, dont la production commence dans le dernier tiers du IIIe siècle, deviennent l'emballage exclusif des denrées liquides. Les récipients de présentation des denrées solides du IIIe siècle sont délaissés au

1 Cette observation sur l'évolution morphologique des biberons a été faite par V. Arveiller au sujet des exemplaires du musée de Strasbourg (Arveiller 1985, 116).

2 Louis 2012, 198.

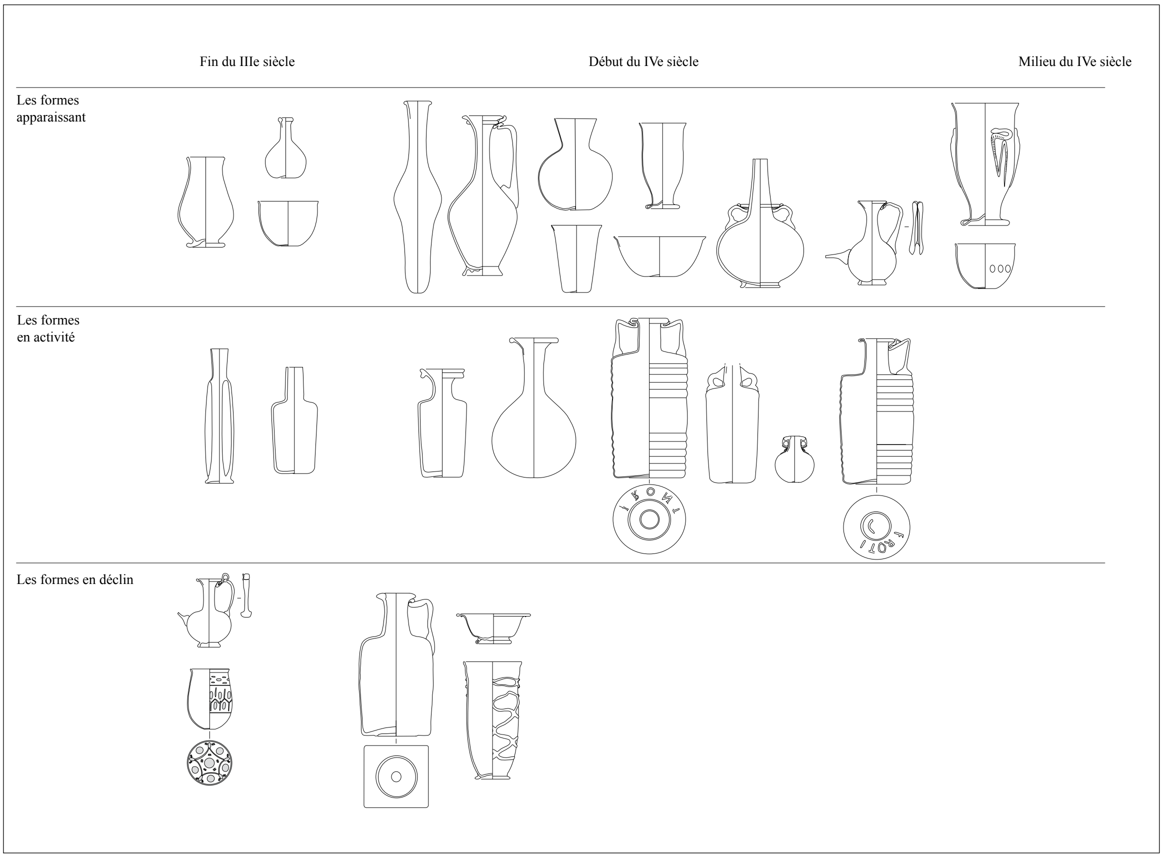

Fig. 3 : Les formes rencontrées à l'horizon 1.

profit d'une unique forme de coupe hémisphérique apode (type Isings 116 et Isings 117).

Le principal faciès verrier de la fin du IIIe siècle au milieu du IVe siècle en Picardie correspond au faciès gallo-romain en usage dans les régions de France septentrionale. Il est basé sur des récipients peu décorés aux formes simples et peu variées. Le mode d'utilisation des verres dans les tombes traduit également une tradition gallo-romaine qui semble propre aux régions du nord et du nord-est de la France.[3] Ainsi, dans les tombes de la fin du IIIe siècle, le service du banquet tend à disparaître et le mobilier funéraire se réduit à un unique récipient en verre, placé de préférence à proximité du crâne du défunt. Dans les premières décennies du IVe siècle, l'assemblage de service semble être réintroduit dans les inhumations. Il est composé de vaisselle en verre, en céramique et ponctuellement en alliage cuivreux. Les différents types de vaisselle se complètent; les récipients à boire en verre sont alors associés à des vases à verser en céramique et inversement. De plus, la pratique du dépôt près du crâne tend à disparaître au profit d'un placement vers les pieds. Quel que soit l'horizon chronologique, aucune distinction du genre du défunt n'est faite dans le choix de la forme ou du décor des récipients en verre. Un second faciès est visible dans les tombes dites militaires d'Amiens, de Saint-Quentin et de Beauvais. Il se traduit par des récipients et des pratiques différentes de ceux du faciès local et proviendraient de régions extérieures. Ainsi, les diotas, les flacons sphériques ou les flacons fusiformes seraient d'influence romaine, voire italienne, tandis que les récipients à décors serpentiformes proviendraient de Germanie. Ces importations transiteraient par les militaires casernés dans les villes de garnison comme Amiens ou dans les stationnements comme Beauvais ou Saint-Quentin, placées le long des voies menant au camp de Boulogne-sur-Mer.

3 Louis 2012.

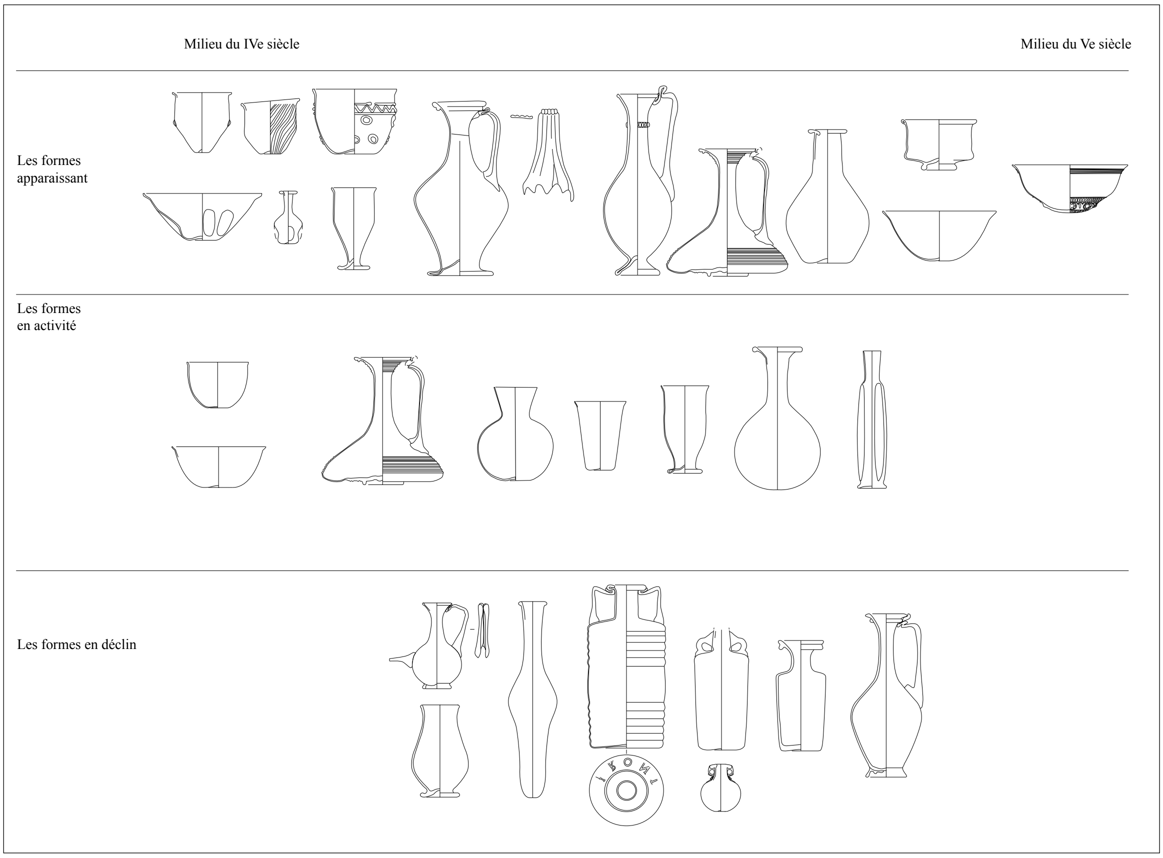

Fig. 4 : Les formes rencontrées à l'horizon 2.

Mi IVe – mi Ve s. ap. J.-C.

L’horizon 2 regroupe un total de 74 récipients. Les proportions des catégories de vaisselle changent. La catégorie la mieux représentée n’est plus la vaisselle à verser mais la vaisselle à boire. La vaisselle de présentation est beaucoup plus présente avec un nombre de récipients presque quatre fois plus élevé qu’à l’horizon précédent.

Les récipients sont réalisés quasi exclusivement dans des pâtes de teinte vert clair. Le verre décoloré devient anecdotique, au même titre que les pâtes bleu-vert ou vert olive.

A l’horizon 2, plusieurs formes initiées au début du IVe siècle disparaissent dans les dernières décennies du siècle comme les barillets, les cruches à bec tubulaire, les flacons fusiformes ou les bouteilles et flacons cylindriques (Fig. 4). Par contre, les récipients de production de masse comme les gobelets hémisphériques, les gobelets tronconiques, les gobelets à pied, les cruches et les coupes apodes persistent. Contrairement à la rupture de la fin du IIIe siècle, les transformations morphologiques apparaissant à l’horizon 2 ne sont pas dues à une révolution technique mais plutôt à de nouvelles modes, de nouveaux goûts esthétiques dont certains sont propres à une zone géographique. Trois grandes tendances apparaissent. Les lèvres meulées connues dès la fin du IIIe siècle perdurent dans la seconde moitié du IVe siècle mais elles sont lentement remplacées, dès la fin du IVe siècle, par les lèvres arrondies qui deviendront exclusives dès les premières décennies du Ve siècle. Vers le milieu du IVe siècle, les panses carénées font leur apparition aux côtés des panses sphériques et ovoïdes. Les pieds ourlés connus à l’horizon précédent sont étirés et pincés, leur conférant une forme discoïde. Les motifs des décors sont sensiblement identiques à l’horizon précédent. Les décors d’applique sont très prégnants, notamment les cabochons de couleur bleu foncé, vert émeraude ou brun. Ils sont alignés au centre de la panse, groupés en triangle, disposés en chevron ou en alternance avec des pastilles de grande taille. Les fils de couleurs brun, rouge, vert ou noir sont appliqués horizontalement ou en zigzags. Les décors travaillés à chaud sont développés comme les dépressions, les pinces, les figures en relief ou les cannelures soufflées-moulées qui seront particulièrement présentes à l'horizon suivant.

Globalement, les formes de vaisselle à boire sont les mêmes que celles de l'horizon 2. Les seuls changements notables sont les panses carénées et les lèvres arrondies qui concernent les gobelets (type Isings 96) et les vases à pied (type Isings 109). On note que les gobelets bulbeux (type Trèves 62) sont moindres. Vers la fin du IVe siècle apparaissent les gobelets cylindriques à base annulaire et lèvre ourlée vers l'extérieur (type Foy 9). La vaisselle à verser est constituée de cruches qui elles aussi, accusent des panses plus saillantes, et de flacons ou bouteilles à panse ovoïde ou carénée (variante Isings 101/Isings 133). La vaisselle de présentation se résume à des coupes hémisphériques apodes pour lesquelles les seules transformations, à la fin du IVe siècle, sont l'arrondissement de la lèvre et la décoration de frises à motifs géométriques soufflés dans un moule. Les rares contenants à soins du corps sont de petits flacons à panse sphérique parfois décorés de dépressions. Enfin, les récipients de stockage et de transport des liquides ne sont plus usités.

Le faciès culturel local évolue peu et regroupe des récipients de formes simples et de décors sobres. En revanche, le faciès exogène change. Les influences romaines se font moins sentir, peut-être à cause de la fermeture des casernements romains dans les premières décennies du IVe siècle. En revanche, les influences "germaniques" sont plus prégnantes, notamment dans la zone située autour de Saint-Quentin (Vermand, Homblières, Sissy).

Du milieu du Ve siècle au dernier tiers du VIe siècle

Les tombes de l'horizon 3 comprennent 92 récipients. La vaisselle à boire est toujours la mieux représentée avec 43 individus, puis vient la vaisselle à verser avec 36 individus et la vaisselle de présentation avec 13 individus. Les contenants de toilette disparaissent. Le nombre important de récipients présents dans les tombes montre que la production verrière se maintient à une époque où dans les autres régions le verre a tendance à s'étioler.

Le groupe des pâtes de teinte vert clair représente la moitié du lot. Les pâtes bleue apparaissent et constituent un quart de l'ensemble. Le reste des récipients est façonné dans des pâtes décolorées ou jaunâtres.

L'évolution technique enclenchée précédemment se précise à l'horizon 3 avec l'abandon des techniques d'influence romaine au profit des techniques apparues au Ve siècle (Fig. 5). Les lèvres coupées sont remplacées par des lèvres arrondies ou effilées qui peuvent être rentrantes. Les panses globulaires tendent à se substituer aux panses sphériques. Les bases discoïdes perdent de l'importance. Les décors de cannelures soufflées-moulées se développent fortement. Elles sont verticales ou obliques. Les décors appliqués perdurent également mais les motifs sont moins variés et correspondent majoritairement à des filets appliqués en spirale. En revanche, un nouveau décor voit le jour. Les arcades de matière colorée rouges ou blanches teintées dans la masse qui ornent la partie inférieure de la panse deviennent le décor phare de cette période.

La vaisselle à boire est composée uniquement de gobelets. Les gobelets tronconiques et hémisphériques perdurent jusque dans la seconde moitié du Ve siècle. Cependant, les gobelets tronconiques sont plus élancés avec une base rétrécie et une lèvre arrondie. Ils sont souvent soufflés dans un moule à cannelures. Les gobelets à pied sont toujours en usage au VIe siècle mais avec un profil allongé, une embouchure plus évasée et un pied plus étroit. Deux nouvelles formes complètent la catégorie : le gobelet biconique (type Feyeux 52) et le gobelet campaniforme (type Feyeux 56). Le gobelet biconique à bouton terminal est caractéristique de l'horizon 3. Son profil peut varier entre des formes plus ou moins trapues, plus ou moins étirées et des ouvertures plus ou moins larges. Le gobelet campaniforme est lui aussi bien présent, avec des profils plus ou moins élancés. Les décors appliqués sur ces deux types de gobelets

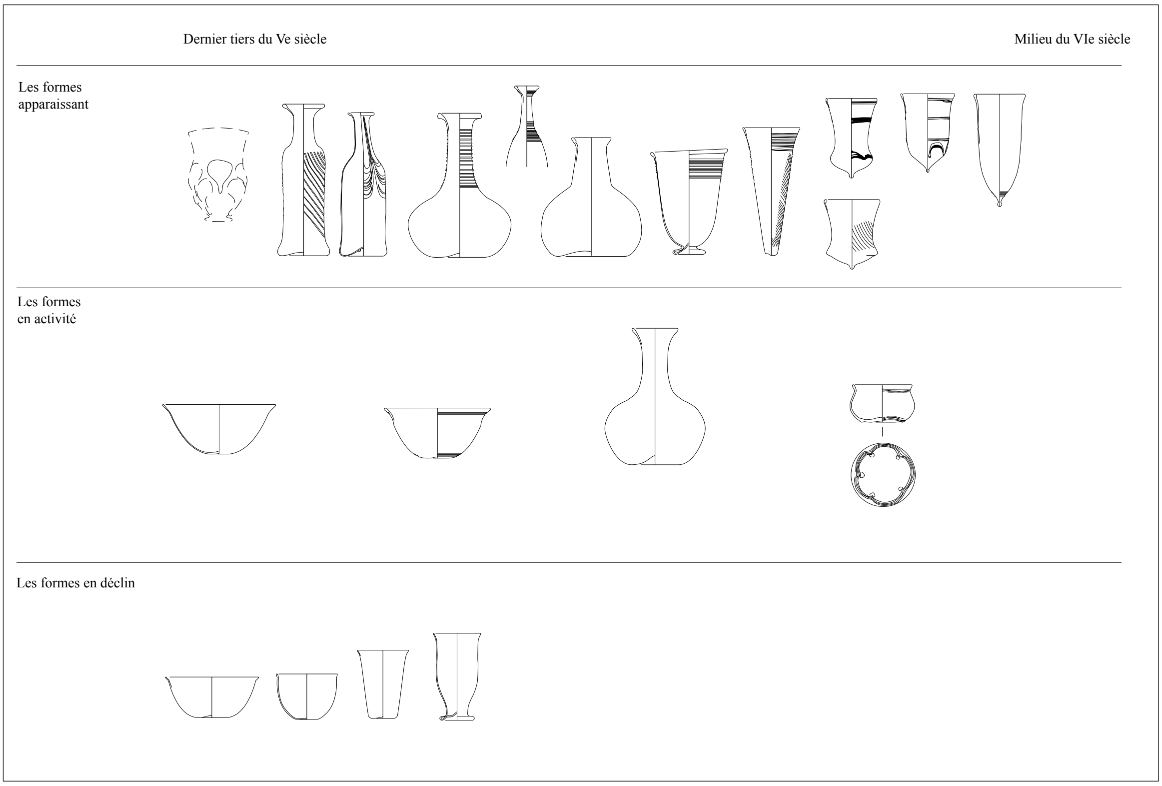

Fig. 5 : Les formes rencontrées à l'horizon 3.

sont standards. Il s'agit de fils horizontaux groupés en bandeaux sous la lèvre, au milieu de la panse et en partie basse et sont associés à des arcades. Les récipients à verser se réduisent à deux formes : les flacons et les bouteilles. Les flacons se différencient de l'horizon précédent par une panse globulaire et un col allongé parfois conique. Les lèvres sont pleines, triangulaires, à bourrelet extérieur ou ourlées par repli vers l'intérieur. Les bouteilles accusent une forme très particulière et originale, avec un corps cylindrique à épaule tombante et une base légèrement pincée. La vaisselle de présentation est peu nombreuse. Elle se réduit à des coupes hémisphériques apodes (type Feyeux 81) et à des pots carénés (type Feyeux 91). Ces derniers sont une création spécifique à l'horizon 3 avec des panses globulaires et trapues.

Au début du VI^{e} siècle, à l'instar des récipients, les pratiques funéraires changent. Le dépôt de vaisselle en verre dans la tombe semble dorénavant être corrélé au sexe du défunt. Les sépultures masculines contiennent assez peu d'objets en verre et le cas échéant, ils sont placés à côté du crâne. En revanche, les sépultures féminines sont beaucoup mieux pourvues, avec des récipients placés essentiellement aux pieds de l'inhumée. Le VI^{e} siècle marque le début du dépôt d'un unique objet, souvent en verre, sur le couvercle du cercueil.

Bien que les régions de l'extrême nord de la France se situent en territoire franc, des influences extérieures se font sentir. Ainsi, le dépôt du récipient en verre dans un coffre en bois le long de la jambe du défunt comme on le voit dans les sépultures dites "germaniques" de Bulles (Oise), de Goudelancourt (Somme) ou de Limé (Aisne), trouve des comparaisons dans les sépultures d'Alsace et d'outre-Rhin. A l'opposé, les nécropoles de la côte maritime semblent être en lien avec les régions d'outre-Manche comme en témoigne la présence de vases à décor de trompes (type Evison 33) dans les sépultures de Saint-Sauveur (Somme). Enfin, il convient de mentionner l'apparition dans la première moitié du VI^{e} siècle des décors chrétiens. Ces pièces sont découvertes dans les sièges du pouvoir ecclésiastique comme Homblières ou Vermand, correspondant aux anciens fiefs du pouvoir militaire et politique romain. On peut remarquer par ce biais, une persistance des lieux de pouvoir entre l'époque romaine et l'époque mérovingienne.

A partir de la fin du VIe siècle, la quantité de mobilier funéraire diminue et les récipients ne sont plus disposés dans le cercueil mais sur le couvercle. Le faible nombre de tombes exploitables ne permet pas de discuter des pratiques pour cette période mais il semble que le dépôt aux pieds soit toujours de rigueur.

L'étude du mobilier en verre en contexte funéraire montre qu'il est possible, au-delà des informations chronologiques et typologiques offerts par une sériation d'ensembles clos, de distinguer des groupes de population et leur interaction. En Picardie, il apparaît clairement que les pratiques funéraires liées au verre sont guidées par un faciès culturel local empreint de romanité mais qui sait conserver ses particularités locales. La région picarde est également un carrefour où se mêlent les populations venues de régions extérieures et parfois lointaines.

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STAŠŠÍKOVÁ-ŠTUKOVSKÁ Danica, PLŠKO Alfonz

DIFFERENCES BETWEEN THE FINDINGS OF SEGMENTED BEADS IN SKELETON GRAVES FROM THE REGION OF MIDDLE DANUBE DATED TO 7TH–11TH CENTURIES

In this paper, the focus is on cross-wise segmented beads that are located among the numerous skeleton graves in the territory of Middle Danube and its surroundings. For this purpose we have analyzed 2217 beads that were located in 317 graves of women and children at 63 burial sites dated from between the 7th and 11th century (Fig. 1). The findings belong to nine separate cultural groups from the Early Middle Ages and originate from three modern-day EU states (the Czech Republic, Austria and Slovakia).[1]

Typological classification and interdisciplinary analyses

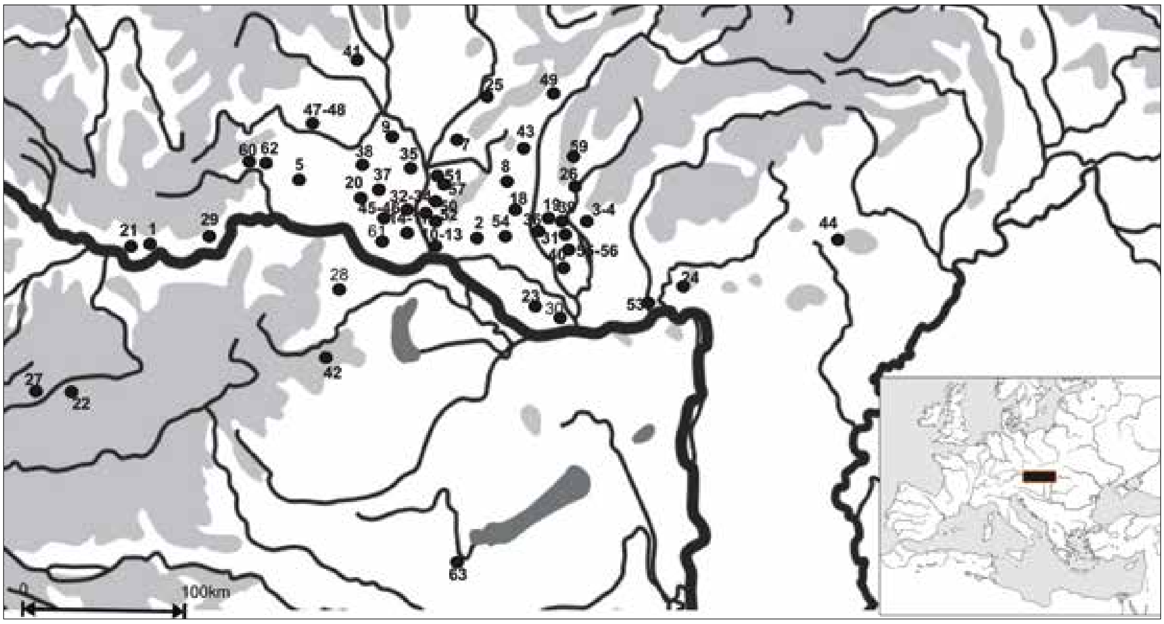
Typological classification[2] aims at a detailed presentation of the findings of cross-wise segmented beads in different geographical locations. Based on the forming technology and morphological signs, we have divided the 2217 crosswise segmented beads into 11 categories (Fig. 1).

Category 1 (Fig. I: 1a-3b; description=Plate 1)

970 pieces of segmented beads from 209 graves belong to this category, which represent 44% of the total findings discussed in this paper. 53. 8 % of the beads from the same category come from 107 graves of 31 sites dated to the 9th century. 38. 7% come from 77 graves and have been dated to the beginning of the 8th and early 9th century. They belong to the culture of the Avar Khaganate, pre-Great-Moravian culture and Carolinian-Kötlashian culture. 7% have been dated to the 10th century. The whole set of 9 analyzed segmented beads represent three chemical types of sodium glass melted with plant ash (Pl. 2: G45b_1,2; T19; T3; T7; T21; T263_47; B19; T23; T24; G38a) . The set of 5 beads were made by Na_2O-K_2O-CaO-

1 Findings from Hungary are taken from published works - Dekówna 1990b; Dekówna 1991.

2 When deciding on categorization, we used macroscopic analysis with the help of the equipment of Discovery V12, Zeiss, on working places in TnU AD Trenčín, AI SAS in Nitra.



Map 1: Map of archaeological sites with findings of cross-wise segmented beads in this work. Austria: 1-Auhof, 21-Gusen, 22-Hohenberg, 237-Krungl, 28-Leobersdorf, 29 -Linz-Zizlau, 42-Pitten, 61-Wimm. Czech republic: 5-Blučina, 6-Bojkovice, 7-Boleradice, 9-Brankovice, 14-17 Břeclav, 19-Dolní Věstonice, 25-Količín, 32-34 Mikulčice, 35-Modrá, 37-Mušov, 38-NechvalínI, 41-Pěnčín, 45-46 Prušánky I, II, 47-Rajhrad, 48-Rajhradice, 49-Rudimov, 51-Staré Město, 52-Strážnice , 57-58 Uherské Hradiště, 60-Vysočany,62-Znojmo. Hungary: 62-Zalakomár. Slovakia: 2-Bernolákovo, 3,4-Bešeňov, 8-Borovce, 10-13 Bratislava, 18-Bučany, 19-Čakajovce, 23-Holiare, 24-Ipeľský Sokolec, 26-Kostoľany pod Tribečom, 30-Malé Kosihy, 31-Michal nad Žitavou, 36-Mostová, 39-Nitra, 40-Nové Zámky, 43-Pobedim, 44-PršaII, 50-Skalica, 53-Štúrovo,54-Trnovec nad Váhom, 55-56 Tvrdošovce, 59-Veľké Hoste.

MgO-SiO_2 glass. Relatively few close parallels were observed between beads that were cut as straight sections in terms of the totals and proportions of principal glass-forming constituents, although the glass composition appears similar overall. The transparent blue color of beads T7 is the likely result of iron oxide (Fe_2O_3- 1,25, 0,59, 0,67wm%) strengthened by CuO (0,24 wm%) and redox conditions. The blue color of sample B19 is the result of CoO and Fe_2O_3 (1,07wm%). The green color of sample T3 and T21 is the result of Fe_2O_3 (combination of FeO : Fe_2O_3).

The glass of type Na_2O-K_2O-CaO-MgO-SiO_2 was generally known in the early medieval period. Some specimens were produced or processed secondarily in Bulgaria (10th century), at Haithabu and Old Ladoga (9th–10th century).[3]

The glass of type Na_2O-K_2O-CaO-MgO-Al_2O_3-SiO_2 (translucent blue T19 (8th/9th century AD) and T23 (9th/10th century), turquoise G38a (9th/10th century) and yellow T24 (dated to 8th/9th century AD) is in technological terms, similar to the chemical type described above. The only difference is the higher aluminum content. Two samples (blue T19 and yellow T24) also have PbO 4% and 4.4% in its content. According to L. Ščapova, this quantity influences the characteristics of the glass.[4] A contrasting opinion states that only content = > 5% should be taken as a criterion for the definition of type Na_2O-PbO glass.[5] It cannot be excluded that the two specimens (T19 and T24) could be considered as glass type Na_2O-K_2O-CaO-MgO-SiO_2 while PbO should be treated as a coloring agent, as it was present on the yellow opaque beads of the Merovingian time (Hoffmann 1994, 1624-1625,

3 Sayre and Smith 1961, 1825-1826; Dekówna 1980, 134-140; Dekówna and Purowski 2012, 95.

4 Ščapova 1973, 31.

5 Dekówna and Olczak 2002, 190, pl. 2.

Fig. 1: Examples of segmented beads in the region of middle Danube. Category 1: 1a,b – Čakajovce grave 594, 2a,b – Borovce grave 82, 3a –Trnovec nad Váhom grave 303, sample n. G38, b- BSE image of the glass of the beads-sample G38. Category 2: 4a-e- Čakajovce grave 594,sample n.G24, b- BSE image of the core of the bead, c- part of profile of the bead, arrow show metallic folia, d- BSE image of edge of the bead, arrow show the metallic folia, e- BSE image of glass outer layer. Category 3: 5a,b- Borovce grave 82, 6 – Borovce grave 82, 7 – Borovce grave 145 core and outer layer with remnants of metallic folia, sample T5. 8a,b – Čakajovce grave 579, core of the bead with remnants outer layer and metallic folia, Category 4: 9a-d- Mostová grave n. 18, sample n.G48 d- BSE image of the glass of core of the bead. Category 5: 11- Borovce grave 234, 12a,b- Nové Zámky grave 27/56,sample n.G25 b- BSE image of glas of the beads, sample n. G25. Category 6: 13 – Dolní Věstonice grave 321_48, profil, 14a- Znojmo grave 760, sample n. G50. b-BSE image of the glass with colour part of the edge, sample G50. Category 7a: 15a,b- Dolní Věstonice grave 321_48. Category 7b: 16-Rajhradice grave 378, 17a,b- Dolní Věstonice grave 321_48. Category 8: 18a,b – Dolní Věstonice grave 140/46. Category 9: 19a,b- Dolní Věstonice grave 263_47. Category 10: 20- Prušánky I grave 113, 21- Staré Město grave 274/AZ. Category 11: 22a,b- Borovce grave 82.

tab.6, G20, G1, G59, G46). Merovingian beads colored with this technique correspond to glass of low quality.[6]

The sample T263_47 shows a proportion of PbO of 14.8% and glass of type Na_2O-K_2O-CaO-MgO-PbO-SiO_2 (Pl. 2: T263_47). This type of bead corresponds to glass of low quality. Similar findings of yellow segmented beads have been found in Prague and are made of opaque glass Na_2O-K_2O-CaO-MgO-PbO-SiO_2 (sample P2 with a content of PbO 21.20%). The glass is heterogeneous, opaque with microscopic crystals of 2PbO.SnO_2 of a yellow color. Pb could have been introduced into the glass material as a $PbCO_3$ cerusit or Pb_3O_4 minium and Sn as a SnO_2 kassiterit.[7] The color of this bead cannot be defined, because of a high degree of disintegration, but it is possible it used to be blue. Due to this, it can be concluded that the role of PbO in the aforementioned sample was different to that of the glass in the bead from Prague.

The extent of glass analyses for objects representing alkaline-lead and lead-alkali glass is currently insufficient to support conclusions concerning places of production. It is only known that manufacturing waste of different types of bead made with yellow opaque alkaline-lead glass opacified with SnO_2 occurred in Old Ladoga.[8] According to technology that uses correlation (Na_2O+K_2O+PbO):(CaO+MgO), two glass specimens from Janów Pomorski (n. 506 a 676a) are identical (2,32 and 2,44) to our sample T263_47 (2,65), but are different in terms of the oxide content of (correlation in %) sand. There is no additional similarity with other glass types of Na_2O-K_2O-CaO-MgO-PbO-SiO_2.[9] Two of our beads with a content of PbO 4.4% and 14.8% are dated to 9th–10th century and bead T-19 (blue) to between the 8th and 9th century. They probably originate from different workshops.

Category 2 (Fig. 1:5a-6g; description=Plate 1)

820 beads (38%) belong to this category; they were discovered in 136 graves from 36 sites, but were not found in combination with beads from the third and forth category. The findings are dated to between the 8th and first half of the 9th century.

During the chemical analyses (Pl. 2: TA6a,b, T14a,b, G27a, T12B_1,2, D3, D4), the results of segmented beads (samples of beads D3 and D4) were also used. The beads originated from Zalakomár, a site in the region of "middle Danube".[10] The whole set of analyzed segmented beads from category 2 represent two chemical types of sodium glass melted with plant ash Na_2O-K_2O-CaO-MgO-Al_2O_3-SiO_2 (Pl. 2: T12B_1,2,TA6a,b, T14a,b, G27a). The only find from Zalakomár has a composition in the coating layer of glass Na_2O-K_2O-CaO-MgO-SiO_2 and in the core Na_2O-K_2O-CaO-MgO-Al_2O_3-SiO_2 (Pl. 2:D3,D4; Dekówna 1993, pl. 5:3,4). The content of MnO 1,39wm% shows that the levels at which MnO actually works as a decolorizing element varies (by Brems and all 2012, 2905). With regard to other samples of sodium glass melted with plant ash beads from category 1 and 2, the concentration of MnO lies between 0.45-1 weight % and has probably been influenced by the recycling of glass cullet.[11] Chemical analyses (with the exception of the aforementioned sample from Zalakomár) have proven the use of the same glass in the core and on the surface layer of the beads from category 2. There are differences in the composition of coloring oxides CuO, MnO a Fe_2O_3. The covering layer of sample G27 has not been analyzed. BSE images show that the glass in the core of beads (coloured yellow-brownish) is extremely heterogeneous and contains many gas bubbles (Fig. 1.4b-c). M. Siegmann has named this kind of glass "satin glass" and considers it a purposefully made product that was fashioned by highly specialized glass masters. The core of such glass that is covered with an

6 Hoffman 1994, 1613; Heck and Hoffmann 2000, 355.

7 Černá *et al.* 2001, 70.

8 Dekówna and Purowski 2012, 157-159.

9 Compare tab.III_T263-47 with Dekówna 1980, 83, pl. 13 and Dekówna and Purowski 2012, pl. 17:1,2.

10 Dekówna 1991, 278, fig. 5; Dekówna 1999, pl. 3.

11 Brems *et al.* 2012, 2905.

outer layer of colored glass is reminiscent of a covering with golden or silver folio.[12] Our glass analysis that Ag folio was used in the beads with a turquoise coloured covering layer of glass (Fig. 1.4c-d).

The outer glass layer is much more homogeneous, transparent and very thin. The thickness of the outer layer measures 0.1-0.9 mm (Fig. 1.4e); the thickness of the silver folia measures 0.05 mm (Fig. 1.4d).

From the point of view of the heterogeneous material of the core, four beads and their fragments from category 2 are analogous to the findings from Janów Pomorski made from glass type Na_2O-K_2O-CaO-MgO-Al_2O_3-SiO_2 and Na_2O-K_2O-CaO-MgO-SiO_2.[13] The material of the core of these beads from Janów Pomorski is not considered glass, but sinter.[14] The results of the glass we analyzed from category 2 as well as those of the analogous samples from Janów Pomorski (correlation of K_2O: (Na_2O+K_2O).100%) are the following: 13.81%-18.7% and 16.96%v-19.87% respectively. There were similarities in the content of different specimens of halophyte plant ash well of plants originating from the regions of Iraqi, Iran, Pakistan and Syria.[15] Concerning the correlation of sand and alkali (SiO_2+Al_2O_3+Fe_2O_3) :(Na2O+K_2O), the similarities are not stable: in our samples they are 3.98-5 and 47; and in the beads from Janów Pomorski 3, 5-4 and 18. The number of oxides CaO+MgO present are very close (our samples = 9.95-12.7 and Janów Pomorski = 10.25-12.21).[16] There are also similarities in the use of MnO for colouring the core and also for the coating for both the samples from Janów Pomorski and in our collection. Based on the comparative method of study of the glass recipes, the origin of glass-formation and alkali materials, the authors of the analysis from Janów Pomorski have concluded that the multilayered segmented beads with metal folio were produced with eastern techniques.[17] This technology originated from the Islamic centres in Middle Asia and were produced by secondary manufacture in Old Ladoga (from 750 AD till 11th century and longer).[18] In the middle reaches of the Danube River, the turquoise segmented beads were able to be identified on 10 sites of the Avar Khaganate and were dated to the first half of the 9th century.

The researchers of the Albanian beads from Bukël studied a broader spectrum of European findings, including those from Borovce, grave 103, samples T14, “middle-Danube” category 2. S. Greiff and E. Nalbani have come to the conclusion through the comparison of results of analyzed beads and the subdivision established by I.C. Freestone that almost all the segmented beads from Bukël and some from European regions (including “middle Danube” samples T14) fall into the Sassanian high-magnesia subdivision of plant ash glass.[19] All the beads from our “middle Danube” Category 2 can also be placed into this subdivision of plant ash glass according to the content of MgO and CaO.

Category 3 (Fig. 1, 5a-8b; description=Plate 1)

114 pieces of such beads (4%) of the entire researched collection come from 22 graves on 16 sites. 13 (60%) graves consisted of 1, 2 or 3 beads from this category. These burials, which contained the most beads from this category, belong to the second half of the 9th to the first half of the 10th century. Chemical analysis (Pl. 2: T5, D5, D6)[20] demonstrated the use of one common recipe for ash glass Na_2O-K_2O-CaO-MgO-SiO_2, which was discussed above. This glass was used for the inner and outer layers. The foil was silver and was spotted as a layer in the profile.

12 Siegmann 2006, 954-955.

13 Dekówna and Purowski 2012, 113-115, ryc.35: 427, 178/I, 726, 167.

14 Dekówna and Purowski 2012, 113-115.

15 Stawiarska 1984, ryc. 3; Dekówna and Purowski 2012, 117, pl. 13: 9-14.

16 The data for the ratios of oxides from Janów Pomorski are mentioned in Dekówna and Purowski 2012, pl. 13, for our samples tab. III category 2.

17 Dekówna 1980, 225; Pöche 2005, 56.

18 Dekówna and Purowski 2012, 122.

19 Greiff and Nalbani 2008, fig. 8, 367.

20 Samples D5 and D6 (Dekówna 1990b, pl. 1:5,6).

Samples T5 and T7 contain beads from a very significant necklace found in grave 145. Glass of type Na_2O-K_2O-CaO-MgO-SiO_2 is well known in different locations within Europe and has been dated to between the 8th and 10th century (see above). It is believed that the multilayered beads with a metal foil layer were imported from the East (from Islamic and perhaps also Byzantine centres of production), but they were also produced in Old Ladoga (840–860 AD and in the 10th century) and perhaps in Haithabu, although they were based on Eastern technologies.[21] The beads from this category were produced with technology close to those with similar recipes in categories 1 and 2 and were part of segmented beads made from ash glass with foil within Europe.

Category 4 (Fig. I: 9a-10; description=Plate 1)

We named these multilayered segmented beads that, in this case, give an optical impression of non-soldered metal foil. M. Siegmann[22] outlined this category of beads and named it Pseudo "Metallübefangperlen". Our "pseudo foil" beads have a core fashioned from quality glass (Fig. 1. 9a-d, 10). On the surface of the core, there is another layer of colourless glass (Fig. 1. 9b a 10). Chemical analysis of our samples have proven the glass to be of type Na_2O-K_2O-CaO-MgO-Al_2O_3-SiO_2 (Pl. 2: G48-27a, b), although a metal layer has not been proven. In terms of the bulk and the resulting sum of the main glass-forming ingredients, the glass used in our sample (G48_27) is close to that of category 2 from Zalakomár (D4) and Borovce (TA6a), as well as the glass from category 1 from Borovce (T19) and Čakajovce (T24). The correlation between Na_2O and K_2O is analogous to the glass used in bead 49 from Zawada Lanckorońska.[23] However, the glass sample G48_27 from Mostová differs in terms of the correlation of sand and alkalis (7.79), which is close to the content of other glass from the group 3 (7,69 a 8, 72).

21 Dekówna and Purowski 2012, 175-176.

22 Siegmann 2006, 954-955

23 Dekówna 1999, pl. 2:12,13.

The beads from category 4 represent 0.4% (10 pieces of bead) in our "middle Danube" corpus of findings that originate from 5 graves on 4 sites. This number should be considered a preliminary estimation, because there has not been an opportunity to verify the presence or absence of foil on all the beads through the methods of natural science.

Category 5 (Fig. 1.11-12b; description=Plate 1)

260 pieces of segmented bead represent 11% of our collection. They come from 62 graves on 22 sites dating to the period of the 7th-9th and 10th century. They were most numerous in graves dating from the 8th and the beginning of the 9th century. The latest were found as single pieces among necklace beads that originate from the 9th – 10th century.

Chemical analyses was carried out on four beads (Pl. 2: T11, TA1, T6, G25b:1.2), which were dated to different periods of the Early Middle Age: see G25b from the Avar period,TA1 and T11 from the pre-Great-Moravian horizon and sample T6 from the late 9th -10th century. Three samples (TA1, T11 and G25b) were cast from mineral soda glass Na_2O-CaO-Al_2O_3-SiO_2. The correlation of Na_2O and K_2O highlight the use of mineral soda. Sample TA1 was made from soda glass Na_2O-CaO-MgO-Al_2O_3-SiO_2 and had a content of MgO 3.81%w. The origin of the MgO should be examined in the context of dolomite sand.[24] The correlation and content of MgO show that the remaining three samples, moulded with the use of mineral soda, also contained dolomite sand. As a colouring oxide, PbO is present in one recipe of soda glass: T1= content PbO 1.45%, CuO and Fe_2O_3. The production of soda glass lasted for a long period in the region of the River Rhine, even after the fall of the Roman Empire.[25]

The bead T6 (category 5) was taken from the necklace found in grave 145 from Borovce, where bead samples T6 and T7 (category 1 and 3; Pl. 2:T6, T7) were also collected and

24 Stawiarska 1984, fig. 5; Henderson 1985, 277.

25 Černá *et al*. 2001, 73-74.

Category	Technique of forming	Number of shapes	Diameter	Heigh	Colour of outer glass	Publications on technique of forming
1	Segmented beads from single-layered tube made by the drawing technique. Tab. I:1a-3b	2_9	3,5-7 mm	3,5-8 mm	blue, yellow, white, green, homogeneous	Dekówna and Szymański 1971, Tab. 1a,b,c; Dekówna 1990a, p.42, Abb. 11; Siegmann 2006, pp. 932-937; Shape like Andrae 1973, Taf. VI: 13-15
2	Multilayered segmented beads with a core of inhomogeneous glass, a metal layer and an outer quality glass. Tab. I:5a-6g	2_5	3,5-7 mm	3,5-7 mm	turquois, yellow, golden, silver, white	Dekówna 1999, p. 55-56, 69; Siegmann 2006, p. 952--955;
3	Multilayerd segmented beads with a core of translucdid glass, a metal layer and an outer glasstab. Tab. I : 5a-8b	2_12	3,5-7 mm	3,5-7 mm	colorless, homogeneous	Dekówna 1999, 56; M. Siegmann 2006, p. 952-953; Greiff and Nallbani 2008, 359.
4	Multilayerd segmented beads with the impression of a metall foil. Tab.I:9a-10	2_12	3,5-7 mm	3,5-7 mm	colorless, homogeneous	Siegmann 2006, 954-955
5	Segmented bead made throughout winding of a glass thread and gluing of segments with conic shape while they are warm into desired look and numbers. Tab. I:11-12b	2_5	4-7 mm	3,5-6 mm	colorless, translucent green, opaque dark brown, green, yellow	Dekówna/Szymański 1971, Fig. 2 c; M. Siegmann 2006, p. 974, 985-986, Taf. 17:2,3
6	Bead formed by the technique of winding up of the glass thread on a metal tubulus, two-coloured, the glass of the corpus is coloured lokaly or with colour striae. Tab. I:13-14b	2_5	4-7 mm	4-6 mm	colourless, homogeneous or with colour striae, translucent green	
7a	Bead formed by the technique of winding up of the glass thread on a tubulus. There is a metal tubulus in a channel which sometimes comes out of the hole of the channel. Tab. I:15a,b	2_4	5-7 mm	4.6 mm	translucent green	
7b	Bead formed by the technique of winding up of the glass thread on a metal tubulus with differently wide segments. Tab. I:16-17b	3	5-7 mm	5-7 mm	translucent green	
8	A bead formed by the technique of screw-winding of a glass belt. Tab. I:18a,b	4_12	4-6mm	3-5mm	translucent green, brown	Siegmann 2008, 928, 972-973
9	Two-colured bead, always two-segmented, with dark corpus, ornamented by circle round line or by spots of glass on the surface. Tab. I:19a,b	2	6-9 mm	7-9 mm	dark brown ornament yellow, blue	
10	Segmented bead formed by a technique of blowing of glass. Tab. I:20-21	2_3	6 mm	7-9 mm	colorless, bluish, yellow	
11	Segmented bead probably formed by the technique of drawing of the glass thread with a longtitudinal plastical-gandrooned. Tab. I:22a,b	2	6 mm	4,5 mm	colorless, bluish,	

Pl. 1: Descriptions of the categories of beads 1-11.

analyzed. All three typologically different beads were made from soda ash glass Na_2O-K_2O-CaO-MgO-SiO_2 (K2O= 2,08wm%) as discussed previously. By optic observation, bead T6 was not different in terms of size and shape from the beads in the same category that were dated to an earlier period (Pl. 2: T11, TA1) and was melted with the use of mineral soda.

Category 6 (Fig. 1.13-14b; description=Plate 1)

Chemical analyses were carried out on only one of the beads in this category - a fragment of cross wise- segmented bead made from colorless homogenous glass (Na_2O-CaO-Al_2O_3-SiO_2). Part of a pink-coloured ornament was preserved on one part of the corpus. Other segmented beads from this group featured a colo-

Site, grave	Category of bead	Sample name	Colour	abs.dat	Meth.of analyses	SiO2	Na2O	K2O	Al2O3	PbO	TiO2	MnO	Fe2O3	MgO	CaO	ZnO	CuO
Borovce_25	1	T19	blue	8_9.c.	ICP	67,96	10,84	2,43	1,8	4	0,1	0,47	0,98	4,81	5,69	0,19	0,16
Borovce_74	2	T12B_1 (outer layer	silverfish	8_9.c.	ICP	71,87	11,68	2,13	2,17	0,05	<	0,58	1,47	3,81	6,14	<	0
Borovce_74	2	T12B-2 (core)	flounder	8_9.c.	ICP	71,4	12,75	2,55	2,12	0,04	<	0,45	0,67	4,05	5,98	<	<
Borovce_79	5	T11 (outer layer)	turqois	8_9.c.	ICP	63,84	16,81	0,86	2,34	1,45	0,14	1,25	1,92	0,82	6,73	0,11	2,84
Borovce_79	5	TA1 (core)	?	8_9.c.	ICP	64,8	17,1	0,83	2,58	0,53	0,18	1.jan	1,47	3,81	6,11	<	<
Borovce_82	1	T3	green	9_10.c.	ICP	71,21	12,12	2,02	1,37	0,07	0,06	1	0,44	5,1	6,6	0,05	0,01
Borovce_82	1	T21	green	9_10.c.	ICP	70,71	10,84	2,08	1,5	1,83	0,09	1	0,64	4,75	6,52	0,06	0,04
Borovce_103	2	TA6a (outer layer)	turqois	8_9.c.	ICP	66,9	13,9	2,86	2,57	0,41	0,11	1,39	0,74	4,1	6,85	0,02	0,04
Borovce_103	2	TA6b (core)	flounder	8_9.c.	ICP	64,5	14,6	2,71	2,51	0,88	0,14	2,29	0,89	4,13	7,25	0,02	0,04
Borovce_103	2	T14a (outer layer)	turquoise	8_9.c.	ICP	67,07	14,91	2,52	2,34	0,15	0,13	2	0,78	4,06	6,74	0,1	0,02
Borovce_103	2	T14b (core)	flounder	8_9.c.	ICP	64,5	14,6	2,71	2,51	0,88	0,14	2,29	0,89	4,13	7,25	0,02	0,04
Borovce_145	3	T5 (core)	colorless	9_10.c.	ICP	73,4	10,9	1,8	1,67	0,72	0,05	0,78	0,42	4,16	6,06	0,05	0,04
Borovce_145	5	T6	green	9_10.c.	ICP	69,52	9,94	2,08	1,44	4,13	0,07	1	0,72	4,03	6,02	0,18	1,05
Borovce_145	1	T7	blue	9_10.c.	ICP	71,35	11,1	1,99	1,79	0,14	0,08	1	1,25	4,46	6,6	0,06	0,24
Čakajovce_276	1	T23	blue	9_10.c.	ICP	68,11	12,57	3,19	2,11	0,46	0,1	1,25	1,27	3,63	7,17	<	0,14
Čakajovce_276	1	T24	yelow	9_10.c.	ICP	67,22	11,18	2,3	2,03	4,42	0,11	1,25	0,79	3,64	7,05	<	0,01
Čakajovce_594	2	G27a_core	colorless	8./9.c.	WDS	65,41	16,43	2,69	2,17	0,03	0,12	0,48	0,65	4,97	6,68	<	0,08
D.Věstonice_263/47	1	T263_47	?	9.c.	ICP	46,1	15	4,5	1,9	14,8	<	<	3,6	8,4	5,6	<	0,1
Mostová_18	4	G48a-27	colorless	10.c.	WDS	63,3	14,78	3,23	3,5	0,03	0,18	1,95	0,85	4,5	8,53	<	0
Nitra Lupka_?	1	G45b_ana1	blue	9.c.	WDS	65,24	13,85	2,71	2,08	0	0,11	1,05	0,67	5,25	6,76	0,02	0,03
Nitra Lupka_?	1	G45b_ana2	blue	9.c.	WDS	67,28	15,72	3,01	1,81	0,01	0,08	0,53	0,59	3,69	6,52	0	0
Nové Zámky_27	5	G25b_1	colorless	8.c.	WDS	72,75	13,94	0,64	3,33	0,01	<	1,42	0,43	0,61	8,97	0,00	0,03
Nové Zámky_27	5	G25b_2	colorless	8.c.	WDS	74,41	15,57	0,62	2,12	0,01	<	0,18	0,94	0,65	8,22	0,01	0,00
Staré Město _122	1	B19	blue	9.c.	ICP	68,01	14,08	2,88	1,64	0	0,09	0,63	1,07	5,35	6,01		
Trnovec n. V.409	1	G38a	turquoise	9./10. c.	WDS	67,29	13,01	2,50	3,12	0,00	0,10	1,05	0,64	5,15	6,50	0,03	1,04
Zalakomár	2	D4 (core)	gray	8./.9.c.	D.1993, tab.5	64,44	15	3	2,4	<	0,12	1,2	1,1	4,6	8,1	<	0,03
Zalakomár	2	D3 (outer layer)	turquoise	8./9.c.	D.1993, tab.5	64,29	15,4	3,3	2,2	0,12	0,12	0,76	1	4,3	6,8	<	1,6
Zalakomár	3	D5 (outer layer)	gray yelow	2. 1/2 9.c.	D.1990,tab. 2	63,53	17	3,8	1,8	<	0,079	0,64	0,76	4,5	7,6	<	0,29
Zalakomár	3	D6 (core)	yelow brown	2. 1/2 9.c.	D.1990,tab. 2	46,03	17	3.maj	1,3	<	0,08	0,16	0,64	4,2	6,6	<	<
Znojmo	6	G50b_ana1	colorless wtih red	9.c.	WDS	70,11	15,42	0,62	2,88	<	0,07	1,23	0,37	0,65	8,40	<	<
Znojmo	6	G50b_ana2	colorless wtih red	9.c.	WDS	68,49	15,55	0,64	2,91	<	0,05	1,17	0,34	0,61	8,42	<	<

*Pl. 2: Chemical analysis of samples of segmented beads from "middle Danube region". * WDS quantitative analyses, microanalyser Cameca SX-100, Department of special laboratories Laboratory of electron microanalysis State Geological Institute of Dionýz Štúr, SK-Bratislava and in the Department of Earth Sciences houses, UK- Bristol on the JEOL JXA 8600 micro-probe equipped with the AN10000 Energy Dispersive Detector and a Camecca CAMEBAX MicroWDS quantitative analyses, microanalyser Cameca SX-100, Department of special laboratories Laboratory of electron microanalysis State Geological Institute of Dionyz Štúr, SK-Bratislava and in the Department of Earth Sciences houses, UK- Bristol on the JEOL JXA 8600 micro-probe equipped with the AN10000 Energy Dispersive Detector and a Camecca CAMEBAX Micro, UK. ** ICP - The samples were pulverized and consequently decomposed in the mixture of hydroflouric acid and perchloric adid. The chemical composition of samples was determined by emision spectral analysis with ICP analyzované na pracoviskách University of Alexander Dubcek in Trencin (SK) and in the Department of Earth Sciences houses, UK- Bristol.*

ured red belt (Fig. 1.13) while another bead had blue spots.[26] The glass masters who made these beads either lacked the requisite knowledge of melting conditions or tried to experiment.

Categories 7a-11

Chemical analyses of glass finds in these categories were not carried out as the beads are rare.

Conclusions

According to their forming technique and optical features, the set of 2217 "middle Danube" cross-wire segmented beads can be divided into 11 categories and deliver uneven statistical results. Considering their technique and uniformity of shape, it can be assumed that beads in categories 1-4 are very close to products that were probably made in some Muslim centres and in Byzantine workshops (that also operated in foreign territories, among others, Russia), as well as produced or processed secondarily in Bulgaria (the 10th century), at Haithabu and Old Ladogs (the 9th–10th century).[27] Chemical analyses of our samples have proven that three formulas were used on the ash basis: Na_2O- CaO-MgO-Al_2O_3-SiO_2, Na_2O- CaO-MgO-SiO_2 and Na_2O-K_2O-CaO-MgO-PbO-SiO_2. These results corroborate the origin of the glasses as mentioned above, with the exception of the formula using PbO. Contents and proportions of the elements in this formula had no analogy in European production centres or in the Near East. The beads produced by the technique of winding a glass fibre (categories 5-8) have less uniform shapes. Among them, only category 5 was remarkable in its statistics; it can be assumed the content of other categories were locally produced. Chemical analyses have proven that two formulas with natural soda were used on the sodium glass basis (Na_2O-CaO-Al_2O_3-SiO_2 and Na_2O-CaO-MgO-Al_2O_3-SiO_2). Contents and proportions of sand that were used indicate these recipes were local and have no clear analogies. Morphological analogies of the beads as well as their occurrence are connected with the older period of the Early Middle Ages. Notably, the glass formula with mineral soda linked to the beads was produced by the winding technique and in the territory under study even a furnace was found.[28] In the second half of the 8th and in the first half of the 9th century, sodium ash glass was present in glass beads from categories 1-4 i.e. those produced by the basic technique of glass drawing.

26 Staššíková-Štukovská and Ungerman 2009, fig. 3:5.

27 Sayre and Smith 1961, 1825-1826; Dekówna 1980, 134-140; Dekówna and Purowski 2012, 95.

28 Farkaš and Turčan 1998.

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MEDIEVAL GLASS IN BRATISLAVA (ca 1200–1550)

Bratislava received a foundation decree from Hungarian King Andrew III (1290–1301) as late as 1291; however, it had started to develop as a medieval town in the last decades of the 11th century. Glass vessels appeared in Bratislava in the first half of the 13th century. Until now, 30 series containing glass were excavated in the city, 18 of which have been analysed (Fig. 4.1). The finds come from the historical centre, from refuse pits and fillings of wells.

Bratislava had natural geographical, economic and political relations with the surrounding countries and so the development of glass in Bratislava can be compared with that of Moravia,[1] Hungary[2] and Lower Austria.[3]

13th century Bratislava was remarkably rich in glass; however, the finds almost exclusively concern bottles with body-tubular rings (also *Kropfflasche*) and prunted beakers. The (probably deliberate) distinct brown tone of the major part of the glass - of both beakers and bottles - was due to the high proportion of manganese and melting in an oxidation atmosphere.

The earliest vessel found so far is a bottle with a body-tubular ring from a refuse pit. dated to the first half of the 13th century in Ventúrska 7 (Fig. 1.1). It is a variant with a barrel-shaped bottom section that occurred between the 13th and the 16th century, especially in western Hungary[4] and in the former Yugoslavia.[5] These specimens are rare in Moravia and are yet to be reported from Lower Austria.

In the second half of the 13th century, bottles with cylindrical bottom sections were widespread in the territory of western Hungary, Lower Austria, Moravia and Bohemia. On the other hand, they are exceptional west of the south German border.

Prunted beakers represent the other basic type of glass vessel in Bratislava during the period.

1 Esp. Sedláčková 2000; Sedláčková 2001; Sedláčková 2003 and Sedláčková 2006.

2 Esp. Gyűrky 1986,; Gyűrky 1991 and Gyűrky 2003; Mester 1997.

3 Esp. Tarcsay 1999; Tarcsay 2002 and Tarcsay 2003.

4 E.g. Gyűrky 1986, tab. IX:3, X:1-5.

5 E.g. Han 1975, 123, figs. 9 and 10.

In the 13th century, these were large vessels with cylindrical bodies and tall funnel-shaped rims. The prunts are large and snail-shaped.

Body fragments and fragments of at least 50 vessels were excavated in the refuse pit at Radničná 1: specifically, 20 prunted beakers and 30 bottles with body-tubular rings. The pit was sealed around 1300 with a daub cover in which a fragment of a Venetian beaker was found. The prunted beakers are large with rim diameters of up to 12.6 cm and a height of 12.8-15 cm (Fig. 1.3-10). In contrast, the bottles with body-tubular rings show a greater variability in size. The smallest almost complete specimen found was about 15 cm tall; other body fragments indicate vessels over 20 cm tall (Fig. 1.11–17).

Individual vessels and sets of a bottle and a beaker were also discovered in other refuse pits in Bratislava. The origin of vessels made of "brown" glass remains unclear. Although *Kropflashe* bottles occur in northern Italy,[6] beakers of this kind are not known from the region. Judging by the analyses of several vessels of brown glass from Brno[7] and Bratislava, the glass body had a high content of Mn (2–4%) and was chiefly of sodium composition, yet this is highly variable; in addition, vessels made of potassium glass were found in Bratislava as well.[8]

Only one beaker in the Radničná 1 series was not made of "brown" glass. A small beaker is of colourless glass and the other beaker has a plain thread at the bottom (Fig. 1.2, 3). In the typology of Italian glass, these beakers are considered earlier basic versions that occurred in Sicily in the 12th century and then spread in the 13th century to the rest of Italy, as well as to countries north of the Alps.[9] A luxury variant, the body of which is decorated with alternating rows of colourless and blue prunts has yet to be found in Bratislava; the nearest finds from the second half of the 13th century come from Brno[10] and the Veselí nad Moravou castle.[11] The occurrence of beakers with a plain thread at the bottom, both monochrome and with blue prunts, ends in the late 13th century.

The last decades of the 13th century and the 14th century saw some major changes in the import of glass. Brown glass was replaced with colourless glass, often decorated with blue threads. Both the number of features on the glass and the number of types and variants of vessels increased.

By the mid-14th century, glass had made its way to wells in Františkánské náměstí 7,[12] Sedlárska 6[13] and Kapitulská 7; after the mid-14th century, a large series was produced by a town hall in Hlavné náměstí 1.[14]

The finds can be divided into luxury and ordinary items. The former category involves Venetian beakers decorated with colour enamels, the production of which in Venice is confirmed by written sources from 1280–1343 when they were distributed all over Europe.[15] Two almost complete beakers come from Františkánské náměstí: one with the motif of lionesses and the other with a decoration of mythical unicorns (Figs. 2.1, 2 and 4.2).[16] Fragments of another two beakers come from two refuse pits at Radničná 1.[17] The nearest finds come from Olomouc and Opava;[18] in contrast, Venetian beakers are unknown in Brno and Vienna. In Budapest, a Venetian beaker is connected with the reign of King Andrew III;[19] a body fragment also comes from Mende-Leányváru.[20]

An Islamic beaker is probably represented by an undecorated fragment of the upper section from a well at Sedlárska 6. The makeup of the

6 E.g.Visser Travagli 2000, 268, fig. 4.

7 Analyses of several samples were finished at the Technical University, Berlin (Katharina Mueller). Prepared for publishing.

8 Analyses of selected samples are being carried out at the Institute of Chemical Technology, Prague (Dana Rohanová). Prepared for publishing.

9 Newby 2000, 258.

10 Sedláčková 2006, fig. 4.6 and 7.

11 Brno City Museum, no. A 54/08–2348.

12 Hoššo, Lesák, Resutík 2002.

13 Janovíčková and Sedláčková 2008.

14 Plachá and Nechvátal 1980.

15 Krueger 2003.

16 Hoššo, Lesák, Resutík 2002, figs. 2:1,3 and 3.

17 Lesák 2010, 80.

18 Olomouc: Sedláčková 2006, fig. b; Opava: Sedláčková 2011.

19 Gyűrky 1986, 56, tab. XXIV:3.

20 Gyűrky 1991, fig. 61:1.

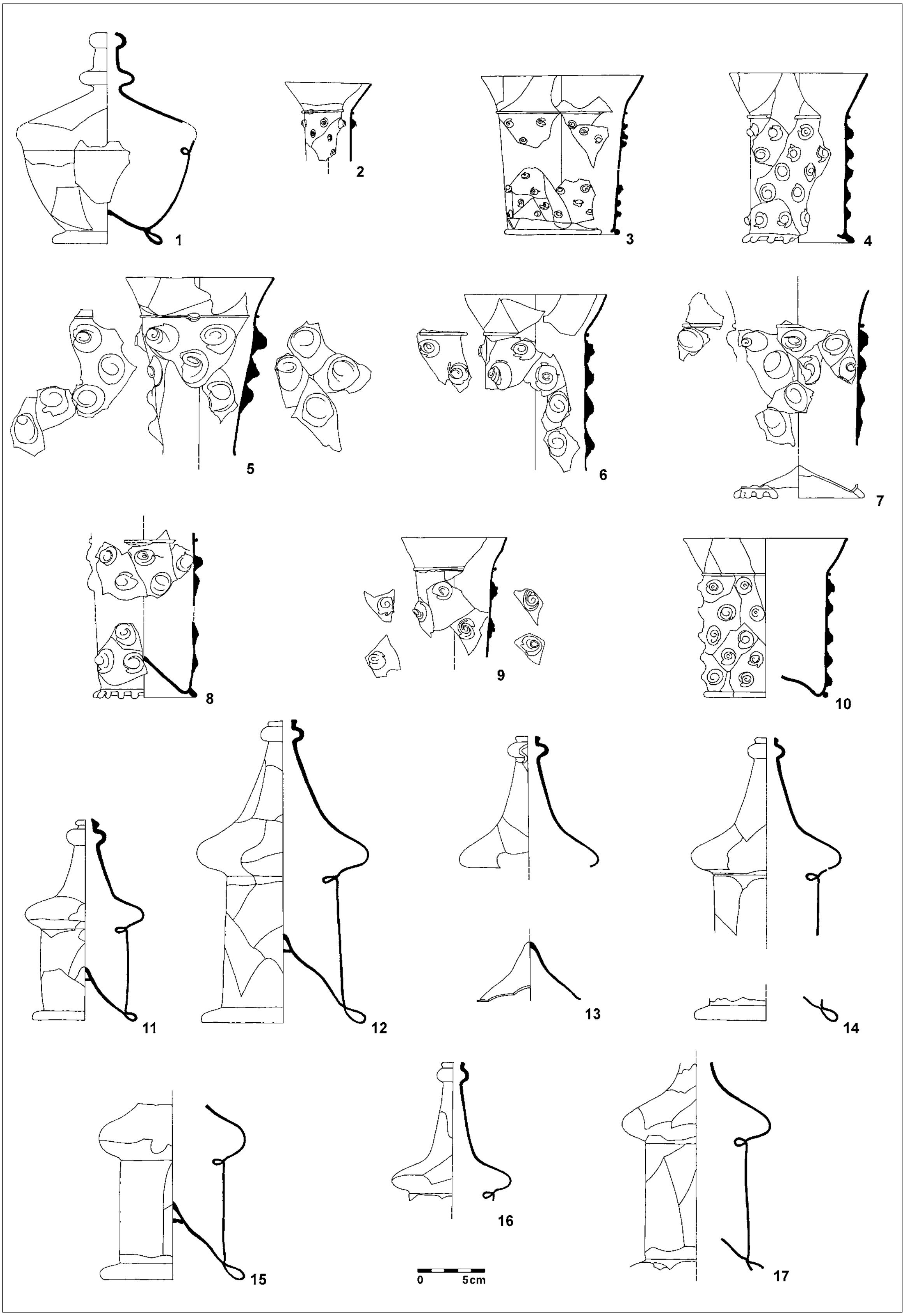

Fig. 1: Bratislava, 13th century. 1. Ventúrska 7; 2–9 and 11–17. Radničná 1; 10. Panská 16.

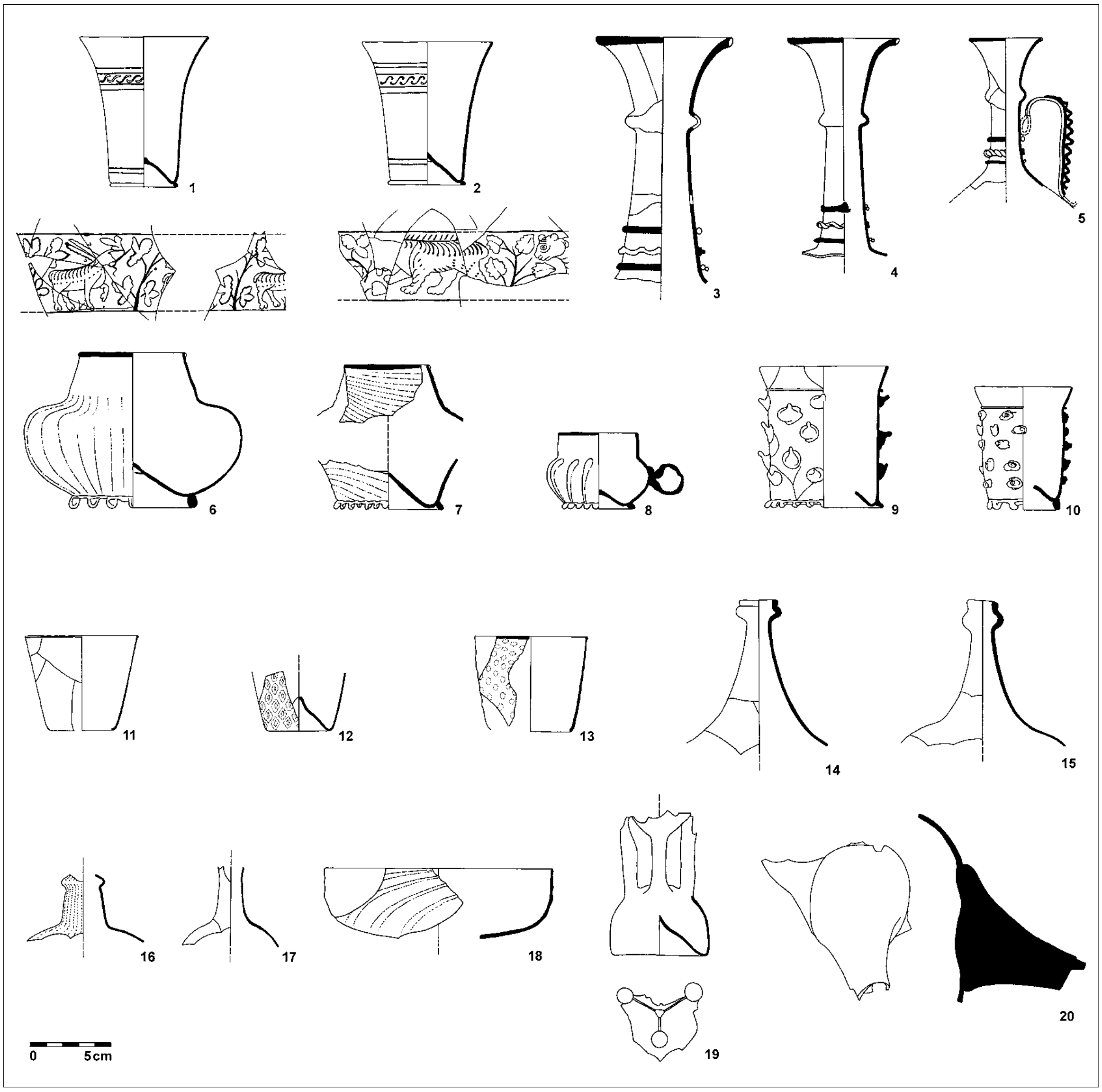

Fig. 2: Bratislava, last decades of 13th century – 14th century. 1, 2, 19: Františkánske námestie Square; 3–8, 18: Sedlárska 6; 9–17, 20: Kapitulská Str.

finds from the well is particularly interesting: it comprises a ewer, ten table bottles, five or six *scheuer* cups, one bottle with a body-tubular ring (brown glass) and only one prunted beaker. “Mečová” type ewers and “Nuremberg” type table bottles (Fig. 2.3–5)[21] occur in a broad belt along the Danube, from Slovenia to the Hansa towns in central Germany, and are associated with the highest aristocratic strata, the patritiate and the clergy.[22] Cups (Fig. 2.6–8) used during ceremonies cover more or less the same territory.[23] Fragments of these bottles and cups have also been found in Bratislava in Hlavné náměstí 4 and at Bratislava Castle.[24]

A series from Františkánské náměstí and Kapitulská Street featured more types of vessel. Apart from the aforementioned Venetian beakers, they contained several prunted beakers; in comparison with previous periods, these are small with low rims (Fig. 2.9, 10). A new type is represented by small and simple beakers, either

21 Sedláčková 2006, fig. 4.1, 2; Baumgartner and Krueger 1988, 276 and 277, nos. 308 and 309.

22 Janovíčková and Sedláčková 2008.

23 Tarcsay 1997; Sedláčková 2005.

24 Mináriková 2000, 133, figs. 3:9, 10, 14, 15.

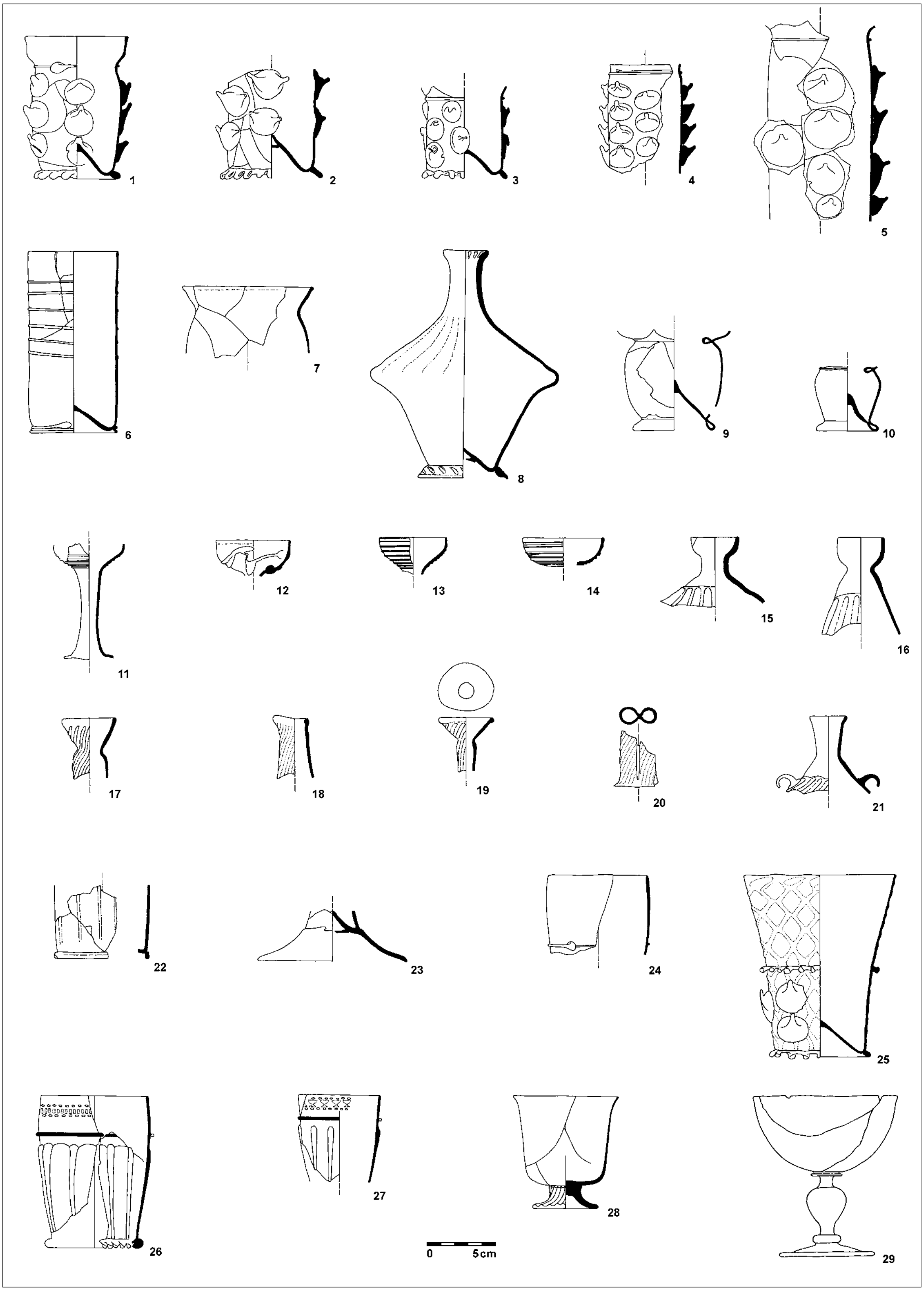

Fig. 3: Bratislava, 2nd half of 15th – 1st half of 16th century. 1, 5: Ventúrska 5; 2–4, 8, 23, 25: Michalská 6; 6, 9: Ventúrska 3; 7, 11, 13, 14, 21: Ventúrska 7; 12, 15, 22: Panská 16; 10, 17, 18, 20: Sedlárska 6; 16, 24, 26–28: Sedlárska 4; 29: Hlavné námestie Square 1.

plain or with optic-blown decoration preserved in several specimens (Fig. 2.11–13).[25] In Italy, these beakers were associated with mass-produced cheap goods. Bottles with body-tubular rings of colourless glass are less plentiful and are of a more refined style (Fig. 2.14, 15). Their popularity as late as the last decades of the 14th century, in the territory of what is today known as Slovakia, is illustrated by a mural from 1380–90 in a church in Kocelovce.[26] In the series from Kapitulská Street, several vessels of light blue-green, thin-walled clear glass stand out. They are upper and bottom sections of several small bottles, some with optic-blown decoration of ribs (Fig. 2.16, 17). Further bottles in the series are of quality colourless glass and several are made of heavily corroded potassium glass. A fragment of an alembic confirms that the convent housed a pharmaceutical "alchemistic" laboratory (Fig. 2.20). It is the oldest find of a glass laboratory vessel in Europe north of the Alps.[27]

All of the aforementioned series also contained the occasional vessel. At Sedlárska 6, there was a low bowl with diagonal optic-blown ribs (Fig. 2.18) that has analogies in Brno[28] and *Palazzo Ricchieri* in Pordenone.[29] The Františkánské náměstí series contained a *kutrolf* (Fig. 2.19),[30] with a single analogy in Brno.[31] A small plain beaker with a hollow ring at the bottom[32] from Kutná Hora in Bohemia has only been identified, apart from specimens in Italy,[33] Brno and Skály Castle in Moravia.[34]

The majority of features dated to the period after the mid-14th century contained beakers with prunts and bottles with body-tubular rings. The largest number, possibly ten beakers and at least five bottles, come from Hlavné náměstí 1;[35] at least five beakers come from Hlavné náměstí 4[36] and two almost complete specimens come from Ventúrska 3 (Academia Istropolitana; Fig. 4.3).[37]

In the 13th and 14th century, these were chiefly made of high-quality glass of a sodium composition manufactured in and imported from glassworks in Italy. Nonetheless, most of the Bratislava series also featured a small amount of heavily corroded glass of potassium composition[38] made outside Italy. Heavily corroded glass - originally brought by colonists from German lands[39] - is also found in a series from Moravia.

The 15th century in Bratislava makes up a special chapter as only a few series with glass (dated to the first half of the 15th century) are known from the era. This period can be positively associated with only a handful of specimens of tall beakers of the Bohemian type from Františkánské náměstí and Ventúrska 5.[40] Owing to Emperor Sigismund's ban on trade with Venice issued in 1417, the import of glass from Italy to Hungary ceased, and even typical products of German glassmaking such as vessels of green "forest" glass are missing.

In the last decades of the 15th century and the first half of the 16th century, a large series of glass emerge in Bratislava. Refuse pits and wells at Michalská 6, Sedlárska 4 and 6, Panská 16, and Ventúrska 5 and 7 were filled in this period. The contents show a distinct affinity with finds from Vienna and other Lower Austrian towns as well as Buda and west-Hungarian towns where glass figured in large quantities. A glassmaking boom can be observed, in particular, in Hungary

25 Hoššo, Lesák, Resutík 2002, fig. 4:3.

26 Hannig 2009, fig. 246, 3.

27 Buda, alembic dated to 1375-1427: Gyűrky 1986, 72, tab. XXXI:5.

28 Sedláčková 2006, fig. 4.14 and 4c.

29 Zuech 1997, 73 and 76, tab. 1 and fig. 18.

30 Hoššo, Lesák, Resutík 2002, fig. 4:12.

31 Sedláčková 2006, fig. 5.21.

32 Hoššo, Lesák, Resutík 2002, fig. 4:10.

33 Lehečková 1975, 476, no. 134, fig. 6.

34 Brno, e.g. Dominikánské nám.: Brno City Museum, no. A 99/67–1201/83-7; Skály u Nového Jimramova: Moravian Museum, research by L. Belcredi, not catalogued.

35 Plachá and Nechvátal 1980, 436-437, figs. 1.1-10; Janovíčková 1999, 137, nos. 241 and 242.

36 Mináriková 2000, 133, figs. 3:1-8.

37 Janovíčková 1999, 136 and 137, nos. 239 and 240.

38 Analyses of selected samples are being carried out at the Institute of Chemical Technology Prague (Dana Rohanová) and are being prepared for publication.

39 Sedláčková 2012.

40 Lesák 2009, 15, fig. 1:5.

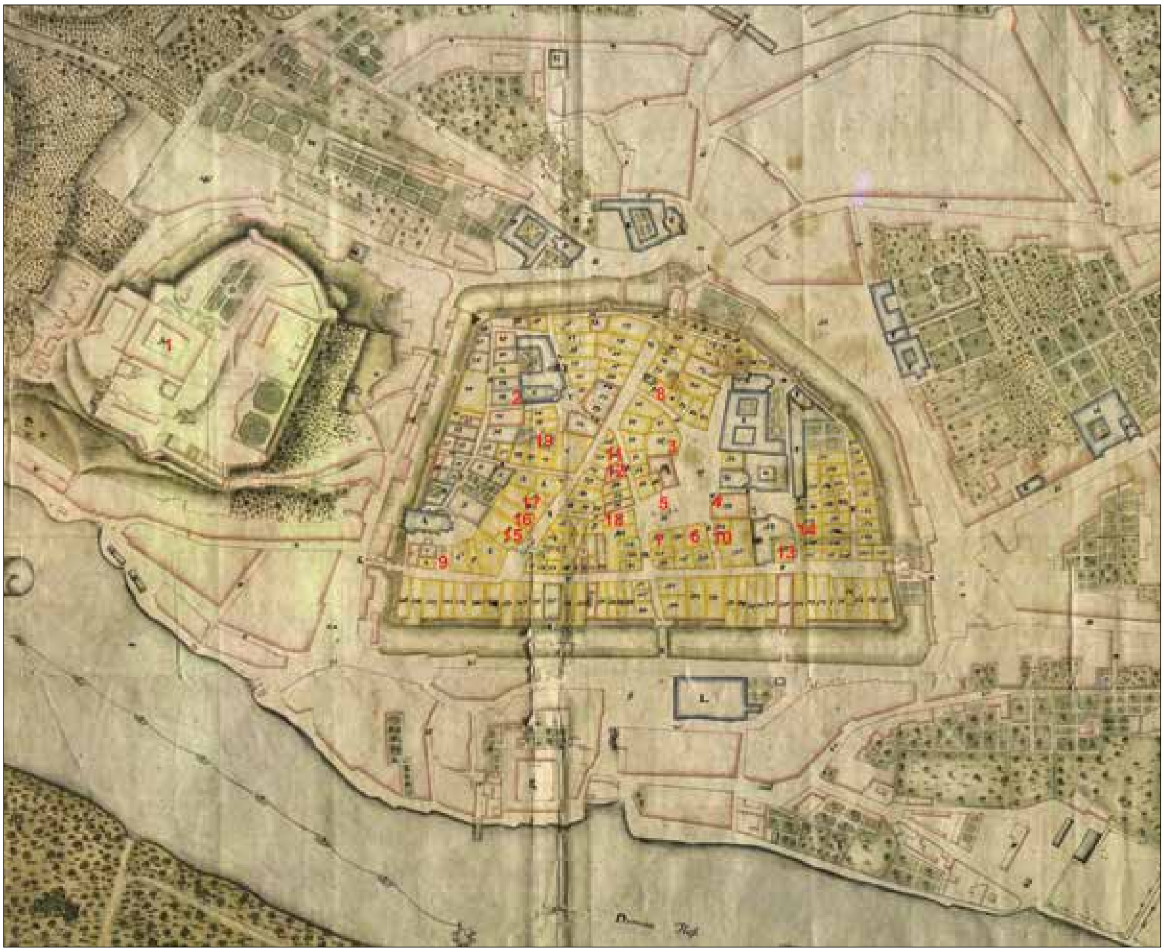

Fig. 4.1: Map of Bratislava, Marquart 1765. 1. Bratislavský hrad; 2. Kapitulská 7; 3. Františkánske námestie Square 7; 4. Hlavné námestie Square 1; 5. Hlavné námestie Square area; 6. Hlavné námestie Square 2; 7. Hlavné námestie Square 4; 8. Michalská 6; 9. Rudnayovo námestie Square; 10. Radničná 1; 11. Sedlárska 4; 12. Sedlárska 6; 13. Uršulínska 6; 14. Uršulínska 9; 15. Ventúrska 3; 16. Ventúrska 5; 17. Ventúrska 7; 18. Zelená 4; 19. Ventúrska 11–13.

where, when trade with Venice was banned, local glassworks started to imitate Venetian models. The presence of glassmaker Antonius Italicus is recorded in Buda in the mid-15th century, and he was probably not the only Italian expert active in the country.[41]

The series also contain classic types of German glass, such as *krautstrunk* and *stangenglas* (Fig. 3.1–5), table bottles with ribs and bowl-shaped rims wound with a thread (Fig. 3.11–14), *kutrolfs* with one or more necks, pilgrim bottles and bottles with optic-blown ribs (Fig. 3.15–21). Bottles with body-tubular rings and barrel-shaped bottom sections (Fig. 3.9, 10) are only represented by fragments. However, there are also vessels without close analogies, such as cylindrical beakers wound with threads and a large pot-shaped beaker (Fig. 3.6, 7). Glass that was originally colourless or light-green is now heavily corroded, and it is debatable whether these were imports from German glassworks or products of Hungarian glassworks inspired by German shapes.

Four double-conic bottles originally of green glass[42] from Michalská 6 are definitely genuine German products (Fig. 3.8). This type was widespread between the 14th and the 17th century, especially in Central and Upper Rhineland, occurring only sporadically

41 Gyűrky 2003, 48.

42 Hoššo 2003, 101, fig. 2:16.

Fig. 4.2: Bratislava, Františkánske náměstie Square 7. Venetian enameled beaker.

Fig. 4.3: Bratislava Castle. Venetian enameled and gilded goblet.

outside this region.[43] Bottles from Michalská and Visegrád[44] present the easternmost finds so far.

Glass produced directly in Venice made its way to Bratislava around 1500. Almost a complete goblet decorated with colour enamels and gold was found at Bratislava Castle[45] (Fig. 4.3). A set of two beakers with ribs and a decorative border of enamel points and gold-leaf comes from the well at Sedlárska 4 (Fig. 3.26, 27). Another goblet with a body of colourless glass has a ribbed foot of deep blue glass (Fig. 3.28). The last, almost complete vessel known as *berkemeyer* comes from Michalská 6 and was not necessarily made in Venice or at another Italian glassworks (Fig. 3.25).[46]

The amount of luxury Venetian glass described above is extraordinary in comparison with the surrounding countries. Not a single find is known from Vienna; only two beakers with ribs and enamel decoration were discovered in Brno and Olomouc[47] while no finds are recorded from Bohemia and the German lands. On the other hand, numerous finds are associated with Hungary,[48] which can be linked to its restored contacts with Venice during the rule of Matthias Corvinus[49] along with his penchant for the Italian renaissance, and glass in particular.[50] Several goblets of possibly domestic provenance reflect Venetian shapes (Fig. 3.29).[51] Unfortunately, glass pieces in Slovakia today are only known from written sources[52] and their assortment remains unclear.

Until the mid-16th century, the Bratislava series contained products from Bohemian

43 Hannig 2009, 133-134.
44 Mester 1997, 21.
45 Barta *et al.* 2011, 115.
46 Light blue-green clear glass of sodium composition: analysis was finished at the Institute of Chemical Technology, Prague (Dana Rohanová). Being prepared for publication.
47 Sedláčková 2006, figs. 11a and 11aa.
48 Gyűrky 1991, figs. 32:6, 45:2, 3, 46:6,7 and 58:10.
49 Gyűrky 1991, 78.
50 Balogh 1975, 283-285.
51 Plachá and Nechvátal 1980, fig. 1.
52 Koóšová 2005, 499 and 500.

Fig. 4.4: Bratislava. Ventúrska 3 (Academia Istropolitana). Prunted beakers.

glassworks, such as fragments of a beaker with applied ribs and of tall beakers with prunts (Fig. 3.22–24).

Glass from Germany arrived in Bratislava before the mid-16th century when Hungary became part of the Habsburg monarchy in 1526. The late-Gothic and early-Renaissance refuse pits yielded vessels of rich green and blue-green glass such as beakers with optic-blown decoration and the *krautstrunks* and *stangenglas*. They were probably made in the Schwarzwald glassworks and are features of Austrian towns, such as Vienna[53] and Salzburg.[54] In southern Moravia, this kind of glass appears in the manors of Anabaptists, who came from southern Germany and Switzerland.[55]

Glass products remain a somewhat neglected historical source, despite the fact that they illustrate historical contexts in countries and towns better than objects made of other materials. Until the late 14th century, glass indicated supreme social and economic status, and spread among the middle strata in the 15th and 16th century. Imported glass reflected political relations and economic standards while domestic output bore witness to technical progress and craftsmanship. Glass from Bratislava is conveyed in the same context.

53 I had the opportunity to study a series of glass from Vienna thanks to Kinga Tarcsay.

54 I had the opportunity to study glass from Salzburg, Getreide Gasse 3, thanks to Wilfried K. Kovaczewic.

55 Sedláčková 2006, 221, figs. 11.12, 13.

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VALIULINA Svetlana

EARLY ISLAMIC GLASS OF THE VOLGA REGION IN BULGARIA

The first oriental glass vessels from the Middle Volga and Kama regions were discovered in burial ground complexes dated to between the 5th and 7th century. One such find is an oil lamp made of colourless glass with blue drops, which was obtained from the Turaevo burial mound at the beginning of the 5th century. The chemical composition of the glass[1] is similar to those featured in the glass recipes of handicraft centres in the South-Eastern Mediterranean.[2] So far, the Turaevo oil lamp remains the utmost northeastern find among similar items widely available from the monuments of Late Romanesque to Early Byzantine period. Another glass vessel from the Early Middle Ages is a large cup from the II Comintern burial ground, dated to a period between the second half of the 6th and beginning of the 7th century. The cup has an Iranian origin (height: 9.7 cm; diameter: 9.4 cm), is made of matted blue glass and decorated with incised four crosses in a circle (Fig. 1.1). It reflects the relationship between the Middle Volga and the Nestorian culture of Sasanian Iran. Similar Persian items with different carvings are related to the same period: for example, the cup from the Birsk burial ground (Fig. 1.2) in the South Urals and the cup (Fig. 1.4) kept at the Leiden museum.[3] The older vessel, dated to between the 4th and 5th century with either a Roman, Persian or Egyptian origin is kept at the Boston Museum of Fine Arts and can be considered a prototype for the whole group.[4] Judging from the typography of the finds, Persian glass vessels, Persian silver tableware from the 6th-7th century and certain Cufic coins had found their way to Eastern Europe through the Caucasus.

From the 10th to the beginning of the 11th century, pieces of Islamic art were brought to Eastern Europe, mainly through the Caucasus and Central Asia. Equally likely is the fact that glassware produced in the Near-East was also delivered to Eastern Europe through the Cau-

1 Valiulina 2009, 134-136, pl. 1, fig. 1

2 Henderson, McLoughlin, McPhail 2004, 454; Brill 1988, 262-263, pls. 9-3, 9-4.

3 Recent Important Acquisitions 1996, 131, no. 16.

4 Saldern 1968, no. 46.

casus, whereas the Central-Asian route gained popularity at a somewhat later date due to the growth of the Central Asian market share of handicraft production. Significantly, both directions are clearly represented in the assortment of materials from the 11th-12th century that were obtained at the Samosdelskoe settlement in the Lower Volga (the Caspian Sea region). An almost perfect parity between the Near East and Central Asian glass products is justified through morphological characteristics and the chemical composition of samples.[5]

Glass products from the 10th to the beginning of the 11th century were obtained in Eastern Europe to the North of the Caucasus, in urban centres of the Lower (Samosdelskoe settlement) and Middle Volga (Bulgar, Suvar, Bilyar settlement no. 2).

Miniature vessels with incised and applied decorative features from Bulgar (Fig. 2.1, 2)[6] have direct analogies with similar products dated to between the 9th-10th century from Nishapur,[7] the entire Iranian region[8] and with vessels of Egyptian origin kept at the Victoria and Albert Museum (no. 8274). Similar items available at the Corning Museum of Glass were dated by D. Whitehouse to a period between the 9th and 11th century.[9]

One of the early Islamic incised glass samples available from Bulgar is a fragment (5.9 x 4.6 cm) of a colourless, slightly yellowish vessel (Bulgar State Historical and Architectural Reserve, no. 255/55). Its 3-4 mm walls are decorated with a two-layer ornament furnished with the use of a high relief slant-cut technique, representing a bird (only the head and the gorgeous plumes remained) under the forepaw of an unknown animal (Fig. 2.6). The decorative style is associated with the artistic traditions of Sasanian Iran. The fragment has numerous comparisons with various sites, mainly dated to the 9th-10th century.[10] An inkpot (only the stopper ring survived) from the re-sedimented layer should be also registered with early Islamic samples (Bulgar State Historical and Architectural Reserve, no. 31-48), whereas more informative finds are available from the Suvar site (Figs. 3, 8, 9).

The Bulgar site yielded another two early Islamic plain round glass weights with a stamp on one side, which can be dated quite vaguely to within the pre-Mongolian period. One specimen is an incidental find (Bulgar State Historical and Architectural Reserve, no. 374-251) with a diameter of 2.2 cm (Fig. 2.3) and a weight of 3.01 g, which corresponds to one 'dirham al-kail',[11] another example with a diameter of 1.4 cm (Bulgar State Historical and Architectural Reserve, no. 246-92/89), of which only a fragment has survived. Both weights are made of dark manganese glass, both bearing a round stamp with an oddly-shaped impression in the centre and a protruding roundish rim at the edge (Fig. 2.7). Such items appeared in the East in the 7th century and were in use until the 12th century. They can be seen at many museums, including the Metropolitan Museum of Art,[12] the Natural History Museum of Venice, Abgine Museum in Tehran and so forth. The collections are constantly being replenished thanks to ongoing excavation work, particularly in Fustat.[13] It was determined that the medallion weights corresponded to a certain fraction of a silver dirham.[14] S. Carboni makes a distinction between proper medallions and vessel stamps. According to Carboni, the term 'medallion' refers to items with a diameter of 4.7-10.0 cm with the stamped impressions of animals, hunt scenes, horsemen, lute players and even illustrations dedicated to "Shah Namah", sometimes with Cufic signs. Texts with the names of governors convey absolute dates. The overwhelming majority of these medallions originates from Central Asia or Afghanistan and date back to the 12th century. Finds

5 Valiulina and Zilivinskaya 2010, 75.
6 Valiulina 2005, 42-43, fig. 9, 1.2.
7 Kröger 1995, 132-133, no. no. 175, 178, and 179.
8 Carboni 2001, 111, cat. 2.6d.
9 Whitehouse 2010, 82–83, no. 127-130.
10 Kröger 1995, 163, fig. 15; Whitehouse 2010, 156, no. 266, 197, no. 330.
11 Hinze 1970, 13.
12 Jenkins 1986, 53, no. 66-74.
13 Shindo and Kawatoko 2010, 9, color pl. 11-2, 11-3.
14 Newby 2000, 30-31, no. 19-24.

Fig. 1: Sasanian Iran glass of the Eastern Europe: cup from the II Comintern burial ground (1), cup from the Birsk burial ground (2), cup from the Zebelda (3), cup from the Leiden Museum (4).

from the palace complex of the Ghaznavid dynasty in the old Termez have been dated to a period between the 12th and the beginning of the 13th century.[15] Large medallions were integrated into alabaster frames and therefore, were identified as elements of architectural-artistic design on buildings not only in Termez, but also in Raqqa, Samarra, cities in Egypt and West Asia.[16] Although all items were attributed to either decorative or status function, Carboni quotes the weight of each medallion.[17] Vessel stamps include items of smaller diameter, up to 3.5 cm, their weight commensurate with the value of the coins and dating back to between the 9th and 10th century.[18] Glass 'medallions' were able to be integrated into the lower parts of the vessels' handles and bear a stamp on the obverse side (Fig. 2.5), as is the case with the 9th-10th century items at Nishapur,[19] Dvin and other sites.[20] However, such items usually have the so called 'tails' – fragments of handles (Fig. 2.5). Some scholars suggest that these items used to be deployed in rationing, the weighing of drugs[21] and sealing of foodstuffs while in shipment.[22]

S. Carboni relates all finds from Bulgar to miniature vessel stamps; M. Newby relates them to weights with regard to the multiplicity of dirhams. Apart from Bulgar, weights-stamps are present among samples from Aga Bazaar – a fair located next to Bulgar and an urban settlement in the Ulianovsk region (Fig. 2.5), as well as on the sites of Suvar and Bilyar._Classical glass weight from Novo-Mordovo is of special importance (Bulgar State Historical and Architectural Reserve, no. 538-34/184). 1.1 cm in height and 2.2 cm in diameter, the given patina-free weight piece is cast with high-quality black glass (Fig. 2.4). It has a pyramidal form and a spoon-shaped bottom with a concentric relief in the centre, combined with radial rays. The item's weight is 5.64g, which is equal to the weight of two dirhams.[23] Corrosion-free glass weights guaranteed precise weighing. Drawing on the results of the study of a set of Egyptian medallions, Italian scientists have recently determined the chemical composition of the glass, the weight/diameter ratio and have cross-referenced the medallions with currencies of different dynasties, thus adding significantly to the sources' potential - even in cases with fragmented materials. Moreover, the specific proportions of glass precursor reactants (chemical type Na-K-Ca-Pb(Sn)-Mg-Al-Si) guaranteed maximal chemical stability of such special-purpose products.[24] According to the Italian experts, Bulgar glass weights can be dated back to the 10th-11th century.

So far, the items described remain the only early Islamic glass samples retrieved at Bulgar. Nevertheless, their existence instills confidence in the prospect that further excavation work will produce more materials of this sort.

Two oil lamps originate from the II Bilyar settlement located on the outskirts of modern Bilyarsk, 1.5 km to the northwest of the outwork of the pre-Mongolian Bilyarsk settlement. The surviving lamps remain in good condition and M.D. Poluboyarinova succeeded with their reconstruction. Both lamps exemplify early Islamic suspended luminaries, which have numerous 10th-11th century analogies.[25]

Significantly, a Mesopotamian luster ceramic jar from Bilyar has been dated to the same period of time. It is one of the rarest pieces of Abbasid art in Eastern Europe.[26]

The most impressive collection of 10th-11th century glass from the Middle Volga belongs to Suvar. Practically all types of Suvar vessels have direct analogies with 10th-11th century products found at Nishapur, Dvin, Ani, Derbent and some other cities in Central Asia. Of additional importance are other objects from Suvar: firstly, the ceramic complex bears a clear resem-

15 Mirzaahmedov 2011, 99, Ill. XIII.
16 Carboni 2001, 278.
17 Carboni 2001, 272-281, cat. 73a-e; 73f-j; 73k, m-r; 73s.
18 Carboni 2001, 282-283, cat. 3.49 a-c; 3.50 d, e.
19 Kröger 1995, 102-103, no. 142-147.
20 Carboni 2002a, 22, fig. 10.
21 Jenkins 1986, no. 6.
22 Sezgin and Neubauer 2003, 169, no. 84.
23 Hinze 1970, 12.
24 Vagelli, Cossio, Lovera, Mirti 2012, 423.
25 Kröger 1995, no. 235, 182; Carboni 2002a, 20, fig. 5.
26 Valiulina 2010, 45-52.

Fig. 2: Early Islamic glass of the Eastern Europe: miniature vessels with incised and applied decorations from Bulgar (1-2), glass weights from the Bulgar (3,7), glass weight from the Novo-Mordovo (4), vessel stamps settlement in Ulianovsk region (5), fragment of the vessels with incised decorations from Bulgar (6).

blance to materials from the Caucasus and those from further south. The Suvar collection is, in particular, related to finds discovered at the Samosdelskoe settlement in the delta of the Volga River.[27]

Fragments of two cyan glass vessels with up to 3 mm thick walls belong to inkpots with small diameter inlets and a wide horizontal collar-stopper ring firmly resting on the main body (Fig. 3.8, 9). One Suvar inkpot (Bulgar State Historical and Architectural Reserve, no. 1084-270/402) had an inlet of 2 cm in diameter, a 1 cm wide stopper ring and a conic interior volume (Fig. 3.8). Another specimen had an inlet of just 1.3 cm in diameter, but a wider (2.3 cm) stopper ring decorated with a radial ornament (Fig. 3.9). Decoration features are carved on the lower (inner) side of the stopper ring and are visible only when the inkpot made of dark green glass is not full. In terms of the form and colour of the glass, a direct comparison can be drawn with an Iranian vessel, dated to the 9th-10th century, and from N.D. Halili's collection,[28] which has been registered by E. Savage-Smith as sphere-conical vessels and inkpots.[29] Similar vessels were retrieved in China.[30] Fragments of the inkpot made from colourless glass were found at the Samosdelskoe site. Glass inkpots kept at the Hermitage, the Louvre, the Berlin Museum of Islamic Art, the Metropolitan Museum of Art, in the collection of N.D. Halili and so forth have provided us with an idea of the products' form and size. The height could be up to 11.5 cm, with a maximum diameter that varies from 4.4 - 9 cm. The shoulders could bear between one and six planted handles-eyelets, often next to the stopper ring. Vessels were usually cylindrical, although several specimens from the 10th-11th century were either egg-shaped or sphere-conical, with a roundish base and single handle-eyelet – dual-purpose containers which could be used either as lamps or inkpots.[31] The Samosdelskoe inkpot could be identical in form with the inkpot from the Metropolitan Museum of Art. By the shape of the body and the colour of the glass, both vessels are reminiscent of faceted phials – imitations of Egyptian crystalware. Therefore, the inkpot is probably of Egyptian origin.[32] At the same time, most glass inkpots are usually registered with Iranian heritage. The first publications and the attribution of vessels from Iran were conducted by C.J. Lamm.[33]

Subsequent discoveries and research have served to justify Lamm's definitions. Full analogies can be made between Suvar inkpots and those from Nishapur, dated to between the 9th and 10th century,[34] in addition to samples of Iranian imports to Central Asia. Samarkand Museum hosts at least three inkpots (A-109, no. 355; A-109, no. 358; A-109, no. 484) made of yellowish and light-blue glass of different sizes, with either four or six handles. A colourless (light yellow) inkpot, reminiscent of the Samosdelskoe specimen is kept at the Louvre.[35] Similar inkpots are exhibited at the National Museum of Iran (Bastan Museum) in Tehran[36] and in the Al-Sabah collection of the Kuwait National Museum.[37]

Significantly, the Suvar site yielded the only vessel fragment with a golden painting known in Eastern Europe (State Historical Museum: asset identification number 7798, inventory list no. 2189/1559). It is a tiny (2.6 x 1.4 cm) fragment of thin-walled transparent light blue glass, with a golden spot on the surface. According to S. Carboni, the gold plating/painting technique could have been invented in different Near East centres (Samarra, Damascus). However, it reached the climax of development mainly in Tulunid, Egypt, from the 9th - 10th century.[38]

In the beginning of the 10th century, the Volga region in Bulgaria accepted Islam as a state religion. Judging from burial ground materials, Islam expanded all over the main territory of the Volga from the 10th-11th cen-

27 Valiulina and Zilivinskaya 2010, 63-76.
28 Carboni 2001, 212, cat. 53a.
29 Savage-Smith 1997, 337, cat. 212.
30 Han Han (Lo Yuan Yuan) 1999, 70.
31 Carboni 2001, 202, cat. 53a; Savage-Smith 1997, 337, cat. 212, 213.
32 Whitehouse 2002, 79, no. 9.
33 Lamm 1929-1930; Lamm 1935.
34 Kröger 1995, 176–177, no. 129-130.
35 Pasquier 2007, 43.
36 Sezgin and Neubauer 2003, 162.
37 Carboni 2001, 141-143, cat. 33a, 33b.
38 Carboni 2002b, 201.

Fig. 3: Early Islamic glass of the Suvar: miniature vessels (1-7), fragments of inkwells (8-9).

tury. Set against the backdrop of a nascent Moslem state culture, the amount of oriental type glass tableware in Suvar, Bilyar and other settlements increased significantly. It is possible to say that an emerging Bulgar urban culture almost 'skipped' over the artistic values of Islamic glassmaking from the 9th to the beginning of the 11th century. By the time the need for expensive, luxury fragile products had emerged, Islamic glassmaking had shifted from the style epitomised by early Islamic artistic glass to mass production of more simple articles of prime necessity.

The general image of Islamic glassmaking output had formed by the first quarter of the 11th century and did not change until the middle of the 13th century. Glassmaking in Bilyar began within the framework of the given stylistic and handicraft tradition and as an integral part of Islamic glassmaking.[39]

Acknowledgements

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39 Valiulina 2005, 126-139.

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GLASS FROM LOPPIO (TRENTO, NORTHERN ITALY): AN ARCHAEOLOGICAL AND ARCHAEOMETRIC STUDY

Archaeological study

Since 1998, the Archaeological Department of the Museo Civico di Rovereto has been carrying out summer excavations on the island of St. Andrea within the biotope "Lake Loppio" in the region of Trentino in Northern Italy (Fig. 1). The research, which is still in progress,[1] led to the discovery of the remains of some buildings belonging to a Late Antique/Early Medieval fortified settlement (*castrum*) along the northeast border (Sector A) and near the southern edge of the isle (Sector B). The structures show a sequence of chronological phases that date back to at least the period between the first half of the 6th century AD to the end of the 7th century AD; a Carolingian presence, maybe occasional, is also documented, but no structures belonging to this phase have been recognized so far. The ruins of a building originating from a later date have been unearthed on top of the site (Sector C) i. e. a Romanic church featuring different building phases, which dates back to a period between the 12th and the 16th century (Fig. 2). Many small finds related to weaponry and soldiers' equipment (e.g. spurs, arrowheads, belt fittings, a fragmentary scramasax and sheath elements) that clearly reveal the military function of the settlement, come from the Late Antique/Early Medieval buildings, and particularly from Sector A. The site was actually strategically located along the ancient road that connected the Adige Valley to the northern side of Lake Garda. Domestic and female ornamental objects and an *enchytrismos* infant burial[2] show that soldiers lived there with their families, as Procopius explained with regard to the fortifications of the Cottian Alps and their Gothic garrisons.[3]

Within the settlement, evidence of local craft activities has been found, particularly related to the bone industry, metalworking and probably also glass production. The latter seems to be supported by the presence of drips and coarse chunks of glass (Fig. 3), which can be interpreted as processing residues or waste materials.

1 Maurina and Postinger 2011.

2 Gaio 2005.

3 Procopius, *De bello gothico*, II, 28.

Additionally, two ellipsoidal glass “cakes” with a concave-convex profile, also found in superficial layers, have been interpreted as half-glass ingots - that is semi-finished products intended for remelting - and have been related to a possible local workshop that produced finished objects on a small scale.[4] In order to understand the nature and function of these glass artifacts, archaeometric studies have been carried out at the laboratories of the Museo civico di Rovereto at the Institute for Geosciences and Earth Resources of CNR and at the Department of Geosciences of University of Padova.[5]

Samples from “glass ingots”, glass chunks and a fragment of ceramic vessel with traces of glass (perhaps once a melting pot) found in Sector A have been collected and analysed to investigate the hypothesis of a possible relationship between waste materials, semi-finished products and finished objects. The analytical results have also been compared with a selection of glass artifacts from Sectors A and B (especially goblets, but also bottles, lamps, stained glass and vitreous materials; Fig. 4)[6] and from Sector C (fragmentary pieces of beaker).
(B.M.)

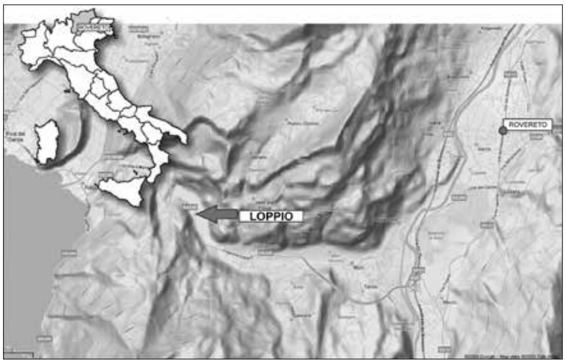

Fig. 1: Geographical localization of Loppio.

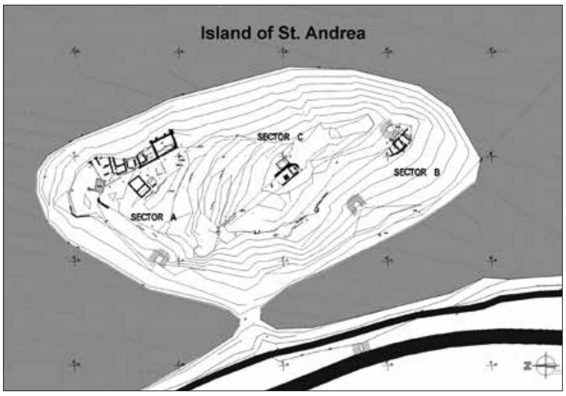

Fig. 2: Plan of the site with sectors.

Fig. 3: Drips and chunks of glass found in Sector A.

Archaeometric study

The archaeometric study was carried out on a selection of glass fragments from Sectors A, B and C (Table 1). The chemical composition of glass fragments was obtained with a CAMECA SX50 electron microprobe (EMP) equipped with four wavelength-dispersive spectrometers (WDS) at the laboratories of the Institute of Geosciences and Earth Resources of CNR, Padua.

Details of analytical conditions and detection limits of EMP analysis are reported in Silvestri and Marcante (2011). Mean bulk compositions were calculated on the basis of 10 random point microanalyses (Table 1). Standard deviations between 0.06 - 0.8 for major elements and 0.01 - 0.1 for minor and trace elements indicate that the glass fragments are compositionally homogeneous.

Results show that all samples (objects and chunks) are composed of silica-soda-lime except the two glass cakes, the detailed minero-petrographical, chemical and micro-textural study of which will be reported in a dedicated paper. Natron was used as flux for the Late Antique/Early Medieval samples and soda ash for the Late Medieval specimens. Based on their

4 Maurina 2009, and references therein.
5 Finotti *et al.* 2009; Maurina *et al.* forthcoming.
6 On the typologies see Pezzato 2006.

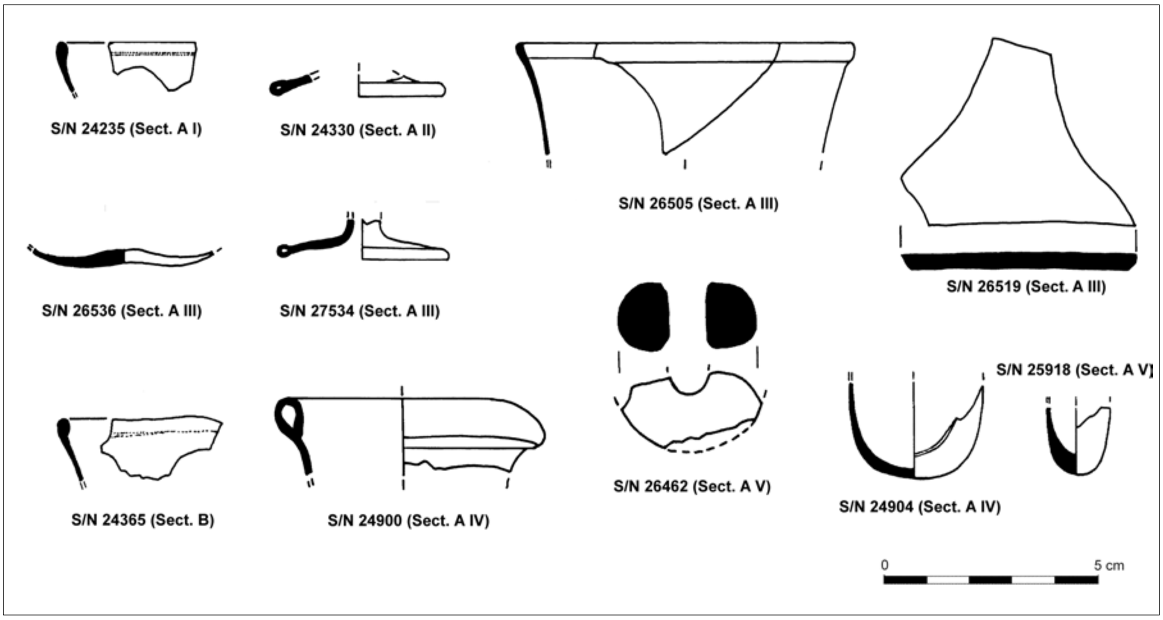

Fig. 4: Main types of glass artifacts from Sectors A and B (S/N = serial number).

chemical composition, we identified four main groups named LP1a, LP1b, LP1c and LP2, consistent with the major compositional groups identified in the Western Mediterranean during the 1st millennium AD (Fig. 5).

In particular, groups LP1a, LP1b, LP1c all obtained with natron as flux, contain Late Roman/Early Medieval samples from Sectors A and B.

Group LP1a is chemically similar to unintentionally coloured Roman glass, spanning the period between the 1st and the 4th century AD,[7] except for samples 24347, 24351 and 26462 (Table 1; Fig. 5). Samples 24347 and 24351 show chemical similarities with Roman glass decolourised with antimony and manganese respectively[8] apart from the high K_2O content of sample 24347, equal to 2.74 wt% as K_2O (Table 1; Fig. 5). Potash can enter the glass melt both as a mineral impurity in the sand and through fuel ash contamination due to prolonged glass working, the latter factor having been demonstrated by Paynter (2008). Potassium-rich minerals, such as feldspar or amphibole, are typically also rich in alumina while fuel ash is also often rich in magnesia and/or phosphate. The low content of Al_2O_3, MgO and P_2O_5 in sample 24347 from Loppio (Table 1) indicates that the high K_2O content is not due to mineral impurities and fuel ash contamination. Therefore, the origin of the peculiar K_2O signature of this Loppio sample remains elusive.

Sample 26462 shows quite good chemical similarities with deeply coloured and black Roman glass[9] although the Loppio sample has higher MnO (MnO =1.32 wt% for sample 26462 vs MnO = 0.3±0.2 wt% for Roman black glass). Likewise, Roman black glass demonstrates very high iron content (FeO= 5.73 wt%, Table 1), suggesting an intentional addition of this element to coloured glass.

The presence within LP1a group of both glass chunks and some objects points to the existence of a Late Antique/Early Medieval secondary glass workshop on the Loppio site, mainly devoted to the recycling of earlier glass. There are traces of at least one of the elements Cu, Sn, Sb, and Pb in quantities above 0.05 wt% (Table 1) in most of the LP1a objects, but not in the majority of glass chunks (except samples 24351and 25903), thus providing further indication of possible recycling. In particular, the presence of Cu is a strong indication for recycling. In fact, its content is too low to have any technological significance as all

7 E.g., Nenna *et al.* 2000; Silvestri 2008.

8 Silvestri *et al.* 2008.

9 Van der Linden *et al.* 2009.

samples, except for sample 26496, have a non-intentional colour, mainly due to iron added in the form of sand impurities.[10] As already observed by Henderson and Holand (1992), there are two explanations for the presence of these elements in glass: one source of Cu, Sn and Pb impurity levels is the introduction of leaded tin bronze alloy,[11] a hypothesis supported by the general "rough" ratio of 1:10 between Sn and Cu in the Loppio samples. The second explanation is that mosaic *tesserae* were introduced into the glass batch to intentionally colour the glass. This does not necessarily indicate that the glass is derived from primary raw materials somewhere in medieval Western and Northern Europe, but that there was a steady supply of *tesserae*. In the context of recycling mosaic tesserae to produce LP1a objects, further support for this hypothesis is provided by a find at the same site of one blue glass *tessera* that has a high content of copper, tin, antimony and lead (sample 28093 – Table 1).

The practice of re-using *tesserae* to colour glass is also reported in Theophilus' treatise *De diversis artibus*, the most important contemporary source on the technology of glassworking in medieval Europe.[12] The practice was common during the Middle Ages to colour vessels and windows, as testified by many studies on medieval glass from Northern and Western Europe.[13]

Group LP1b can be compared with "Group 2" of Foy *et al.* (2003), which may be considered a 'weaker' HIMT (High Iron, Manganese and Titanium) group,[14] and datable to a period between the 6th and 8th century AD.

Group LP1c exhibits a chemical similarity to "Series 3.2", a subgroup of "Group 3" of Foy *et al.* (2003). In particular, "Series 3.2", characterised by lower Al_2O_3 and higher Na_2O than other series of the same group and containing manganese as a decolourant, comprises glass samples from the Western Mediterranean area dated to between the late 5th and early 6th century AD.

Both groups LP1b and LP1c are entirely composed of objects. It cannot be established with certainty whether groups LP1b and 1c were obtained by recycling earlier glass or whether they are the result of a new glass batch intentionally prepared during the Late Roman/Early Medieval period. However, the lack of similarity with previous Roman glass[15] and the absence of glass chunks with comparable compositions seem to invalidate the hypothesis of recycling, as was also confirmed by the generally low levels of trace elements, such as Cu, Co, Sb and Pb.

Group LP2, whose key feature is the use of soda plant ash rather than natron as flux, comprises all Late Medieval samples from Sector C, except sample 18833. The K_2O, MgO, and Al_2O_3 content, together with high FeO, and MnO, suggest the use of Levantine ash as flux and sand rich in feldspars and heavy minerals. Group LP2 is a good match for the chemical composition of "high-Al" Venetian glass[16] and group A/3 from Asolo (Treviso in Italy),[17] both of which are dated to the period between the 11th and 14th century, although Loppio soda ash glass shows a higher content of Al_2O_3 and MnO than reference groups. The similarity with Venetian glass of the same period suggests a probable Venetian origin for the Late Medieval findings from Loppio.

Sample 18833 differs from other glass of the same sector through its higher SiO_2 and lower K_2O and MgO (both < 1.5 wt%) content, suggesting the use of natron as flux (Table 1). This sample is chemically quite similar to the Levantine II group that is associated with the large-scale glass manufacture installations at Bet Eli'ezer near Hadera in Israel, and which seems to have been active between the 6th and the early 8th century. The glass is distinct from Levantine I and European Roman glass by its lower lime and sodium and concurrently higher silica concentrations, indicating a different silica source than that utilized for Levantine I glass. Nev-

10 Henderson 2000.

11 Henderson and Holand 1992.

12 Freestone 1992.

13 E.g., Silvestri and Marcante 2011 and references therein.

14 Foster and Jackson 2009.

15 Nenna *et al.* 2000; Silvestri 2008.

16 Verità and Zecchin 2009.

17 Gallo and Silvestri, 2012.

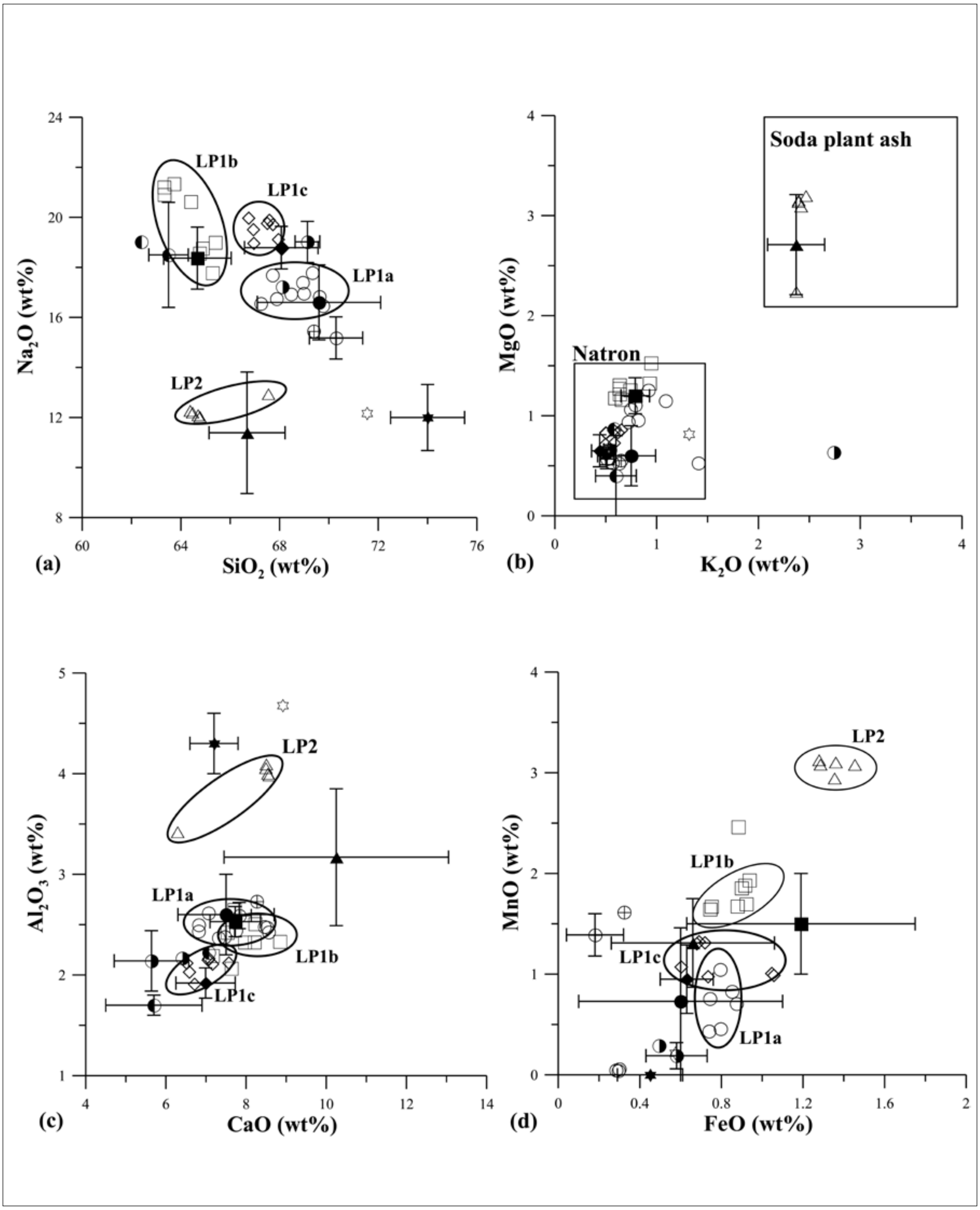

Fig. 5: SiO2 vs Na2O (a), K2O vs MgO (b), CaO vs Al2O3 (c), and FeO vs MnO (d) contents of Loppio glass samples, subdivided by compositional group: LP1a (M), LP1b ((), LP1c (S), and LP2 (.). Samples 24347 (1), 24351 (L), 26462 (n) from Sector A, and 18833 (B) from Sector C (see text for details) also reported, except sample 18833 (B) in FeO vs MnO plot. Main chemical compositions and standard deviations of relevant compositional natron and soda plant ash groups, identified in literature, also shown: "Roman" glass (,), Roman antimony-decoloured glass (1), Roman manganese-decoloured glass (n), Roman black glass (L, except in FeO vs MnO plot), Group 2 (*), Series 3.2 (&), Levantine II (C), "High-Al" Venetian glass (/) (data from Nenna et al. 2000; Foy et al. 2003; Silvestri et al. 2008; Freestone et al. 2000; Van der Linden et al. 2009; Verità and Zecchin 2009).

ertheless, there is still some Levantine coastal sand present.[18] It should be stressed here that glass sample Levantine II is peculiar in composition for the Western Mediterranean (and in particular for Italy) and Northern Europe, where glass that is similar to the Levantine I group, is mostly found.[19]
(A.S., A.M.F., F.Z.)

Conclusions

The combined approach, involving archaeological and archaeometric study, proved a powerful tool to better contextualise the glass assemblage found at the site of Loppio.

The present archaeometric research points to a systematic different composition of glass samples from Sectors A-B and Sector C, consistent with their Late Antique/Early Medieval and Late Medieval age, respectively. Moreover, the compositional overlap of some finished objects and processing residues of group LP1a, found in Sector A, proves the presence of a local secondary glass workshop in Late Antique/Early Medieval times. The compositional characterisation of samples (objects and chunks) from Loppio shows good matches with glass production in Western Europe in the period between the Early and Late Middle Ages, suggesting connections mainly with the Mediterranean area.

The identification of various natron compositional groups in the Loppio glass assemblage, together with the discovery of glass chunks and objects with a typical Roman chemical signature as well as objects with a chemical composition typical of the period between the 5th and 8th century AD, indicates the recycling of earlier glass and the supply of 'fresh' glass in the Late Roman/Early Medieval period. This suggests, on the one hand, the extensive availability of older glass for re-use and on the other, the good commercial connections between Loppio and the Mediterranean area.
(A.S., A.M.F., B.M., F.Z.)

18 Freestone *et al.* 2000; Freestone *et al.* 2002; Freestone *et al.* 2003.

19 E.g., Silvestri *et al.* 2005; Foster and Jackson 2009.

S/N	Type	Part preserved	Sector	US	SiO_2 (wt%)	Na_2O (wt%)	CaO (wt%)	Al_2O_3 (wt%)	K_2O (wt%)	MgO (wt%)	FeO (wt%)	TiO_2 (wt%)	MnO (wt%)	P_2O_5 (wt%)	SO_3 (wt%)	Cl (wt%)	CuO (wt%)	SnO_2 (wt%)	Sb_2O_3 (wt%)	PbO (wt%)	TOTAL	Group
24359	**Goblet**	Fragment of wall	**A III**	**842**	68,46	16,93	7,31	2,37	0,79	1,11	0,74	0,12	0,76	0,09	0,20	0,89	0,12	0,04	0,22	0,15	100,36	LP1a
24900	**Bottle**	Fragment of rim	**A IV**	**879**	67,87	16,75	7,46	2,38	1,09	1,15	0,85	0,14	0,83	0,14	0,22	0,89	0,12	0,05	0,20	0,13	100,32	LP1a
26496	**Goblet**	Fragment of wall	**A III**	**1127**	67,24	16,56	6,81	2,50	0,72	0,94	0,87	0,12	0,71	0,09	0,31	0,99	0,84	0,08	0,63	0,48	99,92	LP1a
25902	**Chunk**	-	**A III**	**926**	68,93	17,40	8,52	2,47	0,63	0,53	0,30	0,06	0,06	0,06	0,21	1,19	<0.03	<0.04	<0.04	<0.08	100,40	LP1a
25903a	**Droplet**	-	**A III**	**926**	69,75	16,47	7,06	2,62	0,92	1,26	0,80	0,12	0,46	0,06	0,20	n.d.	0,08	0,05	0,16	0,13	100,17	LP1a
25903b	**Chunk**	-	**A III**	**926**	69,61	16,83	6,81	2,44	0,74	1,06	0,74	0,13	0,43	0,08	0,22	0,87	0,16	0,07	0,15	0,14	100,51	LP1a
25924	**Chunk**	-	**A III**	**962**	68,98	16,96	8,46	2,48	1,41	0,53	0,29	0,06	0,04	0,07	0,19	1,21	<0.03	<0.04	<0.04	<0.08	100,73	LP1a
25942	**Chunk**	-	**A III**	**971**	69,32	17,79	8,56	2,43	0,57	0,53	0,28	0,05	0,05	0,07	0,21	1,23	<0.03	<0.04	<0.04	<0.08	101,13	LP1a
27401	**Chunk**	-	**A III**	**1107**	67,71	17,69	7,74	2,44	0,82	0,96	0,79	0,18	1,05	0,04	0,42	0,85	<0.03	<0.04	<0.04	<0.08	100,79	LP1a
24347	**Chunk**	-	**A III**	**772**	68,11	17,22	6,41	2,17	2,74	0,63	0,49	0,09	0,29	0,03	0,28	1,21	<0.03	<0.04	0,58	<0.08	100,33	Outlier 1
24351	**Chunk/Droplet**	-	**A III**	**828**	69,38	15,46	8,26	2,73	0,65	0,56	0,32	0,06	1,62	0,05	0,18	0,98	<0.03	<0.04	<0.04	<0.08	100,32	Outlier 2
26462	**Bead**	Half shape	**A III**	**0**	62,39	19,02	7,07	2,22	0,58	0,87	5,73	0,15	1,32	0,05	0,44	0,97	<0.03	<0.04	<0.04	0,09	101,01	Outlier 3
17800	**Goblet**	Fragment of wall	**A I**	**513**	64,87	18,77	7,53	2,42	0,94	1,53	0,88	0,17	2,46	0,17	0,40	0,92	<0.03	<0.04	<0.04	<0.08	101,11	LP1b
17807	**Goblet**	Fragment of wall	**A I**	**536**	65,39	19,00	7,70	2,65	0,74	1,26	0,88	0,15	1,68	0,10	0,39	0,94	<0.03	<0.04	<0.04	<0.08	100,98	LP1b
24235	**Beaker**	Fragment of rim	**A I**	**821**	64,76	18,57	8,84	2,33	0,63	1,27	0,91	0,17	1,88	0,09	0,31	0,99	<0.03	<0.04	<0.04	<0.08	100,21	LP1b
24330	**Beaker**	Fragment of base	**A II**	**655**	63,32	20,91	8,20	2,33	0,63	1,22	0,90	0,15	1,86	0,06	0,46	1,00	<0.03	<0.04	<0.04	<0.08	100,44	LP1b
24365	**Beaker**	Fragment of rim	**B**	**187**	65,28	17,78	8,22	2,51	0,93	1,33	0,94	0,17	1,93	0,14	0,39	0,81	<0.03	<0.04	<0.04	<0.08	100,50	LP1b
25918	**Lamp**	Fragment of base	**A V**	**959**	64,40	20,63	7,63	2,07	0,65	1,16	0,74	0,14	1,65	0,11	0,46	1,11	<0.03	<0.04	<0.04	<0.08	100,81	LP1b
26505	**Beaker**	Fragment of rim	**A III**	**1138**	63,72	21,34	7,16	2,19	0,59	1,18	0,75	0,14	1,67	0,11	0,53	1,34	<0.03	<0.04	<0.04	<0.08	100,80	LP1b
27534	**Beaker**	Fragment of steem	**A III**	**1203**	63,31	21,21	7,96	2,33	0,63	1,31	0,92	0,16	1,70	0,12	0,48	1,14	<0.03	<0.04	<0.04	<0.08	101,33	LP1b
17812	**Stained glass**	Fragment	**A I**	**542**	66,94	18,98	7,56	2,12	0,65	0,86	0,68	0,13	1,31	<0.03	0,43	0,95	<0.03	<0.04	<0.04	<0.08	100,69	LP1c
17822	**Stained glass**	Fragment	**A I**	**564**	66,92	19,52	7,06	2,17	0,58	0,73	0,60	0,11	1,08	<0.03	0,47	0,94	<0.03	<0.04	<0.04	<0.08	100,30	LP1c
24904	**Lamp**	Fragment of base	**A IV**	**879**	67,71	19,73	6,71	1,91	0,49	0,72	0,69	0,10	1,33	<0.03	0,39	0,98	<0.03	<0.04	<0.04	<0.08	100,89	LP1c
26519	**Stained glass**	Fragment	**A III**	**1142**	67,57	19,90	6,51	2,12	0,50	0,83	1,06	0,16	0,99	<0.03	0,30	1,18	<0.03	<0.04	<0.04	<0.08	101,20	LP1c
26536	**Beaker**	Fragment of base	**A III**	**1118**	66,73	19,98	7,15	2,11	0,57	0,86	0,72	0,13	1,32	<0.03	0,46	0,97	<0.03	<0.04	<0.04	<0.08	101,25	LP1c
24353	**Goblet**	Fragment of wall	**A III**	**836**	67,94	19,13	7,04	2,15	0,62	0,84	0,73	0,15	0,98	<0.03	0,30	1,13	<0.03	<0.04	<0.04	<0.08	101,07	LP1c
18791	**Beaker**	Fragment of wall	**C**	**213**	67,54	12,95	6,28	3,42	2,37	2,24	1,35	0,27	2,95	0,44	0,08	0,87	<0.03	<0.04	<0.04	0,16	101,01	LP2
18805	**Beaker**	Fragment of wall	**C**	**211**	64,46	12,21	8,50	4,10	2,42	3,10	1,45	0,18	3,08	0,53	0,12	0,64	<0.03	<0.04	<0.04	<0.08	100,88	LP2
18817	**Beaker**	Fragment of wall	**C**	**289**	64,68	12,12	8,53	4,00	2,39	3,16	1,28	0,17	3,09	0,53	0,08	0,66	<0.03	<0.04	<0.04	0,15	100,92	LP2
18820	**Beaker**	Fragment of wall	**C**	**280**	64,36	12,29	8,57	3,99	2,39	3,14	1,36	0,16	3,11	0,52	0,12	0,68	<0.03	<0.04	<0.04	<0.08	100,77	LP2
18823	**Beaker**	Fragment of wall	**C**	**288**	64,76	12,05	8,48	4,06	2,46	3,20	1,28	0,16	3,13	0,51	0,10	0,69	<0.03	<0.04	<0.04	<0.08	100,98	LP2
18833	**Vessel n.i.**	Fragment of wall	**C**	**204**	71,54	12,18	8,91	4,68	1,32	0,82	0,57	0,13	0,22	<0.03	0,12	0,05	<0.03	<0.04	<0.04	<0.08	100,59	Outlier 4
28093	**Mosaic tesserae**	Whole shape	**A III**	**845**	64,47	19,00	4,23	2,28	0,57	0,72	0,85	0,14	0,32	0,07	0,43	1,12	3,47	0,36	2,60	0,66	101,37	

Table 1: Chemical compositions of artifacts from Loppio (EMPA data). Archaeological data (serial number (S/N), type, part preserved, sector, stratigraphic unit (US)) and compositional group also reported for each sample. Note that Cr2O3, CoO and ZnO contents were measured but not reported here because they are under the EMPA detection limits (equal to 0.03 wt% for CoO and Cr_2O_3, and to 0.04 wt% for ZnO) in all samples.

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FOY Danièle

VERRES ISLAMIQUES DE LA CITADELLE DE DAMAS (IX^E-XIII^E S.). UN APERÇU

Les fouilles archéologiques, l'étude monumentale et la restauration entreprises au début des années 2000 dans la Citadelle de Damas par une équipe franco-syrienne et placées sous la responsabilité de Edmond Al Ajji (Direction générale des Antiquités et des Musées de Syrie) et de Sophie Berthier (Institut Français du Proche-Orient) entraient dans le programme de réhabilitation et de mise en valeur de cette énorme bâtisse pour la rendre accessible au public.[1] L'exploration des niveaux archéologiques de la forteresse – construite à la fin du XIe siècle sous les Seldjoukides, mais réorganisée et agrandie au tout début du XIIIe par Al-Malik al-Âdil, frère et successeur de Saladin, et occupée par une garnison jusqu'au XIXe siècle – a fourni un mobilier abondant couvrant un arc chronologique large.

Les verres les plus anciens, hellénistiques (bols moulés dit grooved bowls), sont en position résiduelle dans un remblai recouvrant des niveaux pré islamiques. La vaisselle en verre du haut Empire romain est quasiment absente, en revanche le mobilier byzantin (Ve-VIIe siècle) est présent dans plusieurs niveaux de la salle à Colonne.

On présentera ici un aperçu du verre islamique provenant de la Salle à Colonnes et de la tour 6 et daté entre le IXe et le XIIIe siècle.

Mobilier de la salle à colonnes IXe-début XIIIe siècle

La Salle à colonnes, grand espace couvert de voûtes d'arêtes, était à la fois une pièce d'apparat et un lieu de passage reliant la porte orientale à la porte nord grâce à la galerie adjacente. Elle a été construite au début du XIIIe siècle et le matériel étudié provient de contextes antérieurs. Nous présentons ici quelques pièces isolées et des assemblages qui proviennent de contextes clos, essentiellement des remplissages de puisards et de caniveaux.

L'un des verres islamiques les plus précoces est le rebord mosaïqué d'une coupe hémisphérique. Il est composé de sections formées par la juxtaposition de minces rubans de

1 Berthier 2002.

Fig. 1 : n° 1 verre mosaïqué ; n° 6 oiseau ; n° 37, 42, 45 verres marbrés.

verre coloré. Cet agencement et l'effet décoratif qui s'en dégage rappellent fortement les perles égyptiennes que l'on rencontre fréquemment sur les sites de Fustat.[2] Ces parentés permettent de dater ce rebord du courant du IXe siècle; c'est probablement une importation d'Égypte (no. 1 et Fig. 1).

Plusieurs fragments très denses, de couleur vert émeraude, ont certainement été fabriqués avec une forte proportion de plomb. Cette catégorie de verre est attestée en plusieurs points du monde islamique en particulier en Égypte à Fostat (plusieurs vaisselles et lampes inédites, sur le site d'Istabl'Antar), et dans le Sinaï[3], en Ifriqiya à Sabra al Mansuriya[4] et en Turquie dans l'épave du Serçe Limani[5]; ils ont voyagé jusqu'en extrême Orient[6] et sont généralement datés autour de la fin du Xe ou début du XIe siècle. Trois rebords vert émeraude appartiennent à un bol hémisphérique (no. 2), à un récipient cylindrique à rebord replié vers l'extérieur (no. 3) et à un flacon dont le goulot est renflé à sa base (no. 4). Cette dernière forme est signalée sur plusieurs sites du début du XIe siècle.[7]

Les verres incolores et taillés sont également représentés par des fonds de gobelets. Ils sont contemporains des verres au plomb. Leur décor géométrique s'apparente au style dit »linéaire« (no. 5) des Xe-XIe siècle.

Plusieurs contextes livrent des assemblages de verres datables du courant du XIIe siècle

2 Scanlon and Pinder-Wilson 2001, 121 no. 47c, pl. IV.

3 Shindo 2007 et Shindo 2009, 311.

4 Foy à paraître. Verre analysé par I. Freestone.

5 Brill 2009, 464.

6 Noppe 2010, 68.

7 Sur le Serce Limani: Puche Acien, Matthews, Bass, 2009, 223-235 et à Sabra al-Mansuriyya: Foy à paraître, no 160.

ou au plus tard des premières années du XIIIe siècle. Une trentaine de pièces étaient dans le comblement du puisard 1063 dont la céramique très abondante a été étudiée.[8] Un mobilier comparable, riche d'une centaine de verreries, provient du remplissage de deux égouts (1042 et 1098) et d'un puisard (1098). Des collages ont été fait entre ces trois derniers contextes.

Les formes variées comprennent de la vaisselle de table, des contenants et du luminaire.

Le seul vase zoomorphe, soufflé dans un verre bleu, représentait un oiseau à long col (no. 6 et Fig. 1). Ce détail le différencie des autres récipients en forme d'oiseau trouvés en Syrie[9] ou ailleurs[10] et datés entre le VIIIe et le XIIe siècles. On ne sait pas comment était décoré cet oiseau dont l'oeil est formé d'une goutte appliquée de verre blanc.

Les flacons à long goulot cylindrique se terminant par un renflement (no. 7 à 9) et parfois colorés en violet (no. 8) avaient probablement une panse sphérique, peut-être soufflée dans un moule comme l'attestent de nombreuses pièces de collection,[11] datées du XIIe siècle et le plus souvent attribuées à l'Iran. Il n'y a pourtant pas d'argument pour rejeter une fabrication syrienne. D'autres goulots courts et bulbeux à lèvre redressée ou repliée vers l'intérieur (no. 10, 11) ou encore à bord coupé (no. 12) peuvent appartenir à des bouteilles à panse sphérique ou autre; la plupart d'entre elles sont dans des contextes du XIe siècle.[12] Les contenants de plus grand gabarit et à large ouverture sont également présents. Ils sont habituellement de teinte naturelle bleu-vert (no. 13 à 15), mais de petits bocaux plus fragiles réalisés en verre coloré au manganèse (no. 16) étaient peut-être destinés à contenir des onguents ou autre substance de prix. La coloration violette engendrée par le manganèse est également celle de plusieurs récipients soufflés dans un moule : bases de flacon (no. 26) et de bouteille cylindrique ou de gobelet (no. 25) ainsi que de nombreux fragments d'autres pièces.

Les coupes à fond plat ou peut-être supportées par un pied tronconique sont très nombreuses. De profil hémisphérique (no. 17 à 24) ou tronconique (no. 22-23) elles ont généralement un rebord arrondi ou plus rarement effilé (no. 23). Les décors relèvent de plusieurs procédés : application d'un filet bleu formant la lèvre (no. 17, 18) bord biseauté et agrémenté de petites incisions (no. 21); bord épaissi pour former un bandeau en relief très étroit (no. 20). Une seule pièce bleu foncé, soufflée dans un moule présente un rebord évasé (no. 24).

Les verres à boire sont des gobelets, cylindriques dans leur partie inférieure, et largement évasés dans leur partie haute. La base est cerclée par un cordon rapporté. Ils sont soufflés dans un verre clair presque parfaitement incolore et sont toujours décorés. Après les coupes hémisphériques ce sont les vaisselles les plus fréquentes dans les contextes du XIIe siècle ou peut-être du tout début du XIIIe siècle. Ils offrent une décoration rapportée, sous forme de gouttes de verre en assez fort relief disposées en un ou plusieurs rangs horizontaux lesquels sont limités par deux filets de verre appliqués. Ce type de verre est bien connu en Occident, dans de nombreuses régions et dans les contextes de la seconde moitié du XIIIe siècle et du XIVe siècle. L'Italie, les pays balkaniques,[13] le sud de la France où un atelier a été identifié[14] ont fourni de nombreux exemplaires en verre incolore. En Suisse, en Allemagne[15] cette vaisselle a aussi été utilisée et l'on peut raisonnablement penser que les pièces soufflées dans un verre verdâtre ou bleuté sont des productions du Nord des Alpes. Les mêmes verres produits dans l'atelier de verrier de Corinthe ont d'abord été datés des XIe-XIIe siècle et attribués à des artisans émigrés d'Égypte.[16] Ces conclusions ont été discutées par D. Whitehouse qui a proposé d'y voir des verriers italiens en activité durant

8 McPhillips 2002.

9 Riis 1057, no. 181, 203.

10 Jenkins 1986, 11 ; Carboni 2001, 302-303, 307 ; Goldstein 2005, 78, no. 74.

11 Collection Monsieur D 1985, 260-261 ; Carboni 2001, 266-239, Goldstein 2005, 244.

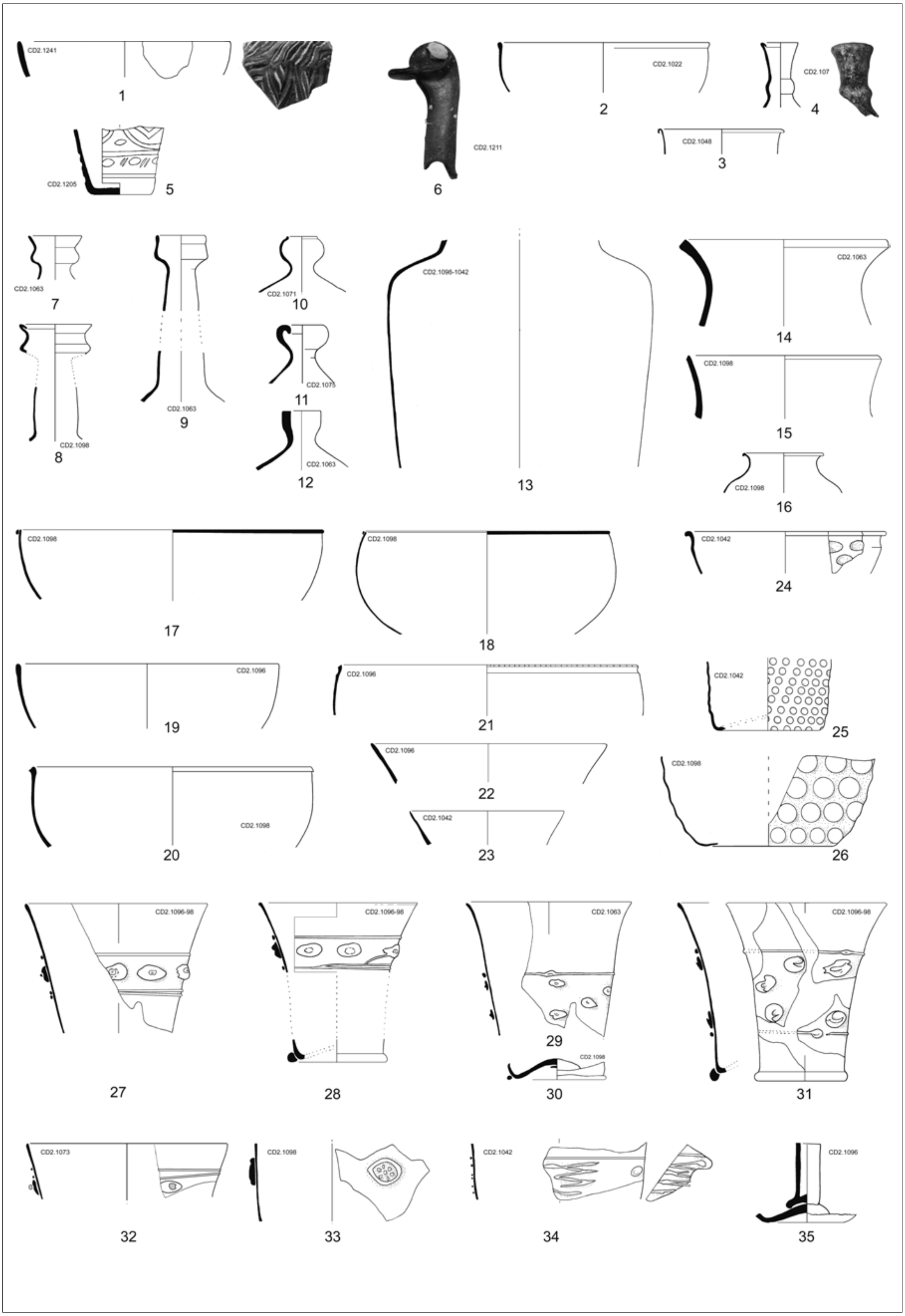
12 Lester 2003, 160-161, fig. 2, no. 22 ; Frifelt 2001, 161 ; Puche Acien and Bass 2009, 215-221.

13 A titre d'exemple voir pour l'Italie : Harden 1966; D'Angelo 1976 ; Whitehouse 1987.

14 Foy 1988, 209-211.

15 Baumgartner and Krueger 1988, 210-217.

16 Davidson 1940, 1952; Weinberg 1975.



Pl. 1 : Salle à Colonnes. n° 1 à 5 : IX-XIe s. ; n° 7 à 35 : XIIe ou début XIIIe s.

le XIIIe ou du XIVe siècle.[17] Les découvertes de Damas relancent ce débat. Le contexte de datation interdit de dater ces verres après les années 1220-1230, et le mobilier associé (céramique et autres verres) excluent une datation antérieure au XIIe siècle : on pourrait imaginer une production vers la fin du XIIe ou au début du XIIIe siècle, c'est à dire une datation pas trop distante de celle qui est admise pour les pièces trouvées dans les pays chrétiens. D'où viennent ces verres? S'agit- il de productions régionales ou d'importations occidentales? On notera que si la plupart des formes de verres islamiques sont produites dans l'ensemble du monde musulman, ce n'est pas le cas pour ces objets qui d'ailleurs ne figurent jamais dans le répertoire de la verrerie islamique. En Syrie, ils sont pourtant assez fréquents si on en juge par les découvertes de Damas et les trouvailles anciennes de Hama;[18] on les connaît aussi au Château de Montfort, dans le nord d'Israël.[19] Dans la mesure où nous ne connaissons pas ces gobelets en Occident avant le milieu du XIIIe siècle nous pouvons privilégier une production régionale qui aurait alors influencé les artisans occidentaux; mais nous ne pouvons pas dire si ce sont les œuvres de verriers syriens ou bien de verriers latins installés en Syrie où ils auraient créé ces »prototypes«. Ces gobelets à gouttes rapportées, tout comme les verreries émaillées imitées dans la lagune vénitienne, pourraient témoigner des liens qui se sont créés entre la verrerie islamique et les productions occidentales grâce au relais vénitien.

On remarque dans ce mobilier syrien des particularismes que l'on ne retrouve pas dans la verrerie occidentale comparable. Le profil est le même mais, dans le détail, les décors diffèrent. A Damas, les protubérances sont sur trois rangs au maximum (no. 29, 30) et non pas jusqu'à cinq, voire huit de manière à couvrir presque toute la panse comme on peut le voir ailleurs, en Italie et à Corinthe. Sur les récipients syriens, les gouttes de verre appliquées sont en relief assez haut car elles sont souvent surmontées d'un second globule de plus petite taille (no. 27); quelquefois il est en négatif (no. 28). Dans certains cas, la seconde goutte de verre est colorée en bleu turquoise (no. 32); ce décor est observé sur une aiguière de Hama.[20] L'utilisation du verre bleu dans ce type de gobelet apparait sur plusieurs pièces occidentales mais il s'agit d'un bleu cobalt bien différent du bleu turquoise; une autre variante, connu également à Hama et sur un verre conservé au musée du Louvre,[21]consiste à estamper la protubérance pour obtenir un décor de rosette (no. 33). D'autres gobelets sont décorés de filets déposés en zigzag (no. 34) alternant avec les gouttes. Cette décoration est observée sur un gobelet du musée du Koweït, supposé d'origine syrienne.[22]

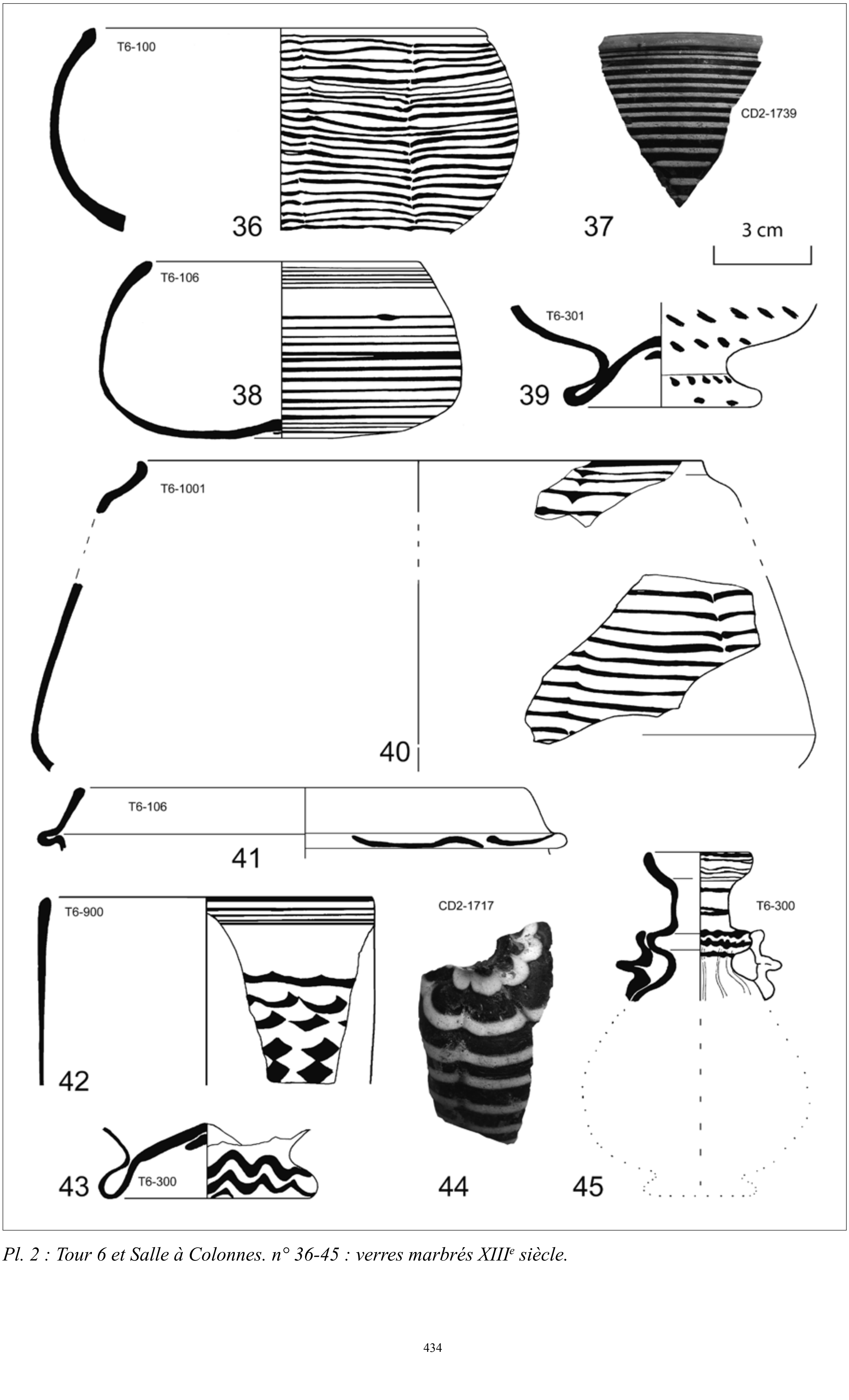
Les lampes à porte mèche intégré sont comparables au luminaire des Xe-XIe siècle (no. 35).

Verres marbrés du XIIIe siècle

Cette catégorie de verre, bien connue en Égypte et en Syrie, est représentée dans la citadelle de Damas par une vingtaine de pièces offrant des formes très variées. Elles viennent essentiellement de la tour 6 et du secteur B de la salle à Colonnes. Toutes sont de teinte aubergine rehaussée de verre blanc fondu dans la masse.

Les bols, à décor de lignes horizontales (no. 38) se poursuivant sous le fond en cercles concentriques ou à motifs de festons (no. 36) sont les plus nombreux. L'un deux, possédant sur son bord un filet vert (no. 37 et Fig. 1) doit être rapproché d'un vase conservé à Copenhague.[23] Un grand vase caréné au rebord bien distinct rappelle une trouvaille de Hama.[24] Les pieds coniques appartiennent à des vases ovoïdes (no. 39) ou bien à des qumqum (no. 43). Leur profils et décor en onde ou moucheté se retrouvent à Hama et dans diverses collections.[25] Quatre pièces évoquent des récipients plus rares: des

17 Whitehouse 1991; Whitehouse 1993.
18 Riis 1957, no. 157-162.
19 Whitehouse 2005.
20 *Id.*, no. 153 ; L'Orient de Saladin 2002, no. 186.
21 Syrie 1993, no. 340.
22 Carboni 2001, 184-185.
23 Carboni and Whitehouse 2001, 141.
24 Riis 1057, no. 197.
25 *Id.* 1957, no. 200; Carboni and Whitehouse 2001, no. 59; Carboni 2001, 310-311.



Pl. 2 : Tour 6 et Salle à Colonnes. n° 36-45 : verres marbrés XIIIe siècle.

pyxides (no. 41 et 42 et Fig. 1) et des flacons. L'un d'eux, une bouteille cylindrique trouve un parallèle dans la collection du Musée du Koweït.[26] L'autre, doté de deux anses (no. 3 Fig. 1), peut être restitué sur le modèle d'un vase du musée islamique de Berlin. Les côtes visibles au dessous du col résultent d'incisions faites par un outil ou par un soufflage dans un moule.

L'ensemble présenté ne donne qu'une image partielle des verres recueillis dans la Citadelle de Damas. Les pièces non décorées ou très élaborées, comme la vaisselle émaillée de la seconde moitié du XIIIe siècle, traduisent par leur nombre et leur variété l'occupation résidentielle du monument. Leur présence dans des contextes bien stratifiés apporte des informations fiables sur l'artisanat verrier syrien et confirme la datation et l'origine des objets coupés de leur contexte et conservés dans les collections publiques et privées.

26 Carboni 2001, 312-313.

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ISLAMIC GLASS FROM SILVES' CASTLE (PORTUGAL)

Introduction

The city of Silves is located in the Algarve region, close to the Arade River in the south of present-day Portugal and was the last capital of the *Gharb al-Andalus* (Fig. 1a).

The Silves' Castle is one of most important and well preserved early medieval fortifications in the Iberian Peninsula (Fig. 1b). Since 1984, archaeological excavation work conducted by the author confirmed the location of the castle construction, which was occupied by Muslims. From the 8th century it was inhabited without interruption until the mid-13th century and thereafter conquered by the Portuguese.[1]

A defensive building was constructed with strong military mud walls at the beginning of the Muslim occupation, now recognized in the central area of the present-day fortification.

These are the remains of the oldest fortified palace found in Silves, which has been dated to between the 8th and early 9th century. In addition, a rare group of polychrome ceramics, also originating from this period, was discovered, and was imported from the Near East. Other specimens came from the Maghreb, produced with very high quality fabrics and decorated with reticulated bands or zigzag painted groups, while additional items were made by local production, reflecting the exquisite taste and wealth of the societies living there.[2]

Above the layer of the aforementioned occupation were other layers, where the remains of architectonic structures, floors, and several other finds formed a long stratigraphic sequence corresponding to what is usually designated in the East as a *tell*, or artificial hill.

Islamic glass

The oldest glass fragments recovered in the Castle of Silves are from layers corresponding to the first Taifa kingdom in Silves (11th century), namely from the remains of the famous "Balcony Palace" where, according to written evidence, the poet king Al-Mutamide lived.

1 Gomes 2003.

2 Gomes 2011.

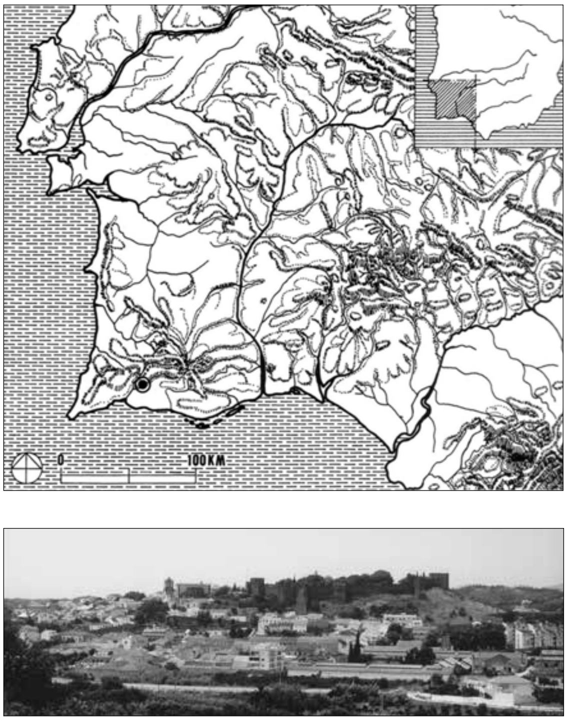

Fig. 1: A – Southern Portugal's map with the location of Silves. B – Southwest view from the Castle (photo by M.V. Gomes).

The most important finds from this period were a group of decorated plaster arches and other architectonic structural remains. However, there were also interesting glass objects, such as a black glass bead with six vertical grooves (Q38/C4-2) and decorated with fine white spiral lines, as well as two vase fragments (Fig. 2a). One fragment is a wall sherd made from opaque grey glass while the other is made of translucent light green glass. Both have relief decoration, one with a geometric pattern (Q10/C4-3) and the other with phytomorphic motifs (Q10/C4-4).

Another palatine building, related to the Almoravides and Almohades occupation, was found above the aforementioned palace remains, where the following glass objects were also recovered: a transparent glass bead, decorated with small blue dots (Q8/C3-2); fragments of a neck and upper body part of a glass flask, produced of brown opaque glass (Q45/C3-3); and part of a handle and the wall of a flask, made of opaque grey glass (Q49/C3-1). This last find presents moulded decoration with an epigraphic string (Q34/C3-1; Fig. 1b).

Archaeology has demonstrated that the better preserved parts of the fortress were built between the Muslim re-conquest of 1191 and the definitive seizure of Silves by Christian troops in 1248. During this period, a large number of constructions were erected, including a large part of the castle's walls, two palaces, a number of houses, a monumental cistern and six enormous underground silos (Fig. 3).[3]

The archaeological finds of that period include coins, pottery, bone and metal artefacts, and an important glass collection. The glass was mostly found in the building where the baths were located in the aforementioned palaces. The glass sherds, when compared to all other archaeological remains, present a small percentage (0.08%), which is possibly related to the fragility of the material. Nevertheless, the glass sherds have a higher percentage than the coins (0.05%), stone artefacts (0.02%) and bone implements (0.03 %), although they are inferior to the metallic objects (0.25%) and ceramic fragments, which form the largest group and highest percentage of the finds (99.57%).

The glass fragments belong to goblets, bowls, jugs and jars, aquamaniles (several handles, bottoms and rims, two of which have zoomorphic figures) as well as small flasks, phials and beads. Although most of the items were found in sherds, a complete bowl and a phial are notable finds, due to their well-preserved state.

The colours of the glass vessels are blue, green, brown, grey, yellow or red, and are decorated in relief or with pinched ribs as well as painted with floral motifs.

The bowls have vertical walls, somewhat oblique or bent and a plain or omphalos base. These were made with blue (Q74/C2-8) or green (Q29/C2-5) translucent glass, but also with opaque green glass (Q20/C2-7; Q39/C2-4; Fig. 4).

Considering the dimensions, some of these vessels could be used for cosmetics. The same can be said about the small flask or phial, which

3 Gomes 2009, 477-488.

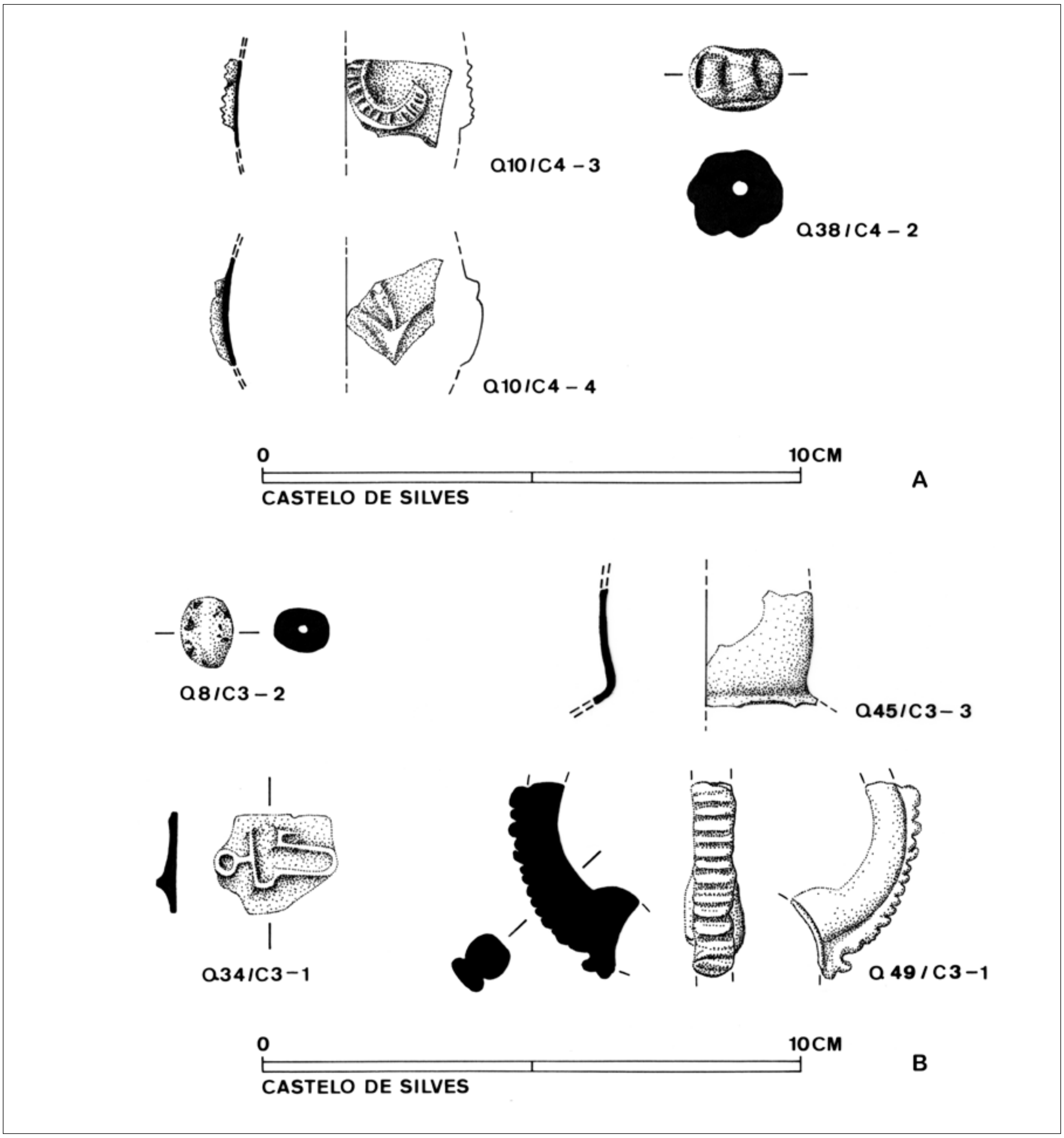

Fig. 2: Castle of Silves – A - The oldest glass fragment and bead; B – Islamic glasses (drawings Ana Machado).

usually have a tall neck, a more or less flattened globular body and an omphalic base.

These finds were made from translucent light green glass (Q74/C2-7; Q35/C2-5; Q158/C2-8; Silo 4-94; Silo 4-96), and brown reddish or grey opaque glass (Q35/C2-7; Q35/C2-6).

One of these flasks is decorated with relief oval motifs (Q74/C2-7). Two others feature very tall necks when compared to the body height while only one has a short neck and a globular body, decorated in relief (Silo 4-94).

Some handle fragments and ring footed fragments could belong to large bowls, jugs and jars or, eventually to mosque lamps (Fig. 5). These were produced with opaque green (Q716/C2-1; Q90/C2-4; Q79/C2-3; Q163/C2-1; Q198/C2-1) or brown glass (Q725/C2-1; Silo 4-95). Some of the handles have in their upper part a plastic decorative element; on the outer surface a vertical relief rope and parallel incised horizontal lines (Q725/C2-1; Q198/C2-1) on several fragments. There are also wall sherds

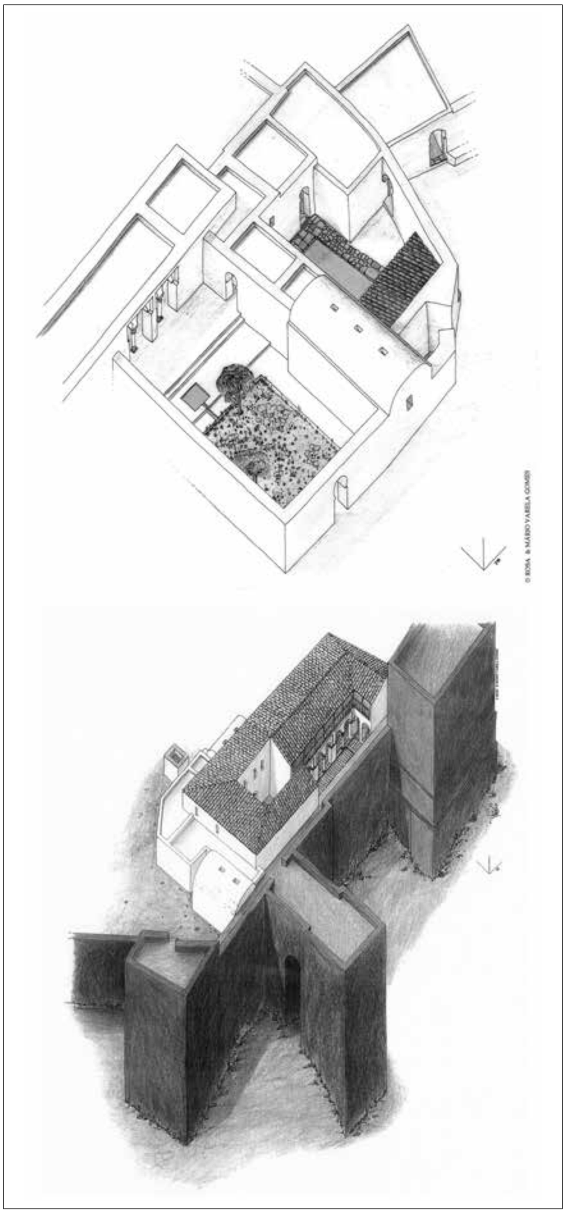

Fig. 3: Graphical reconstruction of the two Islamic palaces from Silves' Castle (drawings J. Gonçalves and C. Gaspar).

with moulded and incised decorative elements, made of white (Q157/C2-3), yellow (Q62/C2-2) or grey (Q33/C2-9) translucent glass.

Three of the fragments (Q35/C2-8) were parts of the bottle neck, or flask, and were decorated in dark red and gold on blue glass to create circles and zigzag lines.

Fragments of two *aquamaniles* made of light-grey coloured opaque glass and with necks ending in zoomorphic elements (Q20/C2/U1; Q20/C2/U1-11), probably protomes of camels, are similar to other examples found in the Castle, although they were produced in ceramic (Gomes, 2003, 242, 250, 312; Fig. 6).

Small lids, rims, necks, walls and omphalos bases that belonged to perfume flasks were also found. These were manufactured of green translucent glass (Q247/C2 -1-4; Q45/C2-3; Q68/C2-2; Q996/C2-1; Q391/C2-1; Q71/C2-1; Q71/C2-2), green opaque glass (Q23/C2-6; Q619/C2-2; Q62/C2-6), brown opaque (Q35/C2-3; Q729/C2-1; Silo 4-99) or grey glass (Q74/C2-10), yellow translucent glass (Q1/C2-4), and opaque blue glass (Q19/C2-2), while some were shaped like small phials, in amphora form, and were made with brown reddish marble type glass (Q282/C2-2; 282/C2-1; 284/C2-1; Fig. 6).

Cultural context and conclusions

The Iberian manufacture of glass objects goes back to protohistoric times and continued during the Roman period and the Middle Ages. In this respect, besides the 9th century glass furnaces from Cordova and Pechina (Almeria), there were other important glass production centres throughout the 11th, 12th and 13th century, such as Malaga and Murcia, thus providing confirmation of the existence of Iberian glass production during the Islamic Period.[4] Nevertheless, so far, current studies have not been detailed enough to adequately reveal the characteristics of production as well as the commercial networks, aspects that will certainly become clearer following the complete study of the discoveries of glass furnaces and their production in Pechina as well as in Puxmarina and Belluga, both of which are in Murcia.[5]

In addition to the integration of this city into the *al-Andalus* commercial networks, commercial relations between Silves and the Near East have been well documented since the beginning of the Muslim presence in the region until the 13th century.[6] In this sense, the presence of glass with an Eastern provenance

4 Castillo Galdeano and Martínez Madrid 2000; Jiménez Castillo 2000; Jiménez Castillo 2006, 52-53.
5 Jiménez Castillo 2006, 53-54.
6 Gomes 2003.

inside the Castle should not be considered odd. In 11^{th} century archaeological contexts, two very fine quality fragments with relief decoration were found (Q10/C4-3; Q10/C4-4). They were possibly produced in Syria, where this technique has been documented since the 7^{th} and 8^{th} century.[7]

The bead found in the same archaeological context (Q38/C4-2) resembles a similar object found in Fustat, and is considered to be a product of the 8^{th} or 9^{th} century.[8] It is possible that the oldest glass objects found in the Silves Castle in an 11^{th} century context may have been imported from the Near East or eventually produced in Iberian workshops imitating eastern objects. A palace of poet king Al-Mutamide in Seville is considered to have been the place and the city where glass furnaces are purported to be located according to 11^{th} century documents,[9] but they were not yet excavated.

A less common decorative feature in glass objects is the use of relief epigraphic bands, as the fragment found in an archaeological context from the 11^{th} century demonstrates. Its presence is more frequent when painted with a golden colour. Both cases refer to Egyptian workshops developed between the 9^{th} and 11^{th} century.[10] The excellent technical quality of the fragment (Q34/C3-1) found in Silves, and the use of an epigraphic string around the bowl, may in fact indicate it was an import.

Amongst the glass originating from the final stage of the Muslim occupation in Silves Castle (late 12^{th} century - mid 13^{th} century) are zoomorphic representations present in the two *aquamanile* fragments, an infrequent feature in glass objects, although several similar vessels made from ceramic material were also found. Glass zoomorphic objects are known in the Kuwait Museum, although originate from previous periods and were produced with a decorative or symbolic function. There is a clear predominance of

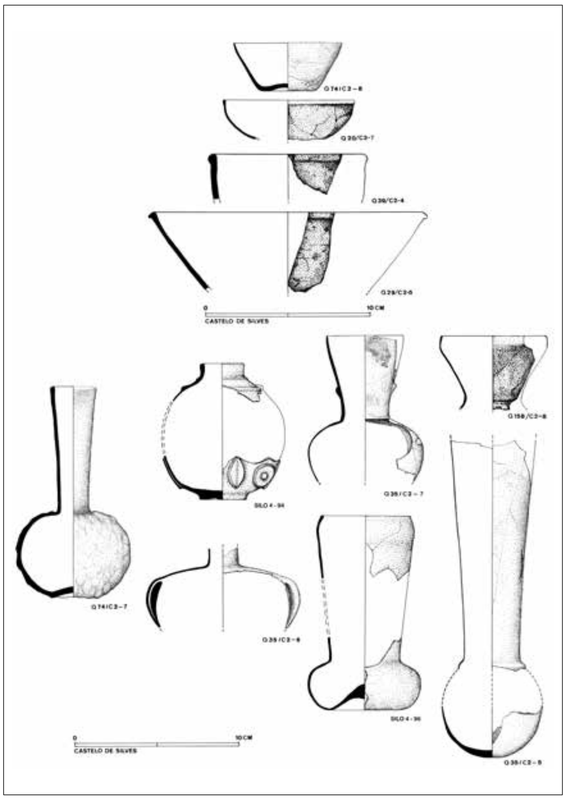

Fig. 4: Castle of Silves – Islamic glasses (drawings A. Machado and S. Costa).

birds, although many other animals have been represented.[11] There are just a few examples of glass objects in *al-Andalus* with these types of representation, the oldest being a bird dated to a period from between the 7^{th} and 8^{th} century that was produced in Egypt or Syria, and which is today part of the Archaeological Museum of Catalonia (Barcelona) exhibition.[12] An animal's head fragment was considered to have been produced in the Puxmarina (Murcia) workshops in the 12^{th} century.[13] Although morphologically different from the two examples identified in the Silves Castle,[14] the surface treatment and the glass colour are similar, thus indicating that the artefacts found in that city may have been manufactured in the Murcia workshops. The commercial contacts between the *Sharq al-Andalus* and the *Gharb al-Andalus* were, up until now, only known

7 Carboni 2001, 39-44.

8 Scanlon and Pinder-Wilson 2001, 120, 122, fig. 47g.

9 Jiménez Castillo 2006, 52.

10 Carboni 2001, 106, 107, 187.

11 Carboni 2001, 187.

12 Carreras 2006, 141.

13 Jiménez Castillo 2006, 54, fig. 8.

14 Gomes and Gomes 2001, 76.

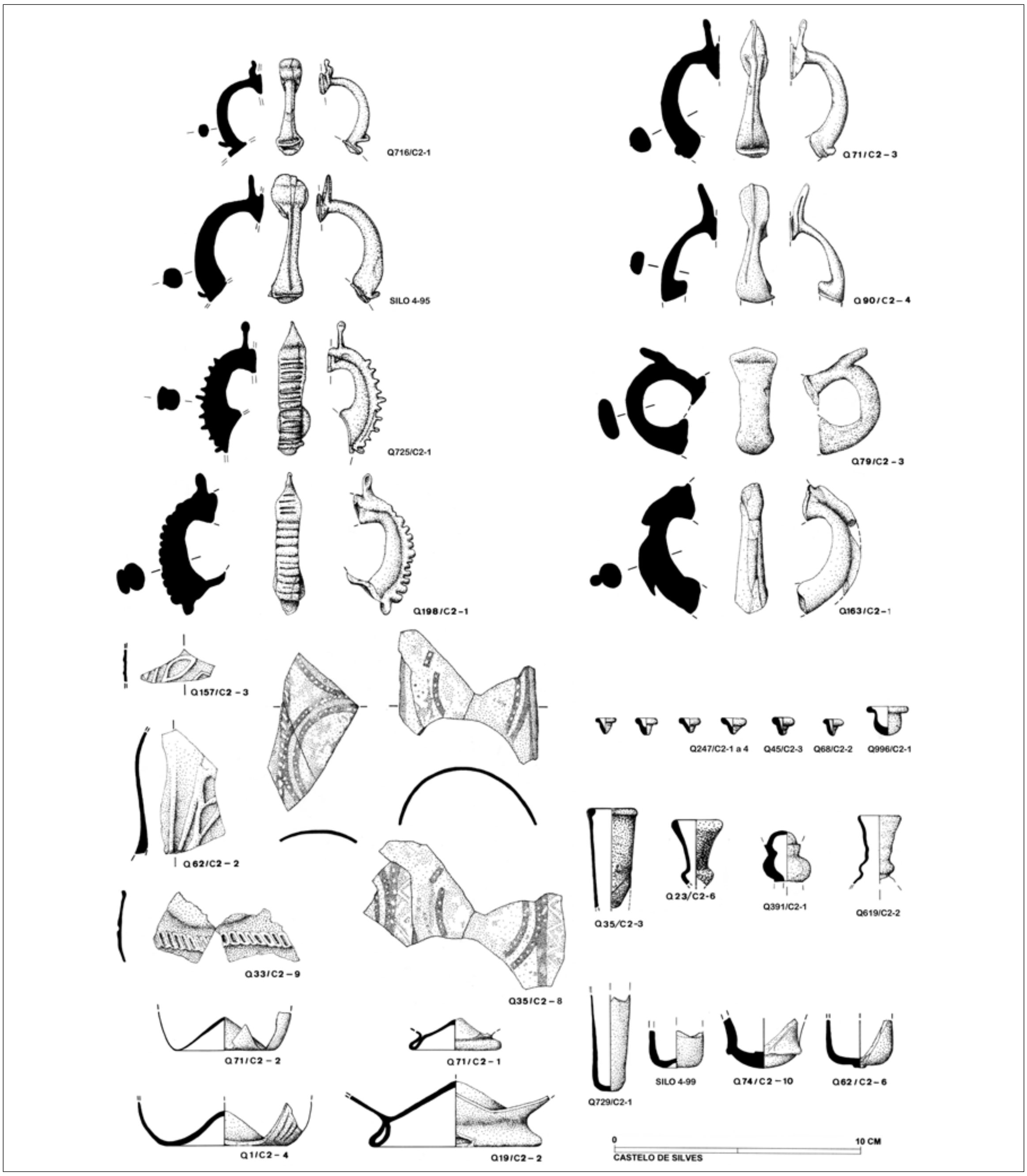

Fig. 5: Castle of Silves – Islamic glasses (drawings A. Machado and S. Costa).

in Silves by the ceramic sherds[15] and further supported by the discovery of glass objects. The zoomorphic glass now presented - with its very distinct body treatment-[16] is quite different from the glass found in the San Nicolás well in Murcia and has been dated from the second half of the 13th century.

The small glass lids for flasks and phials in amphora form are very similar to other specimens with a comparable chronology found in Mértola and Calatrava la Vieja (Carrión de Calatrava, Ciudad Real).[17]

It is therefore possible that some of the bowls, small flasks, phials and jars with plain bottoms

15 Gomes 2003, 288; Gomes 2011a, 115.

16 Jiménez Castillo 2006, 53, 54, fig. 7.

17 Ferreira 1992, 43, 48; Rontomé Notário 2006, 107.

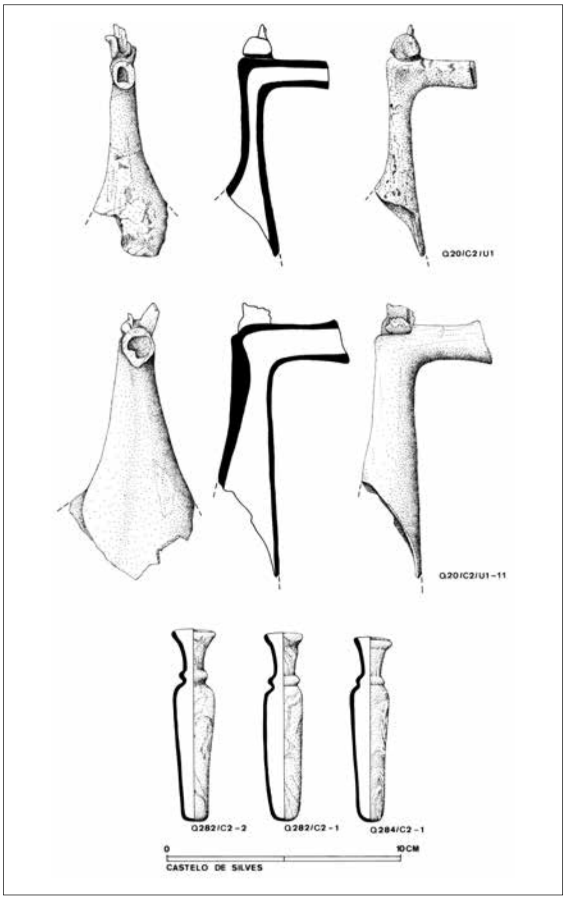

Fig. 6: Castle of Silves – Islamic glasses (drawings A. Machado and S. Costa).

or ring feet found in Silves, were produced in *al-Andalus*.

Several examples of other small flasks shaped like amphorae feature marble decoration and were possibly produced in Syria or Egypt. These are quite different from those made in the Murcia region with specific shapes and decoration.[18]

To summarise, it is believed that the large majority of the Silves finds was produced in the Iberian Peninsula, despite some having been imported from Northern Syria and Egypt, thus revealing the existence of a long distance trade and of a wealthy and exquisite elite able to use glass objects as an element of aesthetical pleasure and as an ostentatious display of political and social power.

18 Jiménez Castillo 2000, 127.

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LAVYSH Krystsina

NEW FINDS OF ORIENTAL GLASS IN THE TERRITORY OF BELARUS

In the 1960s, numerous items of Byzantine and Oriental glass were found during the excavations performed by F.D. Gurevich's in Novogrudok. F.D. Gurevich affirmed that according to the number of finds and to the diversity of forms of vessels discovered they were, and still are, the most numerous and representative medieval glass collection not only in Rus', but also in the whole of Europe. However, since then new finds of Oriental glass, hitherto unknown to researchers, were found in Belarus (in other towns as well as in Novogrudok). It is also worth noting that specimens found earlier on have not yet been introduced into scientific circulation. The purpose of this paper is to supplement and verify the existing corpus of Oriental glass imports, as elaborated by F.D. Gurevich from the 1960s – 1980s. I would like to my express deep gratitude to the following archaeologists: T.S. Bubenko, L.V. Koldeinskiy, O.N. Levko, G.V. Shtykhov and Ya.G. Zverugo, who have all presented materials relating to their archeological excavations, many of which have not yet been published.

The fragments of Oriental glass vessels, found in the territory of Belarus, but not introduced into scientific use, originate from Novogrudok, Vitebsk, Minsk, Drutsk, Grodno, Polotsk and Volkovysk.

A number of fragments of thin-walled vessels, painted with enamel and gold and probably of Syrian origin, were found in Novogrudok in 1992 (excavations by T. S. Bubenko). A fragment of a beaker painted with gold and dark red enamel from Novogrudok is of particular interest (Fig. 1.1). On this fragment is a depiction of a saint and the lower part of a frieze with a preserved Arabic or pseudo-Arabic inscription.[1] The fragment of the inscription is too small to make a conclusion about its Arabic or pseudo-Arabic character. The depiction of the saint was made freely and somewhat carelessly; his clothes appear in large spots of dark-red enamel and gold. The black lines mark the facial features and clothing details as well as outlines of

1 Bubenko 1993, 24, fig. 51.

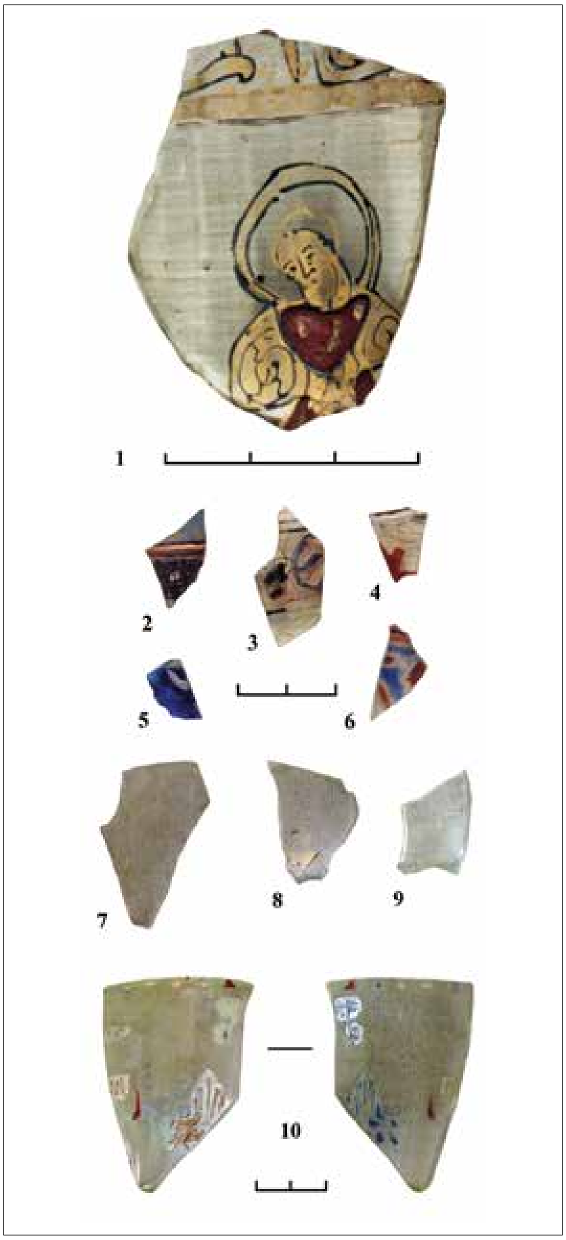

Fig. 1: Fragment of glass beaker painted with gold and dark red enamel. Syria. 1260s. Found in Novogrudok. Excavations by T.S.Bubenko. Novogrudok, Novogrudok Regional Museum; Inv. No. КП 3751 (1), Fragments of glass thin-walled vessels painted with gold and enamels. Syria. 13th c. Found in Novogrudok. Excavations by T.S.Bubenko. Novogrudok, Novogrudok Regional Museum; Inv. No. КП 3777, КП 3779, КП 3801, НВ 3969, НВ 3970, НВ 3973, НВ 3967, НВ 3966 (2-9), Fragment of glass thin-walled vessel painted with gold and enamels. Syria. 1st half of the 13th c. Found in Novogrudok. Excavations by F.D.Gurevich. Novogrudok, Novogrudok Regional Museum; Inv. No. НВ-Д-69/Л323 (10).

the figure and letters of the inscription arranged in the form of a frieze above the depiction of the saint.

This vessel is more likely to have been made in Syria, because it was painted in gold and enamel on colourless glass, which characterizes the Syrian tradition. Close analogies to this vessel fragment are vessels from the Walters Art Museum in Baltimore, the Benaki Museum in Athens, the Furussia Arts Foundation (Vaduz, Liechtenstein), the Louvre and the Hermitage, which researchers consider to have been made in the 1260s by Syrian craftsmen for their Christian customers.[2] Vessels from the Walters Art Museum in Baltimore and the Louvre are beakers of a very popular shape in the Middle Ages. These beakers, resting on an applied foot ring, have a slightly flaring profile, painted with gold and enamel and depict figures with halos and friezes with Arabic inscriptions. Two beakers in the Walters Art Museum also represent scenes from the Entrance of Christ into Jerusalem (Fig. 2.4). The fragment of a bowl or bottle preserved in the Islamic section of the Louvre shows two small haloed personages dressed in long robes and tunics; they appear to hold their hands in front of their chest and turn their heads to the right in what looks like a praying position (Fig. 2.3). A vessel from the Hermitage (Fig. 2.2) differs from the above-mentioned specimens in form – it is a drinking horn, set later in European mounts, probably in the middle of the 16th century, and also painted with enamel and gold. A silhouette of one of the men on the Hermitage vessel, as well as the bend of his head and interpretation of the halo by two parallel lines, are rather close to the depiction of the saint on the Novogrudok vessel. However, the type of face on the personages is different: in one case it is Greek (on the fragment from Novogrudok), in the other Oriental (on the vessel from the State Hermitage Museum). Standing figures similar to those on the fragment from Novogrudok and the drinking horn from the State Hermitage are

2 Georgopoulou 1999, 299-321; Carboni *et al.* 2001, 242-245; Piotrovskiy 2008, 18. My appreciation to A.E.Musin and E.K. Stolyarova for the prompting of analogies.

Fig. 2: The bottle painted with gold and enamels. Furussia Arts Foundation. After: Carboni et al. 2001, 242 – 245 (1), Drinking horn painted with gold and enamels. The State Hermitage. After: Piotrovskiy 2008, 18 (2), Fragment of a beaker painted with gold and enamels. The Louvre. After: Georgopoulou 1999, 316, fig. 9 (3), Beaker painted with gold and enamels. Walters Art Museum in Baltimore. After: http://art.thewalters.org/detail/30576/beaker/ (4).

represented around the neck of the bottle from the Furussia Arts Foundation (Fig. 2.1). There are seven standing religious figures dressed in long tunics of various colors; some wear capes and two wear pointed hoods, although most are bareheaded and haloed. The largest register, placed between two narrow bands, shows open-air scenes in which four architectural scenes alternate with four depictions of agricultural activities, such as ploughing and the harvesting of dates and grapes. One of the buildings is clearly indentified by a large cross as a Christian church. The entire composition of the bottle represents a year in the life of a Syrian monastery.[3] Glasses, such as the Khalili flask and the beaker, repeat the combination of Christian and Islamic motifs, as do pilgrim flasks in Vienna and the British museum. A fragment in the Victoria and Albert Museum, apparently found in Egypt, shows two haloed figures in cloaks. A pilgrim flask in Vienna is also decorated with musicians and drinkers as well as a band of Christian figures round the neck.

Two further fragments, in the Al-Sabah Collection, show men with haloed heads wrapped in cloaks. The beaker in the Khalili Collection has a broad gilt band painted with a row of figures outlined in red, with each head bearing a halo and facing to the left. The decoration of the wine flask in the Khalili Collection is similar in style to that on the rim of the beaker from the same collection. At the base of the neck is a gilt band on which are depicted seven male figures in various robes, their heads bare and encircled with gold haloes. Two of the figures, both in white robes, hold up open books, which are possibly missals. The body of the flask is decorated with a row of figures of musicians and drinkers on a scrolling ground. The figures are finely outlined in red enamel and filled in with gilding where only the details are highlighted in coloured enamels. On the shoulders of the flask are three star medallions composed of interlacing angular elements, which alternate with long-necked birds bearing large beaks, evidently pelicans – an important symbol of the Church in Christian iconography.[4]

The aforementioned glass objects, as well as the objects of glazed pottery and of inlaid metalwork illustrating Christian figures and buildings, indicate that the theme of Christian life and religion also enjoyed significant popularity in Ayyubid Syria. In the 13th century, Christian imagery became a conspicuous element in the inlaid metalwork of the Mosul school and it is significant that during this period, Muslims and Crusaders were in continuous contact, not only as aggressors but also as pilgrims and traders. For example, eighteen metal vessels decorated with Christian themes have been studied by Eva Baer. The inscriptions of three of the most important pieces indicate that they were for members of the Ayyubid ruling class. On these

3 Carboni *et al.* 2001, 242-245.

4 Goldstein *et al.* 2005, nos. 306, 308.

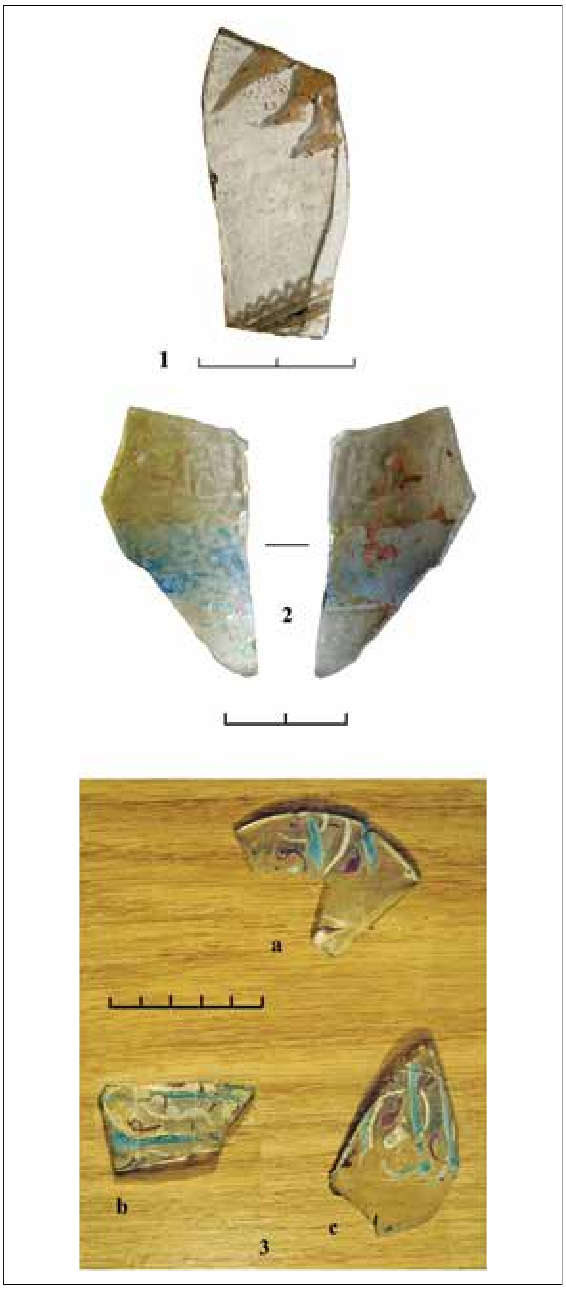

Fig. 3: Fragment of glass thin-walled vessel painted with gold. Syria. 12th – 13th c. Found in Minsk. Excavations by G.V.Shtykhov. Minsk, Institute of History of the National Academy of Sciences of Belarus (1), Fragment of glass thin-walled vessel painted with gold and enamels. Syria. The end of the 13th – 1st half of the 14th c. Found in Slonim. Excavations by G.I.Pekh. Slonim, Slonim Regional Museum; Inv. No. КП 6258 (2), Fragments of glass thin-walled vessel painted with gold and enamels. Syria. 13th c. Found in Drutsk. Excavations by O.N.Levko. Tolochin, Tolochin Regional Museum; Inv. No. КП 2345, КП 2349, КП 2351, КП 2352 (3).

objects, images of royal pastimes alternate with Christians figures and Baer suggests that such Christian imagery, like astrological symbolism, was another decorative element associated with princes - perhaps an implicit claim to authority over their Christian subjects. Several other pieces are decorated exclusively with images of Christian Saints or scenes from the Life of Christ, which would have held little significance for Muslims as a result of which, she suggests that such glasses were probably made for members of the Crusader aristocracy who had settled in the Holy Land.[5]

Rus', a fragment of a similar Oriental glass vessel with a Christian theme was found on the Rurikovo site.[6] It has partly preserved a depiction of two standing male figures, separated with a yellow line, in clothes girt with belts (or possibly tunics) and painted with gold and blue enamel. The men are half-turned towards each other, with arms bent at the elbows at waist height. A similar composition is observed on fragments of the beaker from Dvin (Armenia), painted with enamels.[7] On the preserved fragments, two figures of haloed persons wearing chitons with loose sleeves can be seen. Their arms are stretched towards the altar in the centre, with an arch in the upper part. The drawings are outlined in red. Judging by the remaining small fragments, the other glass vessels with pictures of people found in Novgorod, Smolensk and Yaroslavl[8] were hardly connected with the Christian theme.

The other fragments of Syrian glass vessels painted with gold and enamel that were found during the excavations by T. S. Bubenko in 1992 are small and have no figurative ornamentation. On one of the fragments of colourless transparent glass, an extant part of the ornamental frieze bounded above and below with two lines can be seen. The ornamentation of the frieze reveals rounded vegetative forms, made with brown enamel and thin free-interweaving gold lines.[9]

5 Goldstein *et al.* 2005, 276.
6 Plokhov 2007, 172, colored illustration 5,24.
7 Janpoladyan 1974, 62, no. 52.
8 Plokhov, 2007, 172.
9 Bubenko 1993, 24, 38, fig. 50:4.

Three more fragments of colourless transparent glass are painted with gold and are very faded.[10] Among these, is a fragment painted with red enamel and gold.[11] These fragments have in common the outlines of vegetative quirks, painted with gold, rounded and elegantly pointed at the ends. One more fragment is that of a vessel with a complex system of decoration.[12] On both sides of the salient band of red-brown enamel, which is outlined on both sides with gold lines, there is an Arabic inscription: on one side, gold on a blue background; on the other, dark gray enamel on a gray background. Another fragment of colourless glass is painted with blue and red enamel.

There is a fragment in Novogrudok Regional Museum found in Novogrudok by F.D. Gurevich, but as yet unpublished (Fig. 1.10). It is a fragment of the rim of the vessel, apparently a beaker, made of colourless transparent glass with an Arabic inscription fashioned with blue and white enamels; along its rim the painting is enriched with white and red enamel dots.

It should be emphasized that the fragments referred to above were found in the Novogrudok citadel, as distinct from the famous huge collection of Byzantine and Oriental glass vessels of the highest quality found in the trading quarter and known from the publications of F. D.Gurevich. A fragment of beaker with the image of the saint was found under the VI constructional level, which has been dated by T. S. Bubenko to a period between the 12th and the 13th century.[13] Thanks to the fragment, the dating of which is supported by a number of the aforementioned analogies from the 1260s, the dating of this layer can be narrowed down to the second half of the 13th century. In this layer, most of the fragments previously referred to were found (Fig. 1.3, 4, 9). Other fragments were discovered in upper layers, on the VI constructional level (Fig. 1.6), V constructional level (Fig. 1.2, 5), and in 11 layer (Fig. 1.7, 8). Therefore, these fragments found on VI constructional and upper

10 Bubenko 1993, 4, 24, 40, fig. 50:1, 10, 11.
11 Bubenko 1993, 24, 38, fig. 50:3.
12 Bubenko 1993, 21, 36, fig. 50:7.
13 Bubenko 1993, 23.

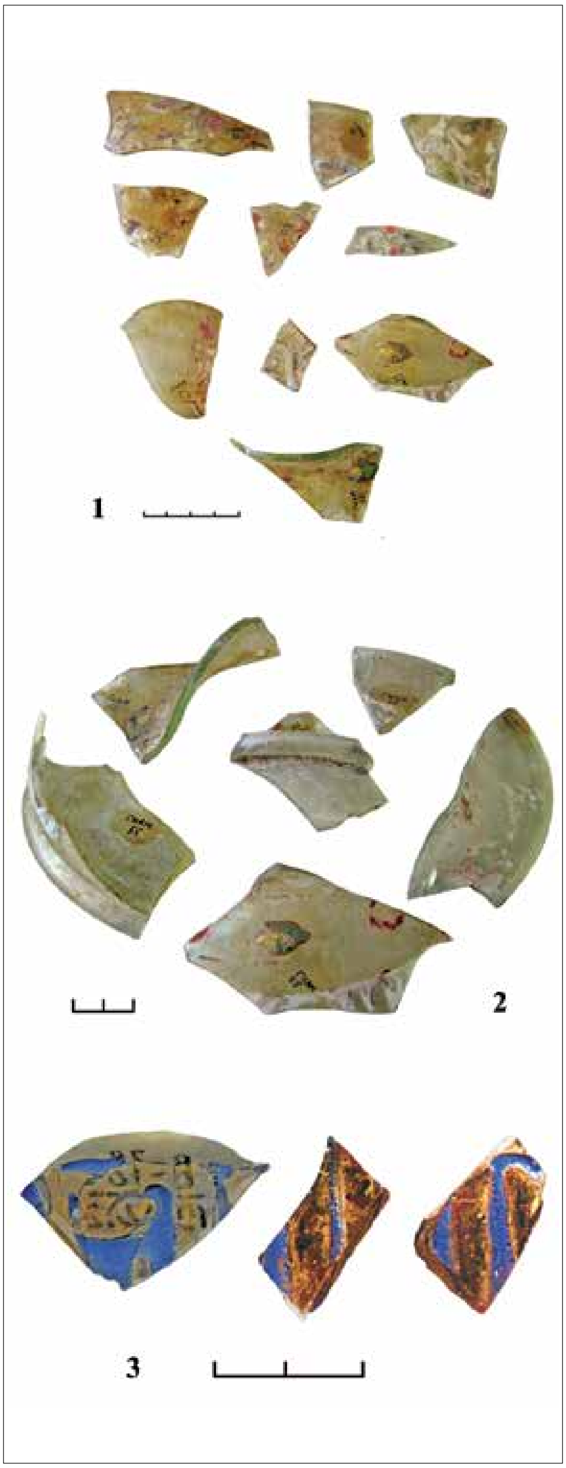

Fig. 4: Fragments of glass vessel (or vessels?) painted with gold and enamels. Syria (?). 13th c. Found in Grodno. Excavations by J.Jodkowski. Grodno' State Museum of History and Archeology; Inv. No. КП 55 (1-2), Fragments of glass vessel painted with gold and enamels. Syria. 13th c. Found in Vitebsk. Excavations by L.V.Koledinskiy. Vitebsk, Vitebsk' Regional Museum; Inv. No. Н/В 10145/4 (3).

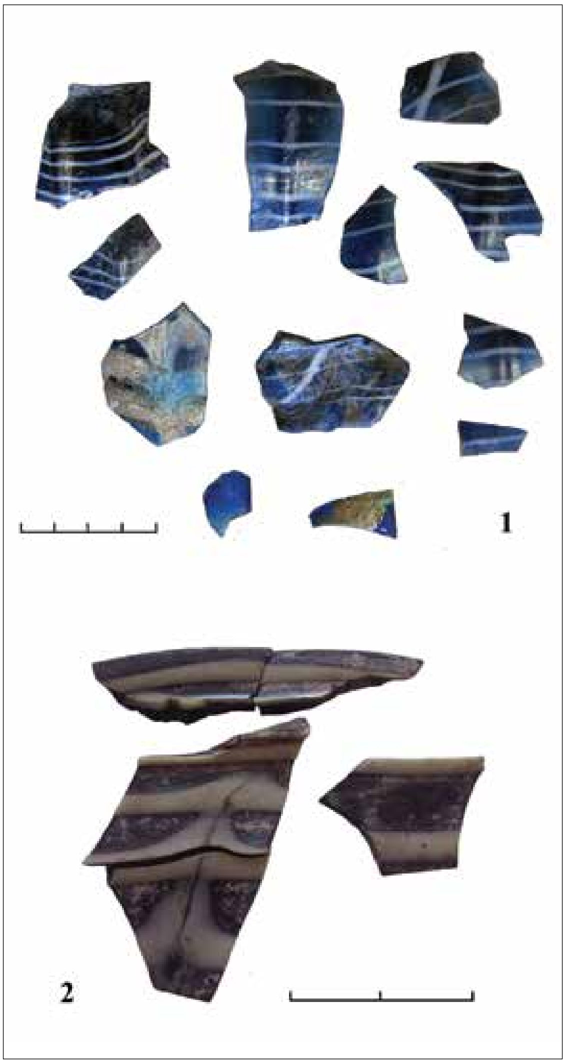

Fig. 5: Fragments of ribbed vessels, apparently bottles, of translucent blue glass, decorated with white applied and marvered trail. Syria or Egypt. 13th c. Found in Volkovysk. Excavations by Ja.G.Zverugo. Volkovysk, Volkovysk' military-historical Museum; Inv. No. КП 2842/6363, КП 2842/10149, КП 2964/151, КП 2842/15147, КП 2842/10951, КП 2429/1153, КП 2842/132, КП 2842/17668,КП 2842/224 (1), Fragments of vessel, apparently bowl, of translucent dark-violet glass, decorated with white applied and marvered trail. Syria or Egypt. 13th c. Found in Polotsk. Excavations by M.K.Karger. Polotsk, Polotsk' National Museum-Reserve of History and Culture (2).

levels can be dated to between the 13th and the 14th century. Most of the fragments were found in the filling of buildings.

A fragment of wall from the Syrian thin-walled vessel, made of colourless glass painted with gold, was found in Minsk (excavations of G.V. Shtykhov). It was discovered in a rich suburb of the citadel in a pre-Mongolian layer along with amphorae and glass bracelets.[14] A picture of a bird's wing and feet, as well as a belt consisting of a combination of zigzag and stripes, were preserved (Fig. 3.1). It is a small fragment of the vessel wall, making it impossible to restore the whole shape on the basis of this fragment alone. Quantitative spectral analysis showed that the glass belonged to ash glass – a subclass of soda: lime: silica glass founded using ashes of the salt-marsh plants.

Another finding by Slomim G.I. Pekh also briefly noted it in a publication in 1966 although its picture was never published and there is no information about the context of the find (Fig. 3.2). It is a vessel fragment in the Mameluke style with an Arabic inscription from a type of vessel that was manufactured in Aleppo. As a rule, they were made of colourless glass and painted on both sides with gold and enamel. Most early specimens date back to 1279, and most of the glassware originates from the period 1293-1341.[15] A fragment from Slonim is that of a thin-walled vessel made of colourless glass, decorated on both sides. On the inside of the fragment, horizontal pink and blue stripes can be observed; on the outside, a very faded Arabic inscription in gold. V.A. Krachkovskaya managed identify only two of several words: "S-alim…learned".[16]

Fragments of thick-walled (probably Syrian) glass vessels made of clear colourless glass, painted with enamels and gold, were found in Drutsk and Grodno.[17] Four fragments discovered in a suburb of Drutsk (Fig. 3.3) preserved a painting featuring blue, dark-red and white enamels and gold. This painting appears in the form of a frieze and resembles Arabic letters, perhaps making it a pseudo-epigraphic decoration. The shape of the vessel may be restored as a beaker. One of the fragments is the lower

14 Shtykhov 1981.

15 My acknowledgment to E.K. Stolyarova for her consultation.

16 Pekh 1966, 279.

17 Gurevich 1989, 15-16; Lyauko 2000, 97.

part of the beaker, which preserved a frieze with epigraphic decoration (Fig. 3.3c). In her publication of 1989, F.D. Gurevich briefly mentioned Oriental vessels found in Grodno, which were not investigated. In Grodno State Museum of History and Archaeology, there are 14 fragments of colourless transparent glass painted with pink, green, blue and white enamel, which belonged to the vessels found by I. Iodkovsky in from the 1920s – 1930s (Fig. 4.1, 2). Unfortunately, archaeological documentation related to these finds was lost. There are several rims of vessels which have been preserved, and possibly fragments of bowls. Diameters of two pieces have been restored, with a measurement of 12 and 16 cm. The diameter of the bottom of one vessel has also been restored to 12 cm. On one fragment is a glass fold, as is the case on the vessel from Novogrudok designed for decantation, but unlike the latter, the fold is located on the outside rather than the inside. It is possible the vessel was also used as a decanter for wine. In Islamic countries, there existed vessels with an outside glass fold used as a decanter for wine. They are represented, along with goblets, in many contemporary reveling or banqueting scenes in several different media.[18] It is hard to restore the characteristics of painting on the fragments from Grodno, but it is possible to state that its decoration was related to vegetation as on some fragments there are buds or buttons and tendrils. Finds from Drutsk and Grodno have in common rather thick vessel walls, which are painted with enamels that used a particular method of enamel application involving a thick layer rather than broad lines of painting. In spite of the fragmentary nature of the finds, there is a stylistic unanimity of painting that is broad and slightly heavy.

Three vessel fragments made of colourless transparent glass found in Vitebsk, in Upper Castle, (L.V. Koledinskiy's excavations), are very close to this group.[19] The vessel they belonged to also had rather thick walls. They preserve part of a frieze with an Arabic inscription made with blue enamel and gold (Fig. 4.3).

18 Jenkins 1986, 45.

19 Tkachev, Koledinskiy 1978, 155.

Fragments of glass vessel of another type were found in Volkovysk and Polotsk. Unfortunately, archaeological documentation related to these finds was lost. One of the vessels is apparently a bottle of translucent blue glass (Fig. 5.1) and another perhaps a bowl made of dark purple glass due to the rather big diameter of the rim (Fig. 5.2). Both vessels are decorated with white applied and marvered trail, tooled into a festooned pattern along the entire surface and refer to Egyptian or Syrian manufacture from the 12th to the 13th centuries. The Durighiello Bottle from the British Museum, sprinklers of violet-purple and dark blue glass from the Kuwait National Museum and the Toledo Museum of Art, and a lidded bowl from the Metropolitan Museum are decorated likewise.[20] The wavy effect was achieved by using a pointed instrument dragged alternately up and down across the threads (combing). The required wavy effect of threads can also be achieved by applying them to objects with ribbed walls; like on the fragments from Volkovysk where the facets of the vessel are clearly visible on many of them. This technique used by Syrians in the Roman period was widely used once again in Islamic times from the 12th to the13th century, especially in Egypt and Syria. One of the possible places where this type of vessels was produced was Aleppo.[21]

All the fragments under consideration were found in big towns, which were the centers of local principalities, and date back to a period between the 13th and the 14th century. In addition to the fragments, the following was also discovered: Byzantine glass vessels (Novogrudok, Vitebsk); Byzantine glass bracelets (Novogrudok, Polotsk, Minsk, Grodno, Volkovysk, Drutsk); a bone plate of the Byzantine casket (Novogrudok), silk fabrics (Novogrudok, Grodno, Minsk); Golden Horde glazed pottery (Novogrudok, Grodno, Drutsk, Slonim); Iranian luster-painted pottery (Novogrudok, Volkovysk); Syrian pottery "Lacabi" (Novogrudok,

20 Ivanov 1990, 63-64, no. 64; Carboni *et al.* 2001, 142-144; Ettinghausen, Grabar, Jenkins-Madinan 2007, 254, no. 421.

21 Carboni *et al.* 2001, 144.

Grodno); and Iranian pottery "Minai" (Grodno). Most Oriental and Byzantine goods imported to Western Rus were luxury goods, belonging to the elite and reflecting the fashion, common to the new European countries, where objects of Byzantine and Oriental art were extremely popular and considered to be articles of luxury. It was therefore, very fashionable to possess them. In this way, the use of Byzantine and Oriental imported goods reflected the trends of artistic taste of people of Western Rus.

Particularly impressive is a set of Oriental and Byzantine imported products of the highest quality in Novogrudok (where more than 340 fragments of glass vessels of Byzantine and Oriental origin were found, among which 270 belong to more than 40 vessels from Byzantium and 70 to 8 vessels made in Syrian ateliers, as well as the aforementioned items discovered with the fragments). It should be noted that according to Belarusian historians, Novogrudok became the center of the Grand Duchy of Lithuania in the mid-13th century, signifying the beginning of its formation. In his letter to the monks of Ordo Fratrum Minorum in 1323, Prince Gedemin called for Vilnius to be the capital of the Grand Duchy of Lithuania. Some sources contain information about the coronation of Mindaugas held in Novogrudok in 1252 (Kronika Polska, Litewska, Żmudzka i Wszystkiej Rusi Macieja Stryjkowskiego, 1582). In any case, Novogrudok was one of the most important cities in the Grand Duchy of Lithuania hence the appearance of Oriental glass painted in gold and enamel - an article of luxury and prestige - was quite logical. Most Byzantine and Oriental goods found in Novogrudok are dated to between the 12th and first half of the 13th centuriey and come from its suburb, but the new archaeological finds under consideration are dated to the period of the Grand Duchy of Lithuania in the history of Novogrudok. The localization of these finds in the citadel provides evidence of the fact that they belonged to the Prince or his entourage.

New data supplements a myriad of finds of Oriental glassware in Western Rus published from the 1960s to the 1980s by F. D. Gurevich and enrich our knowledge of types, shapes and decoration of Oriental glassware used in Western Rus.

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ISLAMIC GLASS WITH IMPRESSED DECORATION: THE PROBLEMS OF DATING AND PRODUCTION

Introduction

The glass with impressed decoration discussed in this article is a unique kind of glass in which the decoration is achieved by pinching the glass from both sides with a pincer to make a variety of patterned impressions. It is one of the techniques used for decorating glass that is typical of the early Islamic period.

It is thought that glass with impressed decoration was first made in Egypt in the 8th century, where the technique flourished and before spreading to Iraq and Iran in the 9th century.[1] This form of decoration then disappeared in the 11th century. The main sites yielding this glass are al-Fustat[2] and Alexandria[3] in Egypt; Pella[4] in Jordan; Caesaria[5] in Israel; al-Mina[6] in Syria; al-Jar (Old Yanbu)[7] in the Red Sea coastal area; Samarra[8] in Iraq; and Suse[9] and Nishapur[10] in Iran. In addition, a similar glass object was discovered under the platform[11] of the stupa dating to the Tung period at the Famen Temple. The temple, located about 138 km west from Xi'an (which was called Changan in ancient times) in China, had not been seen since 874.

The items of glassware with impressed decoration that have been discovered in excavations at the aforementioned archaeological sites provide useful information to consider when attempting to date these items and identify their production sites.

However, although this decorated glass was made across a wide area, stretching from Egypt

1 Institut du Monde Arabe 1998, 186; Pollak 2003, 167, l.30-49.

2 Shindo 1992, 314 pl. IV-6-3-22, 23, fig. IV-6-2-5; Scanlon and Pinder-Wilson 2001, 79-82, figs. 32a-j.

3 Rodziewicz 1984, figs. 384-1 to 8; Majcherek 2009, 155, 164, figs. 5-7, 8.

4 O'Hea 1992, 259-260, figs. 13, 14; O'Hea 2003, 133-137 and 134, fig. 2.

5 Pollak 2003, figs. 1-15, 2-31, 34.

6 Lamm 1931, 366-367, pl.79-11-13.

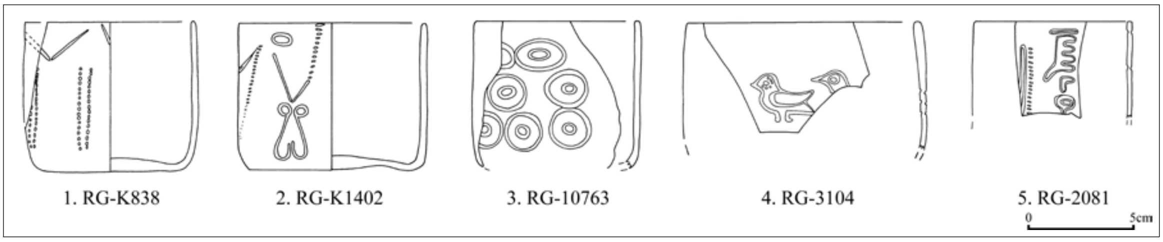
7 Kawatoko 2003, figs. 8-5.

8 Lamm 1928, 48, nos. 165, 166.

9 Kervran, 1984, figs. 8-22 to 8-25.

10 Krüger 1995, nos. 135-140.

11 Ma and Liu 1990, the lower photo on 146.



Pl. 1: Glass with impressed decoration excavated in Raya.

to Iran, the number of excavated examples from these sites is quite small - hence they cannot help us to determine the locations or chronology of the production sites.[12] Therefore, in this paper, I hope to contribute to this topic by considering more than 1,000 fragments of this type of glass that have been unearthed in excavations at the Raya site by the Japanese mission from 1997-2006 and by examining a glass cup, on which date palm trees have been impressed, that is held in the collection of Tenri University Sankokan Museum.

Glass with impressed decoration at the Raya site

The area excavated at the Raya site by the Japanese mission is composed of buildings in the Byzantine style. The site contains two main constructions that effectively divide the site into two distinct areas. One is a fort and the other is a residential area below the fort that extends to the coast. The former has yielded artifacts from the 9th to the 12th century while the latter has been found to contain items dated to the late 8th century and early 9th century.[13] More than 10,000 glass fragments have been excavated in both of these key areas. A comparison of glass examples unearthed in the fort and the residential area has made it possible for us to create a standard that can be applied to the dating of decorated glass.[14]

Glass with impressed decoration accounts for 42.3 percent of all the decorated glass found.[15] In the residential area, almost 90 percent of the excavated objects, including glass, were concentrated in the surface layer or garbage layer that was formed after the 9th century, although some were excavated in the late 8th century layer. It is evident from a stratigraphic study that glass with impressed decoration existed in Raya in the late 8th century.[16] Almost all the glass fragments from both the residential area and the fort are cylindrical cups. An examination of the fragments with rims revealed that most of them could be assigned to a group that consists of cups with rims of 8-10 cm in diameter and a height of 7-8 cm (Pl. 1.1-3, Pl. 2). In addition, fragments were found to belong to other types of artifact: a cylindrical deep dish, the height of which is half of the rim diameter or less; a shallow bowl; and a vessel with a tube-like base.

With respect to color, about 70 percent of the fragments are pale bluish-green, which is naturally produced and the most popular color among the Raya examples. Colorless fragments account for about 10 percent of the finds and there are also some pale green, pale blue and brown types. The glass unearthed in the residential part of the site is severely weathered due to the area being close to the seashore.

Regarding the matter of chemical composition, 33 samples showing no weathering were selected and analyzed on site.[17] The analysis showed that 30 samples were natron glass, named after the alkali source of its chemical composition, natron. Based on the chemical composition, only two samples were identified

12 An 1990; Carboni 2001; Carboni and Whitehouse 2001.

13 Kawatoko 2003.

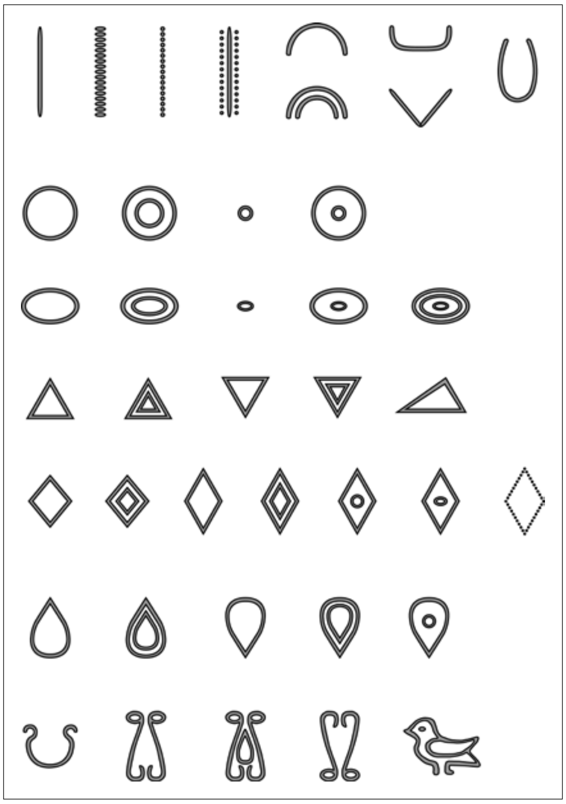
14 Shindo 2003; Shindo 2004; Shindo 2005; Shindo 2007; Shindo 2008.

15 Shindo 2012, 82-83.

16 Shindo 2005; 2007.

17 Kato *et al.* 2009; Kato *et al.* 2010a. The members of Prof. I. Nakai's laboratory at the Tokyo University of Science brought the portable analytical X-ray equipment to Egypt and analyzed the samples on site.

Pl. 2: Cup with impressed decoration excavated in Raya.



Pl. 3: Motif patterns.

to have been made in Egypt in the 8th century while 28 were items of Egyptian glass made in the 9th century. In the case of glass with impressed decoration, no sample was found to have the chemical composition of the Palestine-made glass that was manufactured in the 8th century, yet the other kinds of artifacts unearthed in the residential area of Raya are mostly dated to the 8th century. As for plant-ash glass, only three samples were identified.

Plate 3 shows the basic types of pattern that appear on glass unearthed at the Raya site.[18] The basic elements include, among others, the following lines and shapes: straight line, broken line, arch, U-shape, V-shape, circle, circlet, combination of circle and circlet, ellipse, triangle, diamond, droplet, comma-shaped bead and lilac flower. There are also inverted patterns, two and three concentric ring patterns, and combinations of the basic elements.[19] Prototypes of some of the simple elements are seen in products dated to the pre-Islamic period.[20]

In addition to these basic elements, a star, bird (see also Pls. 1-4) and amphora are among the group of figurative designs as well as Arabic letters.[21] With respect to Arabic letters, similar examples are found in contemporary 9th century luster-stained and linear-cut glass on which Arabic letters are vertically inscribed.[22] One example (Pls. 1-5) excavated at the Raya site bears an inscription reading “drink, and…” The letters are reversed when seen from the outside; they can only be read properly from the inside.

Tree decorated glass cups in Tenri University Sankokan Museum

There is a glass cup with trees decorated in the impressed technique in the collection of Tenri University Sankokan Museum.[23] It has a height of 7.0-7.5 cm, a rim measuring 7.8 cm in

18 The Raya examples do not have the following motif elements: circle, two concentric circles, inverted triangle, two concentric diamond shapes. However, as it is a possibility that these elements were features of this ware, they are provided in plate 3.

19 Considering that a circle can become elliptical due to the fact that glass stretches during the process of forming and that the surface of the object is roundly curved, it is possible that the same circular tools were used for the decoration process. See pls. 1-3.

20 Stern 1995, nos. 169-193.

21 Lane 1938, star: fig. 12F, amphora: fig. 12D.

22 Regarding luster-stained glass, see Salibi 2004, fig. 20, no.50 and pl. 54-d, e. Regarding linear-cut glass, see Shindo 2008, pl. 1-1 to 1-12.

23 Shindo 2012, 83-84.

diameter and a base that is 6.6 cm in diameter. It has a cylindrical shape that opens slightly toward the rim (Pl. 4 and 5). It was made by using the free-blowing technique and there is a trace of a pontil having been used on the inside of the base. It has a simple rim that would have been created by a reheating process, an almost flat base while at the center of the body there is evidence of some swelling. The material is transparent pale-greenish glass. An iridescent weathering appears thinly over the surface.

Identification of the values of MgO and K_2O is the method used to ascertain the alkali source of the glass material - namely whether it is natron or plant-ash based. According to chemical analysis,[24] the values of MgO and K_2O are high, which indicates that this example is plant-ash glass. This result shows that the chemical composition of this example is different from that of Egyptian products dated between the late 8th century and the early 9th century; that is to say, natron glass, which is the most common type of glass artifact found at Raya.

With respect to pattern, the side of the body is divided into four by the use of groups of three vertical wavy lines and the design of the date palm tree is applied four times between this line motif. As shown in the drawing in Plate 4, the four parts of the pattern are not spaced at regular intervals. Additionally, there are signs of an area of swelling on part of the vertical wavy, which is likely to have occurred as a result of the glass being reheated after the concave and convex shapes of the lines had been formed by a tool.[25] The date palm tree motif consists of five branches each on either side of the tree, and elliptical impressions are used to denote the dates that are borne on the lowest branches.[26] The vertical line of the trunk consists of four rounded impressions to represent the ring-like growth habit of the trunk. The ground at the base of the tree is depicted by short and long parallel lines. The patterns of the four date palm trees are almost uniform, and the softness and heat of the glass during the impression of the pattern means that it would have been necessary to apply all four patterns quickly. The speed required to impress four designs in quick succession suggests that some different tools composed of corn shapes, circlets and straight lines were used.[27]

Pl. 4: Cup decorated with date palm trees in Tenri University Sankokan Museum.

The motif of the date palm tree was often used in the pre-Islamic period in Egypt and the Syro-Palestinian region. A motif that is very similar to that of the cup in the Sankokan Museum collection can be seen in the openwork applied inside the neck of an earthenware water-jug filter and earthenware bread stamps made in Egypt. The date palm tree on a water-jug filter in the Bouvier collection is depicted in the same way as that on the cup in the Sankokan Museum collection; that is to say, the dates are borne on the lowest extending branches on both left and right.[28] Moreover, the earthenware stamps, which are kept in the Bouvier collection[29] as

24 This is the result of analysis undertaken by Prof. I. Nakai's laboratory members using a portable X-ray analyzer in 2011.

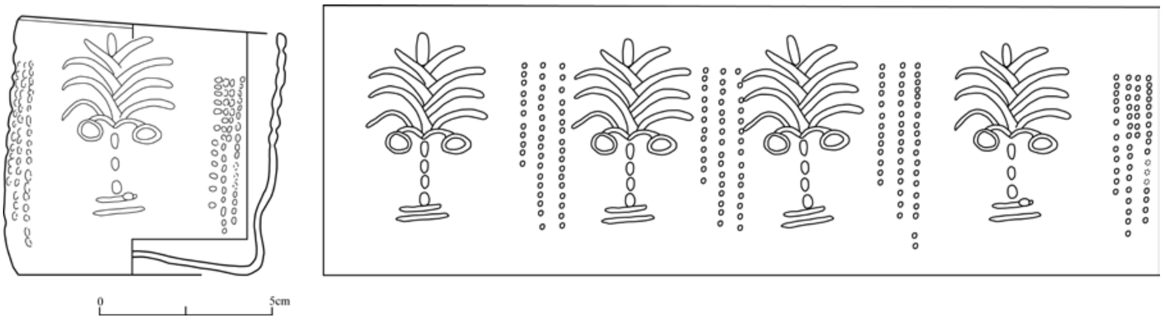
25 This explanation was by Ms. Aya Ishida, who was present at this examination.

26 Dates are ordinarily 2-3 cm wide and 3-7 cm long. A date palm tree bears an abundance of fruit and they appear to form a single bunch when seen from a distance. This interpretation is expressed on this cup.

27 Institut du Monde Arabe 1998, no. 149.

28 Kawatoko (supervised) 2003, 109, no. 262.

29 Kawatoko (supervised) 2003, 123, no. 301.



Pl. 5: Cup decorated with date palm trees in Tenri University Sankokan Museum (drawing by T.Hosokawa).

well as those that are in the al-Fustat collection of Waseda University,[30] also exhibit similarity in their design. In contrast, in the Mesopotamian region, a palmette - a stylized motif of a date palm - was often used from the 9th to the 10th century, but tree motifs seen on luster-painted pottery of the same period are not date palm trees, but other kinds of tree. These differences show that there is a discrepancy between the results of the chemical analysis and the known regional characteristics of tree motifs.

Conclusion

As a result of analysis of the glass with impressed decoration from the Islamic period unearthed at the Raya site and of the cup in the collection of Tenri University Sankokan Museum, the following conclusions have been made:

- Examination of the strata and chemical composition of the glass with impressed decoration unearthed at the Raya site revealed that objects of this kind were manufactured in Egypt in the latter half of the 8th century. However, examples of the chemical composition, which were manufactured in the Palestine region in the 8th century, were not detected.

- More than 1,000 examples that can be dated to the 9th century were discovered in the residential area and the fort although other kinds of artifacts unearthed at the residential area are mostly dated to the 8th century. The majority of them have the following characteristics: pale bluish-green tone; cup shape; simple geometrical pattern; and a particular chemical composition in the case of Egyptian products from the 9th century.

- The pattern of the date palm tree on the decorated cup in the collection of Tenri University Sankokan Museum is rare and no similar examples are known to exist in this category of glassware. Although this pattern is found on some examples of earthenware, such as a water-jug filter and bread stamps made in Egypt, the chemical composition of this cup is plant-ash glass and therefore, there is scope for further consideration about its production site.

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30 Sakurai and Kawatoko 1992, 690-691, pl. IV-9-5-17 (vol. 2).

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THE TECHNOLOGY OF BLUE VENETIAN GLASS: FROM ITS ORIGINS TO THE 17TH CENTURY. HISTORICAL SOURCES AND CHEMICAL ANALYSES

Introduction

The technology of Venetian glassmaking has been widely investigated in relation to clear colourless glass.[1] The analyses have demonstrated that over the centuries Venetian glass was of the soda-lime-silica type. Up until the 12th century, natron type glass was used; however, a period of transition between the 8th to the 9th century witnessed the increased use of soda plant ash glass, which later replaced natron glass completely. Documents record how in Venice plant ash (the fluxer) was imported from the Levant (Syria and Egypt) and from the 17th century onwards, from Spain and the south of France.

Until the middle of the 15th century transparent glass was considered common glass or *vitrum blanchum,* a term used to indicate transparent colourless glass. *Cristallo* (crystal) was the term used in Venice around the middle of the 15th century to indicate a soda-lime-silica glass that had acquired such a perfect decoloration, high light transmittance and homogeneity that it was compared to natural rock crystal. Purification of the plant ash that was used as a fluxer resulted in a significant removal of iron (the colouring impurity), but also of lime and magnesia salts that are less soluble than those of alkali. Therefore, *cristallo* glass made with purified soda plant ash is identified through chemical analysis due to its low calcium, magnesium, iron and phosphorous content.[2] The use of both common and *cristallo* glass continued in Murano without significant changes until the end of the 17th century.

The investigations carried out on Venetian coloured glass are less frequent and fragmentary although studies in this field are of great interest, because colour and polychromy are among the strongest factors that brought fame and fortune to Venetian glass.

The aim of current work is to investigate Venetian blue glass by discussing the chemical analyses carried out on blue glass samples conforming to the Venetian glassmaking

1 Verità and Zecchin 2009a; Verità and Zecchin 2009b.

2 Verità 1985.

Type	Century AD	N. analysed samples		Reference
		blue	turquoise	
Enamels	13th-14th	4	1	Verità 1995; Fiorentino et al. 2007
	16th	15		Biron and Verità 2012; Verità and Zecchin 2008; Wypyski 2009
	17th	1		unpublished
Mosaic	11th	1	5	Brill 2008
	11th-12th	31	3	Henderson and Roe 2006; Brill 1999; Verità et al. 2002; Verità and Zecchin 2012
	14th	6		Verità 1999
	16th	2		Zucchetta and Verità 2002
Blown	15th-16th	11	1	Brill 1999; Verità and Zecchin 2009; 5 blue and 1 turquoise, unpublished
	16th	4		Biron and Verità 2012; 1 unpublished
Rods	16th	3	4	Putzgruber et al. 2012; 3 blue and 1 turquoise, unpublished
Window	9th-11th	4		Verità et al. 2010; Vaghi et al. 2004
	15th	1	1	Hreglich and Verità 1982
Smalt	16th	2		Santopadre and Verità 2006

Table 1: Number (N.) of analyzed blue glass samples grouped following their typology, dating and provenance.

tradition that can be dated to a period between the 9th and 17th century. The analyses will permit the identification of the type of base glass (transparent clear glass to which colourants were added) and the colourants used, thereby verifying the connection between glass composition and the compounds indicated in the recipes of Renaissance Venetian glassmakers.

Blue glass samples

The samples investigated consist of mosaic tesserae, blown glass (goblets, lamps and so forth), window glass, enamels on glass artefacts and glass rods for lampworking. They were selected for their colour, which range from deep blue to a light turquoise (both transparent and opaque glass). The analyses identified various colourants: from the deep blue of the glass coloured with cobalt to the light blue of the glass coloured with copper; this type of glass will be indicated with turquoise and will be discussed separately. Provenance, dating and some general information about the samples discussed in this work are summarized in Table 1. Several finds were discovered through occasional archaeological excavations in areas of the Venetian lagoon described in Verità (1985) although their dating is quite inaccurate. In this study, only samples for which a quantitative chemical analysis is available were considered. Samples were analysed by various authors; methods and analytical conditions are described in references reported in Table 1. The sampling is not fully representative of a wide range of artefacts (for instance, 52 mosaic tesserae and only 6 window glass samples are discussed) nor a broad section of history (for instance, all the blown glass samples belong to the period between the 15th and 16th century), but some interesting results can be obtained and are presented hereafter.

Results

The composition of the base glass and the colourants used will be discussed separately in the following.

Base glass

Three main compositional soda-lime-silica glass groups were identified by the analyses of blue samples (as established for Venetian clear transparent glass): natron type, common and *vitrum blanchum* types and *cristallo* type.

In Fig. 1, the calcium and potassium concentrations (wt% of the oxides) for cobalt blue glass (triangles) are reported and, for comparison, those of Venetian colourless glass analyses (gray squares).[3] Natron type (group N in Fig. 1) includes samples dated to a period between the 9th and 12th century and is characterized by low concentrations of potassium (K_2O < 0.95%), magnesium (MgO < 1.25%) and phosphorous (P_2O_5 < 0.22%). Soda ash type glass (samples dated to between the 11th and 17th century) can be divided into two groups: common and *vitrum blanchum* (K_2O 1.7-6.5%; MgO 1.5-4.5%; CaO 6-12% and P_2O_5 0.28-0.44%), the latter indicated as VB in Fig. 1. Finally, *cristallo* type glass is identified as having a lower content of stabilizers (CaO 2-6% and MgO 0.5-2%) and potassium in the range: K_2O 2-5% (group CR in Fig. 1). *Cristallo* type glass composition was detected only in samples dated to after the 15th century. Most of the blue crystal samples show a lower Ca content (CaO 2-4%) compared to clear *cristallo* glass.

The calcium and potassium concentrations of copper turquoise finds (CuO 1.6-4.2%) are not reported in Fig. 1. It is interesting to observe that six samples (rods and enamels) are made of *cristallo* glass showing particularly low levels of calcium and magnesium (CaO 0.8-1.7%; MgO 0.2-0.5%) and have deteriorated as a result of the scant amount of stabilizers.

Four intensely coloured *cristallo* samples (CoO 1.3-3.8%: three enamels and one smalt) show a larger potassium content (K_2O 4-5%) that was probably partly added as tartar, and will be discussed hereafter.

Colourants

Among the blue samples, the cobalt content varies widely depending on the type of artefact. In blown objects, it rarely exceeds 0.10% while high levels and a wide range of concentrations are present in enamels (CoO 0.3-3.8%) and in smalt (CoO 3.8%). Low cobalt levels were found in tableware (CoO 0.05-0.55%) and window glass (CoO 0.05-0.18%) while in mosaic opaque tesserae, levels up to CoO 0.9% were found.

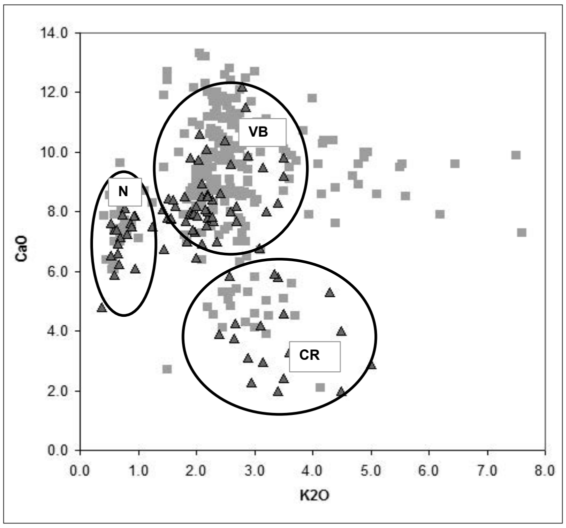

Fig. 1: Diagram of calcium versus potassium oxide for the analysed blue samples (triangles) compared with clear glass (squares). Circles indicate the compositional groups natron-type (N) common and Vitrum Blanchum (VB) and cristallo (CR).

In the considered period, cobalt was added to the glass in the form of an ore at which point it was associated with other elements. Characteristic associations of elements may reveal the origin of the cobalt ore (fingerprint combination).[4] The main characteristics of cobalt types identified by analyzing Venetian blue glass are summarised in Table 2.

A first cobalt type without any specific fingerprint elements (Zn, Ni, As, Bi were not detected; LLD 0.03-0.05%) is the ore used in natron type blue glass (reported as Natron in Table 2). It is the same cobalt ore that was in use during the Roman period, the provenance of which is unknown.

A zinc-bearing cobalt type dated to a period between the 9th and 14th century (group Zn in Table 2) was identified among the Venetian samples, and included two samples of natron type glass. For samples of this group, a positive Co-Zn correlation was found (Fig. 2). Higher values of zinc (ZnO 1-1.15%) not included in Fig. 2 were detected in three Adrevandin

3 Data from Verità and Zecchin 2009a; Verità and Zecchin 2009b.

4 Gratuze *et al.* 1995.

Co-type	N. of samples	Century	CoO	ZnO	NiO	As2O3	Bi2O3
Natron	15	11th-12th	0.02 - 0.20				
Zn	33	9th-14th	0.01 - 0.50	0.03 - 1.15			
Ni	9	15th-16th	0.06 - 1.3		0.04 - 0.63	< 0.05	
Ni-As	11	15th-16th	0.04 - 3.8		0.03 - 1.3	0.08 - 0.35	< 0.03
Ni-As-Bi	18	15th-17th	0.12 - 3.8		0.05 - 1.3	0.15 - 4.5	0.12 - 1.4

Table 2: Cobalt ores identified by the analyses. Number of samples, period of use and range of concentration of CoO and of the main fingerprint oxides are reported.

enamels (14th century) and one example of window glass (11th century). The origin of zinc-bearing cobalt (also identified by other authors in the analysis of glasse from Europe and the Near East) is still not well understood as a result of which, contrasting hypotheses have been proposed: while some authors suggest that it was extracted from Freiberg and Schneeberg in Germany,[5] others argue in favour of a Levantine[6] or Turkish origin.[7]

The 15th-17th century samples can be classified into three groups. In the first group (group Ni in Table 2, 9 samples dated to between the 15th and 16th century), a cobalt ore containing nickel and devoid of arsenic (As_2O_3 < 0.05%) and bismuth was used. The cobalt ore of the second group contains nickel and arsenic, but no bismuth (group Ni-As) while nickel, arsenic and bismuth are present in the third group (group Ni-As-Bi). Similar groups were also identified by other authors through the analysis of blue glass,[8] enamels on metal[9] and ceramic glazes.[10] The analyses of enamels on metals and ceramic glazes have ascertained that the Ni-As-Bi cobalt was in use after the decade between 1520 and 1530 while cobalt ores without bismuth (Ni, or Ni-As) were in use beforehand. The reasons for this change are not clear.[11] By transposing this model onto Venetian blue glass, groups Ni and Ni-As could be dated back to the first half of the 16th century while group Ni-As-Bi could be dated to after the period 1520-30. Therefore, the type of cobalt ore becomes an important factor in the accurate dating of glass samples with uncertain time periods.

Copper, iron and manganese are other colouring elements that have been detected by the analyses of Co-blue Venetian glass. In the natron and zinc groups, a copper content similar to cobalt concentrations was detected (Co/Cu ratio 1/1). The colouring power of Co being much higher than that of Cu makes it likely that the low amounts of Cu were involuntarily introduced with the cobalt ore. Only two natron samples with a low cobalt content (CoO 0.04-0.05%) suggest the voluntary addition of copper (CuO 0.19-0.21%). In groups Ni, Ni-As and Ni-As-Bi, voluntary additions of copper were detected in a few samples with a high cobalt content. Group Ni-As shows the peculiar presence of four samples with a linear ratio Co/Cu 2/1 (range: CoO 0.15-3.0%; CuO 0.0-1.0%), that correspond to enamels on glass dated to the 16th century and were probably made with the same recipe.

By plotting the iron and manganese concentrations (Fig. 3), it is evident that cobalt blue glass has an iron content (Fe_2O_3 1-3% for most of the samples) greater than that of clear glass (Fe_2O_3 0.2-1.5%) whereas their manganese content is similar (MnO up to 1.5%). This suggests that part of the iron entered the glass composition through the cobalt ore, which was added to clear glass decolorized with manganese. The blue samples located bottom right in the diagram in Fig. 3 (Fe_2O_3>1.5%; MnO<0.5%) are enamels (high cobalt content) from groups Ni, Ni-As and Ni-As-Bi. In these samples, it is probable iron

5 Gratuze *et al.* 1995.
6 Henderson 2003.
7 Brill 1995.
8 Gratuze *et al.* 1995.
9 Roehrs *et al.* 2009.
10 Zucchiatti *et al.* 2006.
11 Zucchiati *et al.* 2006; Röhrs *et al.* 2009.

was voluntarily added to modify the cobalt hue (iron gives a gray-green hue).

Concerning turquoise glass coloured with copper, no elements attesting to the use of copper alloys (for instance bronze) or metal slags have been detected. It is apparent that copper was obtained by oxidation of the pure metal. In turquoise samples, there is a wide range of copper content (five tableware: CuO 1.6-4.2%; six mosaic tesserae: CuO 0.23-3.5%).

Venetian glassmaking recipes

Recipes for the preparation of blue glass are reported in several Venetian treatises by Renaissance glassmakers.[12] They include the second and third books of recipes (15th century) of three booklets (*Trattatelli*) lying in the State Archives of Florence: the so-called Montpellier dated to 1536, partially translated and commented by Luigi Zecchin; the *Anonimo* of the 16th century, the Darduin (1644 and early 18th century); and the recipe book of the Venetian glassmaker Brunoro, found in Gdansk (Poland), and dated to 1645. In addition, the first published book on glassmaking, *L'Arte Vetraria* by Antonio Neri, includes a number of recipes of Venetian origin.

In this paper, recipes for various blue hues, purple and black colours (only those in which cobalt was the main colourant) are considered, with a total of 183 recipes. Among them, 159 indicate cobalt as the main colourant and the addition of iron, copper, and manganese is also reported in some as a modifier for the blue cobalt hue. Two sources of cobalt are indicated: only six recipes (2 Brunoro, 2 Darduin and 2 Neri) point to smalt blue pigment coloured with cobalt while others indicate saffre (the cobalt mineral discussed hereafter) as the source.

Of the recipes without cobalt, 19 indicate copper as the colorant and 5 recipes (1 Trattatelli, 1 Montpellier, 3 Anonimo; most of the recipes of these treatises date back to the 15th century) indicate powdered lapis lazuli to be the origin (a rock coloured blue by the mineral lazurite). The use of lapis lazuli was not found in the analyses

12 Verità and Zecchin 2009b.

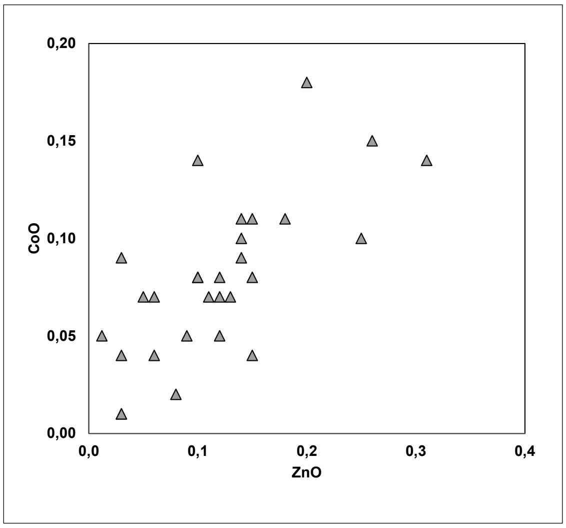

Fig. 2: Diagram of cobalt versus zinc oxides in blue samples coloured with a Zn-type cobalt ore.

of Venetian blue glass, however, it was detected in Islamic enamels on glass.[13]

Base glass

The recipes for blue glass prescribe the use of two main raw materials, i.e. soda plant ash and a silica source. The type of base glass is not indicated in 23 recipes whereas in others the use of common glass (39) or of *cristallo* (93) prepared with purified plant ash is prescribed; in some cases, both of them (11). The reasons for the choice of base glass type are indicated in some recipes. For instance, recipes Neri 22 and Anonimo 6 specify that blue glass prepared with common glass is "*di minor costo*" (less expensive), while using the *cristallo* a blue glass "*in tutta bellezza*" (most beautiful) is obtained. It should be pointed out that in some cases (mainly for enamels and the imitation of gemstones) the treatises of Montpellier, Darduin and Brunoro include the addition of potash to the base glass in the form of tartar (the deposit of wine barrels), either untreated or calcined, or sometimes in a purified form following a process similar to the purification of soda plant ash used for *cristallo*.[14] In some recipes, the amount of tartar added is considerable and a mixed alkali glass is obtained; for instance, Brunoro 25 prescribes the preparation of base

13 For instance in Wypyski 2010.

14 Verità 1985.

Treatise	Century	Saffre	Saffre + Cu	Saffre + Mn	Saffre + Fe	Smalt	Copper	Lapislazuli
Trattatelli	15th	4		1				1
Montpellier	16th	9		6			8	1
Anonimo	16th	7	2	9	2		2	3
Darduin	17th-18th	16	16	14	2	2	2	
Brunoro	17th	5	12	19	1	1	2	
Neri	17th	3	10	14	1	2	4	

Table 3: Number of recipes in Venetian treatises indicating the use of blue colorants. Cobalt (saffre) was indicated alone or in association to other colouring elements.

glass for enamels by mixing calcined tartar and *cristallo* frit in a ratio of 1 to 1.

Some recipes (a few indicate this for the use of imitation gemstones) only prescribe the employment of a lead silicate base glass (composition not identified in the analyses discussed in the present work), or its addition to common or *cristallo* glass.

Colourants

In Venetian treatises, cobalt ore is denoted with different synonyms related to the term *zaffre*. It appears for the first time in a document dated 1446 (Podestà's Acts). No reference to its provenance is found even in later documents, except Recipe 6 in Anonimo, where the German origin of zaffre is referred to.

Kunckel, a German glassmaker of the 17th century, explains that the Co mineral extracted in Erzgebirge was not traded as such, but as intermediate products called saffre and smalt. Saffre consisted of a mixture of powdered calcined cobalt ore and quartz sand, mixed in proportions of 1/2 or more.[15] The moisturized mixture was made up into cakes, which hardened as they were dried, and were then traded in this form.

Venetian treatises give prescriptions for the treatment of saffre before being used in glassmaking. This indicates that the quality of commercial saffre is likely to have varied substantially, thus causing problems with its use. Darduin (Recipe 209) recommends a saffre *sodo, fisso, et pesante* (hard, thick and weighty) and slightly purple coloured. The recipes do agree that saffre had to undergo a long calcination process (fired for 5-6 days in the calcar, following Darduin Recipe 209). Other details are given, for instance by Neri 12 (the most complete recipe), who prescribes the following steps: calcine the saffre for 3-6 days, cool it down in vinegar, then powder, wash and dry it before use.

Another source of cobalt was smalt, a deep blue potash glass (CoO content between 2-8%) that was generally used as a blue pigment in oil and wall paintings from the middle of the 15th century.[16] Smalt production was known in Venice. In Darduin's Recipe 68, *A far smalto da muro bello* (smalt for wall painting), a glass rich in potash was prepared, while Recipe 255 of the Brunoro treatise (*A far il smalto de muro*) prescribes the addition of soda-lime glass cullet to potash glass. A huge amount of zaffre was added to both types of glass (zaffre to frit ratio of nearly 1:1 in Brunoro and 1:2 in Darduin).

Given that smalt is mainly potash glass, glass coloured with this technique should be particularly rich in potash. The comparison between blue base glass and clear glass compositions shows a similar content in K_2O for common and *vitrum blanchum* glass, as well as slightly larger (K_2O up to 5%) in four *cristallo* samples (see Fig. 1). Besides, it should be recalled that the addition of tartar (and therefore, of potassium) was recommended in the recipe books for this type of glass. Therefore, the analysis results seem to exclude the use of smalt as a colorant in Venetian blue glass. Regarding this point, it should be considered that Neri and Brunoro also had other sources of non-Venetian recipes at their

15 Kunckel 1689.

16 Santopadre and Verità 2006.

disposal, and that the two recipes in Darduin date to the end of the 17th century, a period for which only few analyses are currently available. It is interesting to observe that in a recent paper the use of smalt to colour blue enamels was suggested by the unusual high potash content (K_2O 8.2-8.5%) of *façon de Venise* Renaissance enamelled glass.[17] Therefore, the presence of unusually high potash content in blue enamels and glass could become a useful indicator in distinguishing between genuine Venetian and *façon de Venise* glass.

Some recipes indicate the addition of iron, copper and manganese in order to modify the hue of cobalt blue glass. While the addition of iron and copper were identified by the analyses, the addition of manganese was not ascertained. As previously discussed, the amount of manganese in blue glass is comparable to that of uncoloured glass.

Finally, recipes concerning turquoise glass coloured with copper prescribe the use of *ramina* (cupric oxide, CuO) prepared by firing metallic copper in an oxidized environment (for instance, Darduin Recipes 25 and 102). The use of calcined brass (copper-zinc alloy; for instance Neri 20) is indicated only rarely. The analyses of turquoise glass have not detected any other elements associated with copper, showing that only *ramina* was used.

Conclusions

The chemical analyses and the study of recipes in treatises by Venetian glassmakers permit an insightful understanding of the evolution of Venetian blue glass composition and technology, from its origin until the end of the 17th century.

As discovered with clear glass, the analyses reveal an uninterrupted use of soda-lime-silica glass with a gradual transition from a natron type composition towards soda ash-based glass from

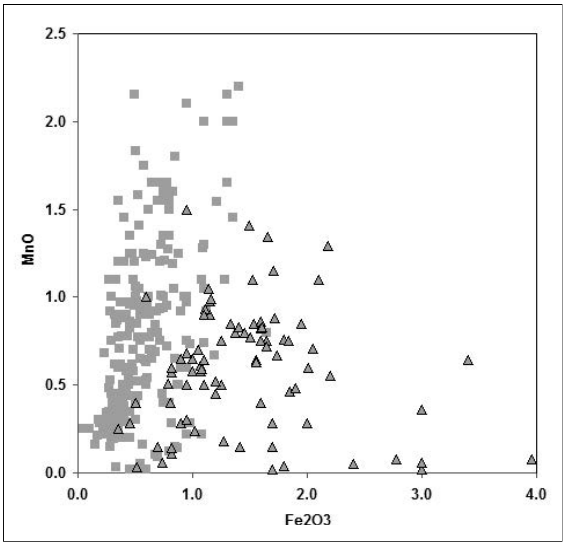

Fig. 3: Diagram of manganese versus iron oxides in the Venetian blue samples (triangles) and for comparison in colourless glass (squares).

the 9th to the 13th century. The improvement in glass quality from *Vitrum Blanchum* to Venetian *cristallo* in the middle of the 15th century was also emphazised.

The analyses of elements associated with cobalt in the ore that was used as a colourant reveals the use of various types of cobalt ore, as is the case with ceramic glazes and enamels on metal.

The analytical data and the recipes demonstrate that zaffre was used as a cobalt source and exclude the use of smalt in Venice up until at least the middle of the 17th century. Therefore, the unusual high potassium content of blue glass coloured with smalt could also be considered a helpful indicator in distinguishing between *façon de Venise* and genuine Venetian blue glass.

Acknowledgements

This research is dedicated to my friend Cesare Moretti, who recently passed away. Bernard Gratuze is acknowledged for any unpublished data.

17 Biron and Verità 2012.

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LE VERRE AVENTURINE: SON HISTOIRE, LES RECETTES, LES ANALYSES, SA FABRICATION

En 2011, Cesare Moretti avait prévu de faire une communication sur l'Aventurine dans le cadre du colloque de Piran. A la suite de son décès en mars 2012, Sandro Hreglich et moi même avons pensé que la meilleure façon de rendre hommage aux travaux de notre ami Cesare était de maintenir ce projet. Cet article est le fruit d'une réflexion et d'un travail commun, dont l'objectif est de confronter la partie documentée des recettes de fabrication de l'aventurine avec les analyses chimiques. Son but est de comprendre les procédés d'obtention de ce verre si particulier, ainsi que les difficultés de sa mise en œuvre.

Le verre aventurine au cuivre

L'aventurine au cuivre est un verre rouge particulier qui doit son aspect aux reflets métalliques des cristaux de cuivre dispersés dans sa masse.

Dans l'"Arte Vetraria" de A. Neri, publié en 1612, ce type de verre n'est pas mentionné. Il est toutefois décrit: "una sorte di pietre con stelle dorate dentro", dès 1614, dans une lettre de Philipp Hainhofer au duc Auguste.[1] Le mot aventurine n'apparaît toutefois pour la première fois,[2] que douze ans plus tard, en 1626, dans l'inventaire des biens laissés par l'orfèvre D. Rimondo Rimondi ("pasta venturina in tocchi") puis à nouveau en 1630 dans celui fait à la mort de D. Esdras Galatin, (pendentifs de "piera venturina").

Pour Luigi Zecchin,[3] l'aventurine a donc probablement été découverte par hasard au début du XVII^{e} siècle dans une verrerie de Murano. Son nom "venturina" est lié aux difficultés rencontrées lors de sa production, qui était une sorte d'aventure ("ventura").

La saga et l'univers des verriers vénitiens, qui durant trois siècles ont été les acteurs de la production de ce verre, ont été décrits par de nombreux auteurs : Luigi Zecchin,[4] Vettore Zaniol,[5] Paolo Zecchin (2005) et Cristina Tonini

1 Krueger 2010.
2 Zecchin 1956, 1981.
3 Zecchin 1986, 46.
4 Zecchin 1987; Zecchin 1989; Zecchin 1990.
5 Bova *et al.* 2004.

(2008). Nous nous limiterons ici à faire une interprétation technique des procédés de fabrication et des difficultés de la mise en œuvre de l'aventurine.

L'aventurine : un verre rouge au cuivre particulier

L'utilisation du cuivre, sous forme d'oxyde ou de métal pour colorer le verre, remonte aux origines de la technologie verrière. Dans une atmosphère réductrice, le cuivre, réduit sous sa forme cuivreuse Cu^{+} (Cu_2O – cuprite)[6] ou métallique[7] précipite dans le verre sous forme colloïdale ou microcristalline,[8] et confère au verre une couleur rouge. La croissance de ces cristaux, lors du refroidissement lent d'un verre rouge, est à l'origine de la formation du verre aventurine, caractérisé par la présence d'étoiles brillantes, dans un ensemble de couleur rouge-brun. C'est de cet aspect que dérive le nom de "stellaria" donné à ce verre dans certaines recettes.

La formation des microcristaux de cuivre, issus de la réduction de l'oxyde de cuivre en cuivre métallique, se déroule lors de la phase finale de la fusion. La réduction de l'oxyde de cuivre, en protoxyde puis en métal, est due à des éléments réducteurs comme les battitures de fer, le tartre, la semoule de blé, le carbone, etc. On a ensuite une phase pendant laquelle les microcristaux de cuivre grossissent et deviennent presque visibles à l'œil nu.

Dès 1870, les travaux de P. Ebell ont montré que la précipitation du cuivre métallique est responsable de la couleur du verre rubis dans l'hématinone et dans l'aventurine, et ont attribué les différences entre ces verres à la dimension et au nombre de particules présentes.[9]

L'aventurine entre donc bien ainsi dans la catégorie des verres rouges au cuivre. Par contre, contrairement à ceux-ci, elle ne peut pas être travaillée directement à chaud. Les cristaux de cuivre ne se forment en effet que pendant la longue phase de refroidissement du verre, et se dissolvent si le verre est réchauffé en atmosphère oxydante, comme le montre l'observation au microscope d'un bloc d'aventurine (Fig. 1).

L'aventurine s'obtient donc sous forme de blocs en brisant le creuset une fois qu'il a refroidi; les morceaux sont ensuite découpés et/ou meulés pour fabriquer des pierres de bijouterie et d'autres objets. Son travail à chaud est cependant possible en la chemisant avec du cristal, de façon à la protéger du contact de la flamme. Selon Luigi Zecchin,[10] l'invention de cette technique est à attribuer à Pietro Bigaglia, de Murano (1786-1876).

Les recettes d'aventurine dans les recueils de recettes de Murano

Les premières recettes connues à ce jour, mentionnant l'aventurine, datent du XVIIe siècle et se trouvent dans le recueil de Darduin (ms 17/04, 1644). Elles ont été publiées et commentées par Luigi Zecchin (1956) qui analyse les rapports entre Darduin et les membres de la famille Miotti. Zecchin montre que les recettes du recueil de Vincenzo et Daniele Miotti (ms17/05, 1669) dérivent en fait de celles de Darduin.

Les difficultés rencontrées pour la production de ce verre sont illustrées par cette phrase de Darduin : "On ne peut jamais être sûr et certain que les ingrédients vont permettre de fabriquer une belle aventurine. C'est pour cette raison qu'on l'appelle "venturina" puisque son obtention dépend plutôt de la chance que de la science".

Trois autres recettes du XVIIe siècle apparaissent dans le manuscrit de Brunoro (ms. 17/09) daté de 1645.[11] Le classement de ces dernières, par Brunoro, dans les recettes de la fin du XVIe siècle, n'est pas si surprenant que cela, si l'on se réfère à la description faite par Philipp Hainhofer dans sa lettre de 1614.

En plus des trois recueils du XVIIe siècle de Darduin, Miotti et Brunoro, une quinzaine d'autres recueils de recettes ou cahiers de ver-

6 Turner and Rooksby 1959.
7 Weyl 1951 420-435.
8 Brun and Pernot 1992.
9 Ebell 1874; Weyl 1951 423.
10 Zecchin 1986, 49.
11 Moretti *et al.* 2004.

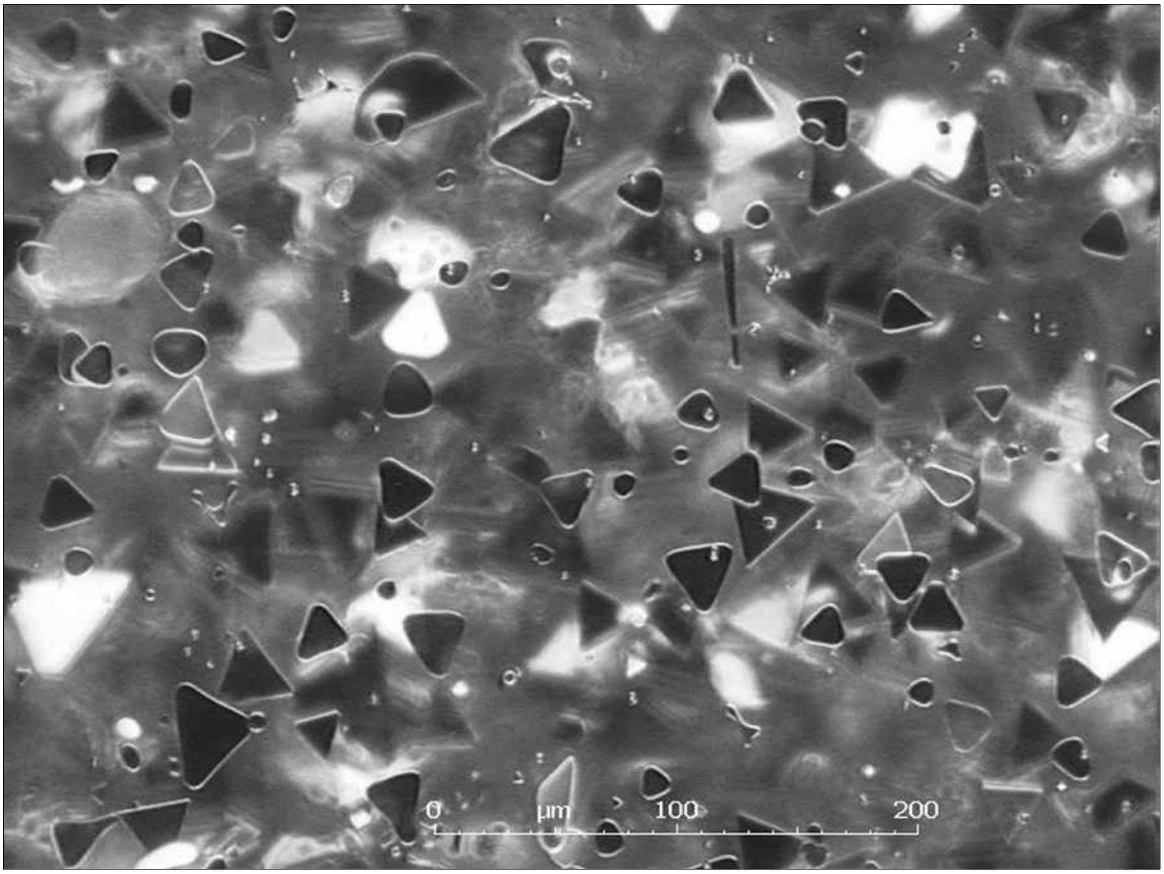

Fig. 1 : Zone superficielle d'un bloc d'aventurine rouge, sur laquelle on voit que les cristaux de cuivre présents dans la zone proche de la surface ont été partiellement dissouts (microscope x100).

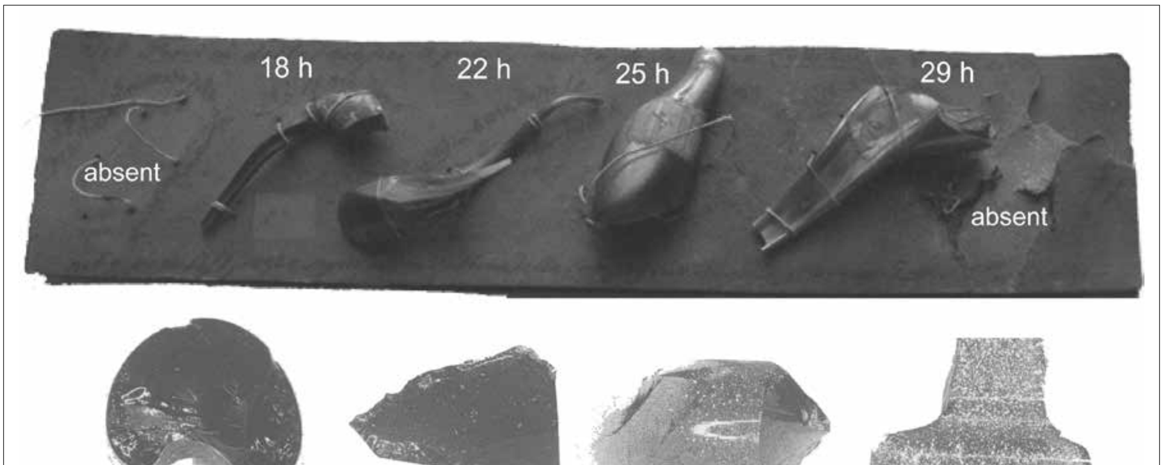

Fig. 2 : Echantillons d'aventurine prélevés dans un même creuset après l'arrêt du four, Vincenzo Moretti, 1892. A l'examen de ces échantillons (il manque le premier et le dernier), nous constatons que le verre a un aspect rouge brique opaque dans l'échantillon prélevé, en surface, 18 h après l'extinction du feu. Le troisième échantillon prélevé après 22 heures présente également cet aspect, alors que de nombreux petits cristaux de cuivre métalliques sont présents dans le quatrième prélèvement après 25 heures, ainsi que dans le cinquième, effectué après 29 heures.

	Darduin	Darduin	Brunoro	Rc Anon.	A. Barbini	A. Barbini	A. Barbini	An.	An.	An.	Rec.1847
Référence du recueil	cm 17/04	cm 17/04	cm	cm 18/19	cm 18/01	cm 18/01	cm 18/01	cm 18/26H	cm 18/26H	cm 18/26L	cm 19/10
Recette attribuée à											Bertolini
Date	XVII	XVII	XVII	XVIII	XVIII-XIX	XVIII-XIX	XVIII-XIX				XIX
Numéro de la recette	149	150	130 e 339	1	1?	2?	3?	1	2	1	84
Groisil d'aventurine non réussi											
Groisil									400,0		
Groisil rouge		100				30,0			300,0		
Groisil ordinaire					250,0	96,0	125,0				
Verre commun-groisil	150,0		12,0	200,0						12,0	560,0
Tot.débris	150,0	100,0	12,0	200,0	250,0	126,0	125,0	0,0	700,0	12,0	560,0
Cuivre rouge	8,0	1,5	0,5	10,3	25,0	20,0	21,0	21,0	20,0	0,7	14,3
Pb/Sn calcinés	8,0	1,0	1,0	5,0			25,0	13,3		0,7	1,8
Battitures (ma-rogna)						0,2	9,0	9,0			12,6
Oxyde de fer				0,3	1,0				6,0		7,7
Acier brûlé											
(oxydes de fer/azzal brusado)		2,0	0,3	3,3		0,0	3,0	3,0		0,3	
Battitures Acier/fer	2,7	0,7	0,3	2,8	1,0	10,0	7,0	1,5	4,0		
Nitrate de Sodium											
Manganèse									2,0		
Semoule				0,1	0,0	1,2		x	x		
somme mat.	18,7	5,2	2,1	21,7	27,0	31,3	65,0	47,8	32,0	1,7	36,3
total	168,7	105,2	14,1	221,7	277,0	157,3	190,0		732,0	13,7	596,3
Résumé											
Débris fondus	150,0	100,0	12,0	200,0	250,0	126,0	125,0	0,0	700,0	12,0	560,0
Cuivre rouge	8,0	1,5	0,5	10,3	25,0	20,0	21,0	21,0	20,0	0,7	14,3
Pb/Sn calcinés	8,0	1,0	1,0	5,0			25,0	13,3		0,7	1,8
Battitures et											
débris de fer et d'acier	2,7	0,7	0,3	2,8	1,0	10,2	16,0	10,5	4,0	0,0	12,6
Oxydes de fer	0,0	2,0	0,3	3,6	1,0	0,0	3,0	3,0	6,0	0,3	7,7
Semoule				0,1		1,2		x	x		
Pour 100 parties de verre											
Cuivre rouge	5,3	1,5	0,5	5,1	10,0	15,9	16,8		2,9	5,6	2,6
Pb/Sn calcinés	5,3	1,0	1,0	2,5			20,0			5,6	0,3
Battitures et débris											
de fer et d'acier	1,8	0,7	0,3	1,4	0,4	8,1	12,8		0,6	0,0	2,2
Oxydes de fer	0,0	2,0	0,3	1,8	0,4	0,0	2,4		0,9	2,8	1,4
Semoule				0,1		0,9					

Pl. 1 : Synthèse des ingrédients utilisés dans les recettes d'aventurine (from Moretti et al. 2013, Archeosciences 37, 135-153 ; Reproduction autorisée par Archeosciences - Revue d'Archéométrie).

rerie[12] des XVIIIe et XIXe siècles, découverts depuis quelques dizaines d'années dans des archives privées,[13] ont livré des recettes d'aventurine.

On citera plus particulièrement ici le manuscrit anonyme de 1847 (ms 19/10) publié en 2001[14] ainsi que les recettes de Lorenzo Radi (ms 19/31).[15]

On observe plusieurs interruptions de la fabrication de l'aventurine au début du XVIIIe siècle et au début du siècle suivant. Celles-ci sont probablement liées au coût élevé de ce type de verre et à ses difficultés d'élaboration. La production d'aventurine redémarrera vers 1825, grâce à Pietro Bigaglia.[16]

Les différents ingrédients employés (colorants et réducteurs) et leurs modes d'introduction

Une synthèse des ingrédients, de leurs proportions et de leurs modes d'introduction, effectuée à partir de toutes ces recettes, permet d'identifier les principales phases de la fabrication de l'aventurine (Pl. 1).

12 Les copies d'une grande partie des recueils manuscrits de recettes sont déposées à la Bibliothèque de la Stazione Sperimentale del vetro à Murano.

13 Moretti 1982; Toninato and Moretti 1992.

14 Moretti et Toninato 2001; Moretti *et al.* 2011.

15 Moretti 2008; Zecchin 2009.

16 Zecchin 1986, 9.

Rec.1847	Rec.1847	Rec. DDM				Lor.Radi	Lor.Radi	Lor.Radi	Lor.Radi	
cm 19/10	cm 19/10	cm 19/13				cm 19/31	cm 19/31	cm 19/31	cm 19/31	
Bertolini	S.Miotti	DDM	DDM	DDM	Giov.Barb.					
XIX	XIX	1863				1844	1846	1859	1864	
85	87	p.59-560	1	2		1	2	3	4	Fréquences
		180,0								1
				1000	150					3
	17,0					34,0	52,0		200,0	7
	545,0	234,0	400,0							6
114,0	218,0							225,6	64,0	9
114,0	780,0	414,0	400,0	1000,0	150,0	34,0	52,0	225,6	264,0	21
20,8	14,5	11,0	14,5	60,0	8,0	0,6	2,8	12,0	4,3	21
2,3		7,0			8,0	0,3	2,8	3,8		14
18,3	18,7	11,5	20,2	20,0						9
9,8	7,0	1,5	1,0	15,0	2,5				4,3	11
	0,5			5,0		0,7	0,7	3,0	0,3	13
	0,5				2,7	0,7	0,8		0,1	14
				10,0						1
				5,0						2
			0,3	0,3						7
51,0	41,2	31,0	36,0	115,3	21,2	2,3	7,1	18,8	8,8	21
165,0	821,2	445,0	436,0	1115,3	171,2	36,3	59,1	244,4	272,8	
										Fréquences
114,0	780,0	414,0	400,0	1000,0	150,0	34,0	52,0	225,6	264,0	
20,8	14,5	11,0	14,5	60,0	8,0	0,6	2,8	12,0	4,3	21
2,3		7,0			8,0	0,3	2,8	3,8		14
18,3	19,2	11,5	20,2	20,0	2,7	0,7	0,8	0,0	0,1	21
9,8	7,5	1,5	1,0	20,0	2,5	0,7	0,7	3,0	4,5	21
			0,3	0,3						6
										Moyenne
18,2	1,9	2,7	3,6	6,0	5,3	1,6	5,4	5,3	1,6	5,9
2,0		1,7			5,3	1,0	5,4	1,7		4,1
16,0	2,5	2,8	5,0	2,0	1,8	2,1	1,5	0,0	0,0	3,1
8,6	1,0	0,4	0,3	2,0	1,7	2,0	1,3	1,3	1,7	1,6
			0,1	0,03						0,3

Lors de la fabrication de l'aventurine l'opération initiale consiste en la fusion de débris de verre commun, telles les brisures de vitres. Parfois ces débris sont mélangés avec des déchets de verre rouge au cuivre, ou même à de l'aventurine "ratée".

Les colorants et les réducteurs sont ensuite ajoutés au verre fondu par petites doses, sous forme de petits sachets introduits et homogénéisés dans la masse fondue. Cette opération se répète plusieurs fois à différents intervalles de temps. La composition des mélanges ajoutés change à chaque fois. Les critères concernant le choix des ingrédients utilisés et les intervalles de temps sont cependant absents des comptes-rendus de fournées.

L'agent colorant principal employé est l'oxyde de cuivre rouge (Cu_2O), qui est ajouté et mélangé à des ingrédients ayant une fonction réductrice. Parmi ces derniers, figurent l'oxyde de fer et les battitures de fer, mais aussi des matières organiques. On ajoute aussi presque toujours du plomb et de l'étain calcinés : le plomb facilite la dissolution du cuivre, et l'étain a une fonction réductrice sur le cuivre.[17]

A partir des vingt-et-une recettes étudiées, on peut estimer que pour 100 parts en poids de verre fondu, on ajoute en moyenne 5,9 parts d'oxyde de cuivre rouge, 4,1 parts de plomb et d'étain calcinés, 3,1 parts de battitures, 1,6 part d'oxyde de fer. Il est intéressant de noter que les

17 Weyl 1951, 427.

quantités mises en oeuvre varient de quelques livres à 1000 livres (soient entre 301 kg, pour des livres vénitiennes légères, et 477 kg pour des grosses livres).

Les notes, insérées dans les recettes, même si elles sont synthétiques, montrent que le but des différents traitements est d'abord de donner au verre une couleur rouge comme le mentionne Brunoro (ms. 17/09) "prima si fa il rosso in corpo". Ce rouge doit cependant être d'une tonalité précise, comme le précise Andrea Barbini (ms. 18/01) "la provola …non sia troppo rossa" qui signifie peut-être que la couleur ne doit pas être trop vive mais légèrement bilieuse. Aucune instruction n'est cependant donnée dans les recettes sur ce qu'il fallait faire au cas où le rouge obtenu n'était pas de la tonalité recherchée.

Arrêt du four et refroidissement contrôlé du verre

Les deux derniers points fondamentaux pour la réussite de l'opération sont la maîtrise du moment où il faut arrêter les ajouts de réducteurs, et de celui où il faut commencer le refroidissement du four.

Les recettes insistent, à plusieurs reprises, sur la façon de procéder à l'arrêt du four et donc au début du refroidissement du verre : le Segreti Briati (ms. 18/01,) mentionne ainsi qu'on ajoute la dernière poudre, puis qu'on arrête le feu et qu'on bouche les trous d'accès du four avec un couvercle.

Le recueil de recettes de 1847 (ms. 19/10) insiste sur le contrôle de la couleur du verre avant de commencer le refroidissement, sans toutefois dire clairement comment doit être le verre à la fin des ajouts.

Cette couleur est précisée par Lorenzo Radi (ms. 19/31 rec.4) : "avant d'éteindre le feu, le prélèvement était clair, et une heure après avoir éteint, il était rouge opaque". Dans une autre recette (ms. 19/40, rec. 1), une note révèle que le verre devrait contenir les premières petites étoiles à la fin des ajouts.

Nous avons pu examiner et analyser les échantillons d'aventurine donnés au Musée du Verre de Murano en 1909 par le directeur de la Compagnie Venezia-Murano.[18] Il s'agit d'une série de prélèvements effectués par Vincenzo Moretti, lors d'une production de 500 kg d'aventurine en 1892. Ils nous renseignent sur l'état du verre à la fin des ajouts et pendant les premières phases du refroidissement. Les cristaux de cuivre commencent à être visibles à l'œil nu après 22 heures de refroidissement.

L'analyse de ces échantillons montre qu'il s'agit d'un verre sodo-calcique qui contient 1,9 % de K_2O, 2,6 % de PbO, 3,4 % de Fe_2O_3, 4,3 % de CuO, ainsi que 0,36 % de SnO_2 et 0,47 % d'As_2O_3.

L'examen de ces recettes fait apparaître la fabrication de l'aventurine comme une opération longue et complexe, qui demandait plus d'une semaine de travail : le recueil de recettes de 1847 précise que 54 heures avaient été nécessaires pour la fusion et les ajouts, et 5 jours pour le refroidissement, soit un total de 7 jours. Le résultat est parfois décrit avec enthousiasme, mais l'opération finit souvent par un échec inexplicable et amer, comme on le prouve ce passage du manuscrit ms. 18/36 : "pas une once n'a été réussie car les étoiles étaient trop minuscules. Que Ta volonté soit faite".

Les tentatives visant à reproduire l'aventurine de Murano et les analyses effectuées sur l'aventurine vénitienne

Au XIXe siècle, de nombreuses études et tentatives ont été faites pour produire ce verre, qui était vendu à un prix très élevé. Elles sont rapportées par P. Beyersdorfer,[19] et montrent qu'il s'agit dans tous les cas d'un verre alcalin mixte, sodo-potassique avec un pourcentage élevé d'oxyde de calcium (CaO 8,6 % en moyenne). Le plomb (1,2%) et l'étain (1,9%) ont été détectés dans seulement quatre des six échantillons analysés. L'oxyde de fer a une teneur moyenne de 3,7 %, tandis que celle du cuivre, exprimée en CuO, est d'environ 4,4 %.

Des analyses plus récentes, réalisées au Centre Ernest-Babelon sur des échantillons d'aventurine fabriqués au XXe siècle confirment

18 Bova *et al.* 2004, 27.
19 Beyersdorfer 1943.

qu'il s'agit de verres alcalins mixtes (Na_2O 14,28 % K_2O 6,32 %) avec seulement des traces d'oxyde de plomb, environ 4,9 % d'oxyde de calcium et des teneurs moyennes de 3,7% d'oxyde de cuivre (exprimée en CuO), 3,1 % d'oxyde de fer et 1,7 % d'oxyde d'étain. Il nous a été également possible de déterminer la quantité de cuivre non dissout en comparant les résultats obtenus par analyse globale du verre (activation avec les neutrons rapides de cyclotron, ANRC) et par analyse ponctuelle de la phase vitreuse (*spectrométrie* des *rayons X* couplée à un *microscope électronique* à balayage*,* MEB-EDX). L'aventurine étudiée contient dans son ensemble 4,1 % de d'oxyde de cuivre (CuO). La phase vitreuse en contient 2,7% sous forme dissoute (CuO) et le reste, soit 1,1%, est cristallisé sous la forme de cuivre métallique (Cu).

L'observation au microscope d'un agrégat de cristaux dendritiques de cuprite au sein d'un des échantillons met en évidence l'équilibre qui s'établit dans le verre entre le cuivre oxydé, le protoxyde, et le métal.

Conclusion

L'étude des recettes nous montre que le procédé de production de l'aventurine consiste en l'ajout de protoxyde de cuivre rouge et de réducteurs directement à l'intérieur du creuset dans le verre fondu, jusqu'à ce que l'oxyde de cuivre arrive au point idéal de réduction. A ce moment-là, le four est éteint et on le laisse refroidir naturellement pendant plusieurs jours.

L'absence d'instruments de contrôle de la température durant les phases d'ajout des éléments réducteurs, et surtout pendant la phase de refroidissement du four, semble être un facteur déterminant de l'incertitude du résultat.

C'est lors de cette longue phase de refroidissement que les microcristaux de cuivre grossissent jusqu'à former les cristaux de grande taille, caractéristiques de l'aventurine.

Les analyses chimiques effectuées ne relèvent pas de grosses différences de composition entre l'aventurine et les verres rouges ; apparemment, le principal facteur déterminant pour obtenir l'aventurine est le traitement thermique différent lors de la phase de refroidissement.

Les études spécifiques faites sur les verres rouges et sur l'aventurine à la cuprite montrent en effet qu'il existe, pour chaque type de verre, une température optimale pour la formation du plus grand nombre possible de germes de cuivre métallique, et pour la croissance maximale de ceux-ci.

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GLASS FINDS FROM THE SHIPWRECK OF CAPE RATAC (ISLAND OF KOLOČEP, CROATIA)

The shipwreck

In 1997, local divers revealed the position of a well-preserved shipwreck site in the northern part of the Koločep Channel, in front of Dubrovnik (Croatia), near Cape Ratac. Six iron guns and a large number of objects belonging to the ship's cargo were exposed in the surface layer, among them rows of window-panes containing hundreds of rectangular glass plates. The ship's cargo also consisted of glassware, metal tools and various metal products. The first official survey, organized in 2005, identified the most delicate areas, where glassware was still present under a thin layer of sand, and performed basic photographic and video documentation.

In 2009, a short documentation campaign was conducted to prepare a photomosaic of the site and to map all of the exposed cargo and ship's equipment. The area covered with finds measured about 10 x 20 m. Some well-preserved wooden parts of the hull were detected under the sand. Another short-term documentation campaign was organized in 2011 in order to perform a 3D photogrammetric survey of the present state of the site. Limited funding supported preliminary testing of the method as well as the elaboration of a detailed 3D model of the central area of the shipwreck. The overall length of the merchantman was about 20 – 25 m. Based on the position of the finds, it appears that the ship sunk on her port side. The starboard part of the hull had undergone erosion due to direct exposure in the ocean while the rest of the hull ought to be well-preserved under the sandy sea bottom. All the glass artifacts recovered from the wreck have been dated to the 17th century.

The glass finds

The glass recovered so far from the wreck includes a group of about 50 objects. Most of them are intact or fully reassembled, and are quite well preserved.[1]

1 A selection of finds was displayed during the exhibition *L'avventura del vetro* in Trento (Italy) in 2010: Medici 2010.

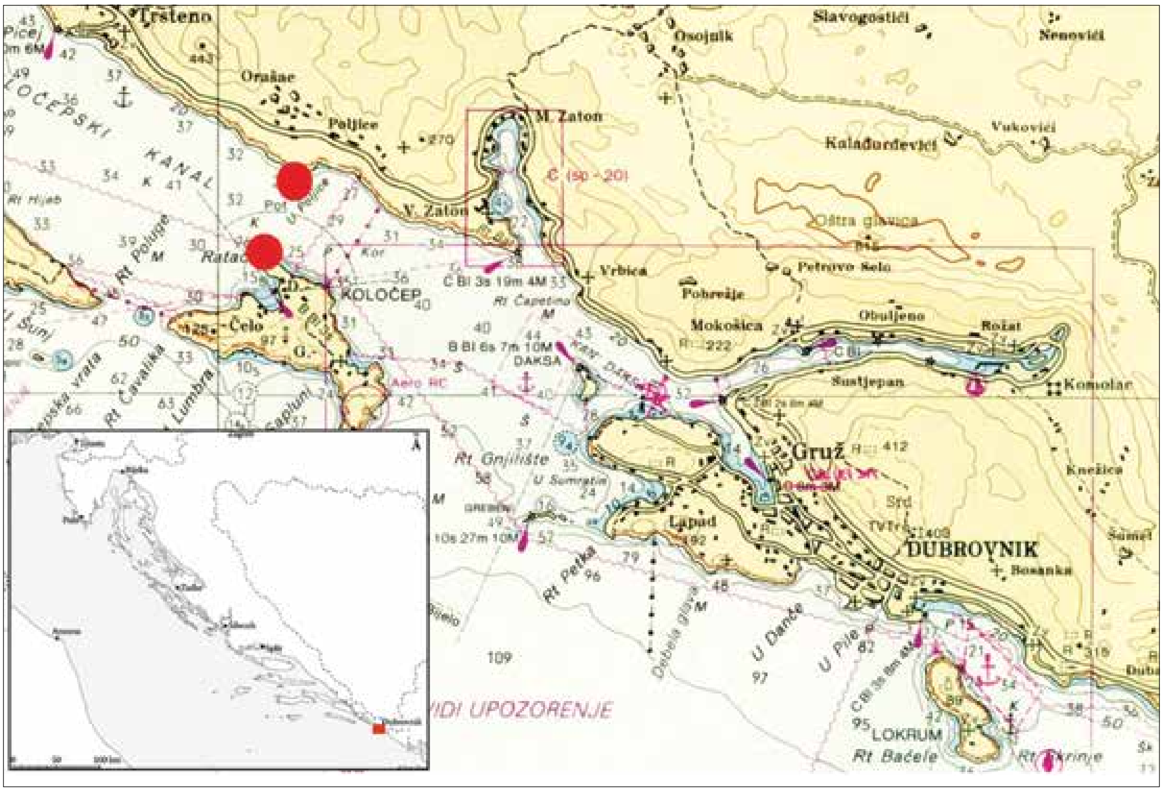

Fig. 1: Location of the shipwrecks.

Clear glass

Stem glasses have features that were common during the 17th century, such as goblets with stems in the shape of a lion's head (Fig. 2a-c) or formed by an elongated inverted baluster, with two opposite wings formed from an applied trail (Fig. 2e). Another goblet (Fig. 2d), with an unknown stem, has an eight-sided bowl with a tooled trail. A goblet with an applied pedestal was decorated with applied canes of opaque white glass on the bowl, and in relief on the surface (Fig. 2f). In addition, two fragments of flask necks with wavy trails or mould-blown decoration on the ribs (Fig. 3a-b), as well as a cupping glass (Fig. 3c), were made with clear glass.

Two fragments of tubular oil lamps with an applied finial were decorated with white and blue applied trails (Fig. 3d). They are the so-called *cesendelli* that were popular in Venice, but also in the Ottoman Empire.[2] Another lamp has a concave bottom and three small handles applied below the folded rim (Fig. 3e).

The window panes recovered from the wreck are dome-shaped of the type intended to be used in the roofs of the *hammam*[3] (Fig. 3f), while a crown glass disk was also retrieved (Fig. 3g). A significant number of panes are still underwater.

Coloured glass

Another group of objects was blown with transparent coloured glass: the neck of a flask (Fig. 4a) and a bowl (Fig. 4b) with brilliant green glass; the lower part of a footed vase with blue glass (Fig. 4c); and a pedestal with dark purple glass (Fig. 4d). A bowl, made with dark purple glass and mould-blown vertical ribs, is dotted with pick-up *avventurina*, red and turquoise spots (Fig. 4e). Additional vessels were made with translucent or opaque glass. A bowl and a bellied tankard (Fig. 5a-b) were made with opaque white glass and pick-up decorative elements, mainly blue with occasional red and turquoise spots. Two bowls were made with light blue opaque glass and featured

2 See for ex. Carboni 2007, 343, cat. no. 164-65.

3 See for ex. Foy 2005, 116-117.

Fig. 2: Clear glass. Stem glass and goblets: a) h max mm 96; b) h max mm 88; c) h max mm 82; d) h max mm 80; e) h max mm 82; f) h mm 72 (© University of Zadar. Photos: Vid Barac).

turquoise and *avventurina* spots; one is bell-shaped with vertical ribs, the other hemispherical (Fig. 5c-d).

Two more bell-shaped bowls with vertical ribs were made with very thin flashed glass, purple on the outside while the inner surface is opaque white (Fig. 5e-f). The external surface is decorated with *avventurina* dots. Despite weathering, it is still possible to appreciate their high quality.

Avventurina glass is also used in the decoration of a group of objects blown with turquoise translucent glass (Fig. 6a-e). The bowls (Fig. 6a-b) and the jug (Fig. 6c) are mould-blown, using a mould with 12 ribs; one of the bowls (Fig. 6a) exhibits the use of the *mezza stampaura* technique. They all have the same truncated conical applied foot. The pick-up decoration on the external surfaces consists mainly of dots of *avventurina* and opaque red glass, with some blue spots. The dots protrude from the surface, but it is hard to say if this is an intentional effect or if it is due to erosion on the surface.

Dark yellow and dark green glass

A group of bottles with metal screw stoppers were made with brownish yellow thick glass (Fig. 4f-h). A thick globular vessel (Fig. 4i) in dark green glass is related to a group of objects identified as hand grenades; they may have also been used for different purposes, as loom weights or containers.[4]

Discussion

A general picture of the entire load is missing, but it is clear that the glass vessels were part of the cargo. They were located in the front part of the hold while the window glass was to the rear. Of all the glass objects, only the globular object could possibly belong to the ship's equipment. The incomplete nature of the excavation of these finds prevents us from drawing firm conclusions about the meaning of the complex. Nevertheless, the collection offers an interesting insight into the glass circulating in the Mediterranean during the 17th century.

4 See for example Carboni 2001, 379.

It is well known that Venetian glass was exported around the whole Mediterranean coast.[5] Fine imported glass was common at the Ottoman court while more customers must have resided in the Balkan countries under Turkish rule - areas known to have depended upon the Venetian market for its supply of glass.[6]

Therefore, it can be assumed that this glass represents a typical example of Venetian trade; the existence of distinctive glassware types on the ship indicates that multiple varieties of glass were produced in Venice for specific markets and were not the end-products of different centres within a wider geographical range - the explanation proposed for the cargo found on the Gnalić wreck.[7] The ship has been identified as the *Gagliana grossa*, which left Venice in November 1583 en route to Constantinople, carrying a cargo of glass for the Sultan's harem quarters. It sank near the town of Biograd na moru, south of Zadar.[8] The compositional analysis of the Gnalić glass indicates that it is all of the same general type, whether clear or highly colored.[9]

A similar interpretation could perhaps also be made for the glass from the Koločep wreck, but more factors need to be considered in this regard. For example, it should be mentioned that during the period in question, the potent Maritime Republic of Dubrovnik possessed a significant fleet. Furthermore, Dubrovnik imported glass from Venice and actively mediated between the Christian and Islamic world in trade for many products. Finally, Dubrovnik was a glass production centre itself.

Therefore, the possibility that the Cape Ratac ship originally came from Dubrovnik cannot be excluded, loaded with a cargo possibly composed of both Venetian and non-Venetian glass.

The registers of the *Assemblee e Consolato di Mare*, the institution to which all misfortunes at sea were declared, are kept in the State Archives of Dubrovnik. They cover the period from 1629 – 1811 and could potentially help in the identification of the Ratac shipwreck. 355 misfortunate incidents caused by bad weather or piracy were recorded during the 17th century, but this particular ship has not yet been identified.

From the stylistic features, it appears that some of these glass objects were actually produced in Venice. The quality of the group made from opaque white glass and of the bowls made from flashed purple glass seems to have required very skilled glassmakers.

Turquoise translucent glass was less common, but was used in Venice from at least the 15th century onwards to blow important enameled cups.[10] A jug with a pinched pouring rim and globular belly can be identified as a typical Venetian jug.[11] In addition, elements decorated with *avventurina*, blue and red dots are characteristic features on 17th century *lattimo* glass. Nevertheless, while single elements composed of this glass can be found among the wares of Venetian and *façon de Venise* production, the combination of colours and shapes makes the assemblage quite odd-looking. The nearest parallel found to date is an excavated bowl now housed at the Louvre and dated to the 17th century.[12]

The wide use of *avventurina* evokes Murano, since it is believed that this quality of glass was mainly produced on this Venetian island. However, it is also possible that more glass factories outside of Venice processed *avventurina*

5 The first document is dated to 1436: Zecchin 1987, 242. Gasparetto (1975-76, 424-25) gives a list of ships carrying a cargo of glass travelling from Venice to the Eastern Mediterranean between 1582 and 1609.

6 Zecchin 1987, 243; Rogers 1983; Carboni 2001, 378. Also see the report probably dated to 1592 on Venetian glass trading to Turkey, Syria and Egypt in Corti 1971.

7 Lazar and Willmott 2006.

8 Gasparetto 1973, 81; Gnalić 2013.

9 Lazar and Willmott 2006; Jackson 2009.

10 For example, see the Fairfax Cup at the Victoria & Albert Museum, inv. no. C17-1959, and British Museum, inv. no WB55.

11 For example, see.: Roffia and Mariacher 1983, 183, inv. no.1321, cat. no 143, fig. 141, 258, and 273, cat. no 185, fig. 180; Theuerkauff-Liederwald 1994, 427-434, no. 474-495.

12 Paris, Musée du Louvre, inv. no. OA12079 - INV7401-443-10114: Barrera 1991, fig. 7, no. 25, 17th c.

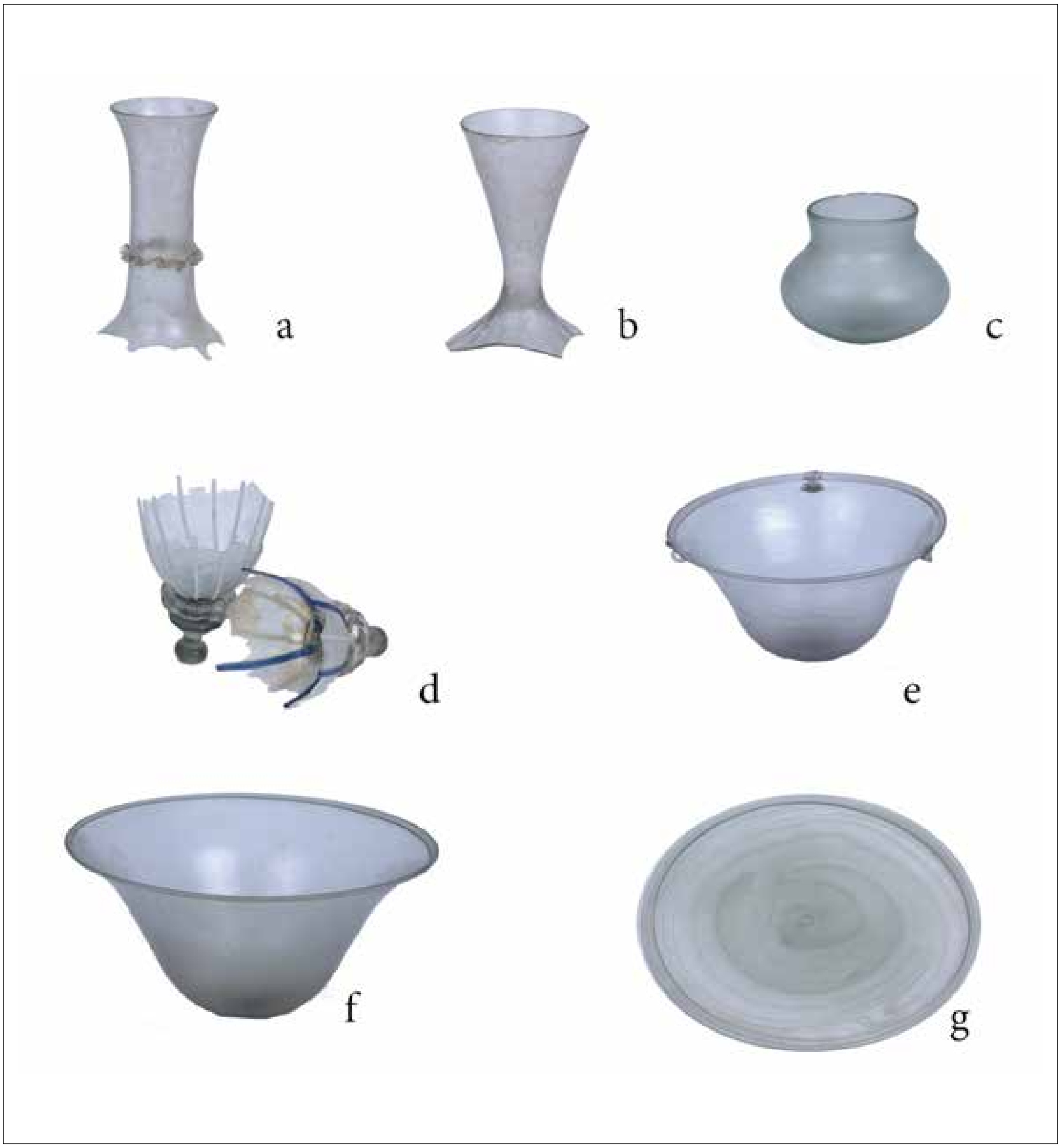

Fig. 3: Clear glass. Flasks: a) h. max mm 175; b) h max mm 150. Cupping glass: c) h mm 54. Hanging lamps: d) h max mm 92 and 94; e) h mm 75. Window panes: f) h mm 90; g) diam. mm 150 (© University of Zadar. Photos: Vid Barac).

glass, because during the 18th century, *avventurina* was traded to be used in the manufacture of jewels.[13] Therefore, theoretically speaking, a certain quantity of glass could have been produced elsewhere while at the same time, using Venetian *avventurina* chips for decoration.

The clear goblets and light blue cups show typical Venetian or *façon de Venise* features, but the possibility that they were produced somewhere other than Venice cannot be excluded. Wings with a curling trail were popular on 17th century stem glasses; the particular feature shown on the stem in Fig. 2 appears in a still life at the Museum Mayer van den Bergh, Antwerp, dated to 1661.[14]

13 Zecchin 2005, 96.

14 Theuerkauff-Liederwald 1994, 401, fig. 78.

Fig. 4: Colored transparent glass. Brilliant green: a) h max mm 215; b) h mm 60. Blue: c) h max mm 34. Dark purple: d) h max mm 36; e) h mm 56. Dark yellow: f) h max mm 33; g) h mm 160; h) h max mm 177. Dark green: i) h mm 135(© University of Zadar. Photos: Vid Barac).

On the other hand, the rather crudely executed pattern employing *vetro a fili* canes on the pedestal beaker seems to rule out a Venetian origin, but on this basis, it could be dangerous to assume that the glass produced in the lagoon was always of the best quality.

The group of bottles made from dark yellow glass could indicate the existence of a produc-

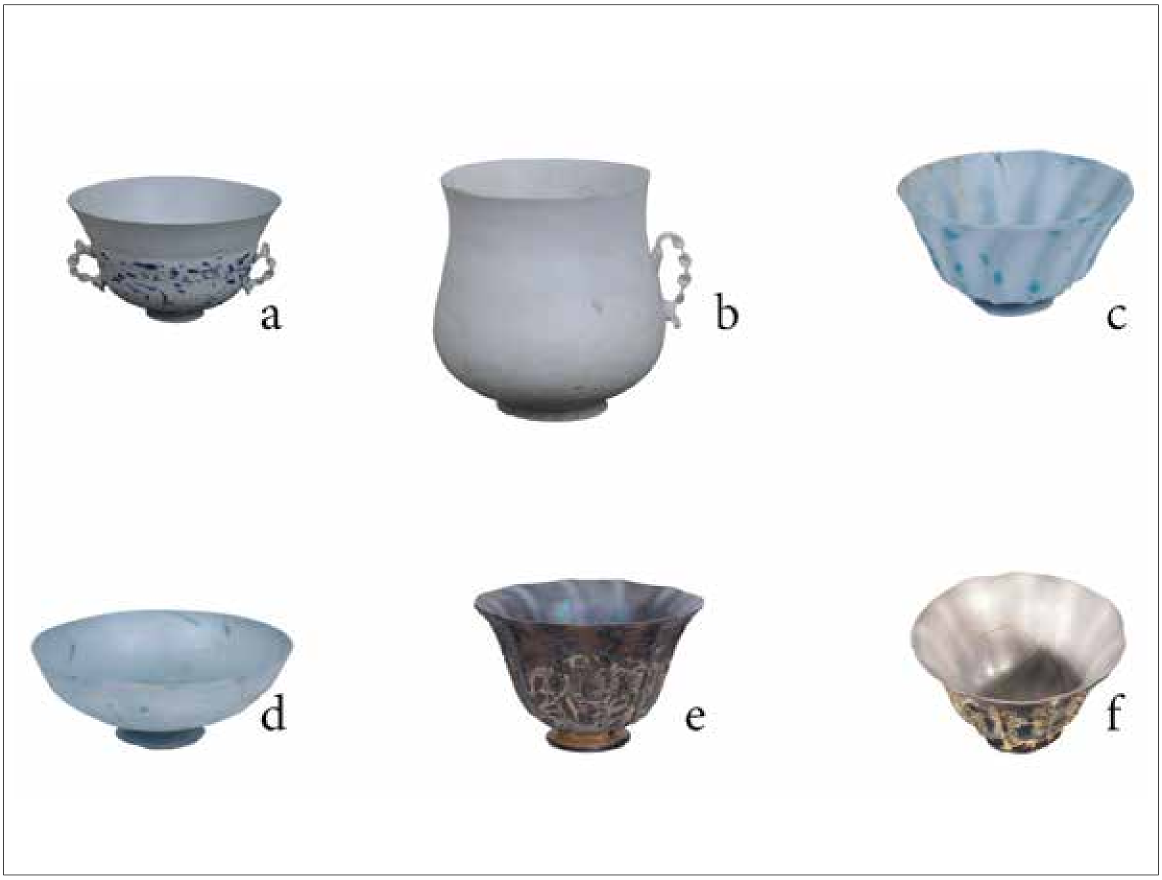

Fig. 5: Opaque glass. White: a) h mm 60; b) h mm 128. Light blue: c) h mm 58; d) h mm 48. Flashed glass: e) h mm 68; f) diam. rim mm 98 (a-e: © University of Zadar. Photos: Vid Barac; f: Photo: Diego Angelucci).

tion simulating valuable Venetian *calcedonio* glass, as these objects are similar in shape to 17th century blown specimens of this type of glass.[15] The use of metal screw stoppers also seems to be typical for *calcedonio* bottles.[16]

Where this hypothetically non-Venetian glass was manufactured is unknown. Glass production in Dubrovnik flourished between the 14th and 16th century, and was promoted by Muranese glassmakers.[17] During the 16th century, the city manufactured *cristallino* glass and engaged in production expressly stated for export ("*per Turchia*", for Turkey). As far as it is known, production came to an end during the last decade of the 16th century.[18] The remark "for Turkey" serves as a useful starting point for speculation concerning the destination of the glass found inside the Koločep wreck. In support of the hypothesis of the Cape Ratac ship having originally come from Dubrovnik, it is worth noting the role played by the Government of Dubrovnik as a mediator for the purchase and transportation of glass between Venice and the Balkan countries, which were ruled by the Ottomans from the 15th - 16th century. Verena Han identified four main trading directions for the glass from Dubrovnik: the Dubrovnik hinterland, Valona, Alexandria and Istanbul.[19] A prosperous Italian community was living in the

15 For example see: Victoria & Albert Museum, no. C.207-1936 (bottle with vertical channels) and no. 5301-1901 (bottle with a long neck); Prague, Museum of Decorative Arts: Hetteš and Vydrová, 1973, cat no. 179, fig. 45 (double-gourde bottle).

16 Besides the objects quoted above, for example see: Theuerkauff-Liederwald 1994, 479, no. 580, inv. no. HA 714; Bova 2010, 340, cat. no. III.3; Roffia and Mariacher 1983, 187, no. 197, inv. no. 1380.

17 Han 1973, 167; Han 1981, 218 and 237.

18 Han 1973, 167; Han 1981, 237.

19 Han 1973; Han 1981; Han 1985, 260.

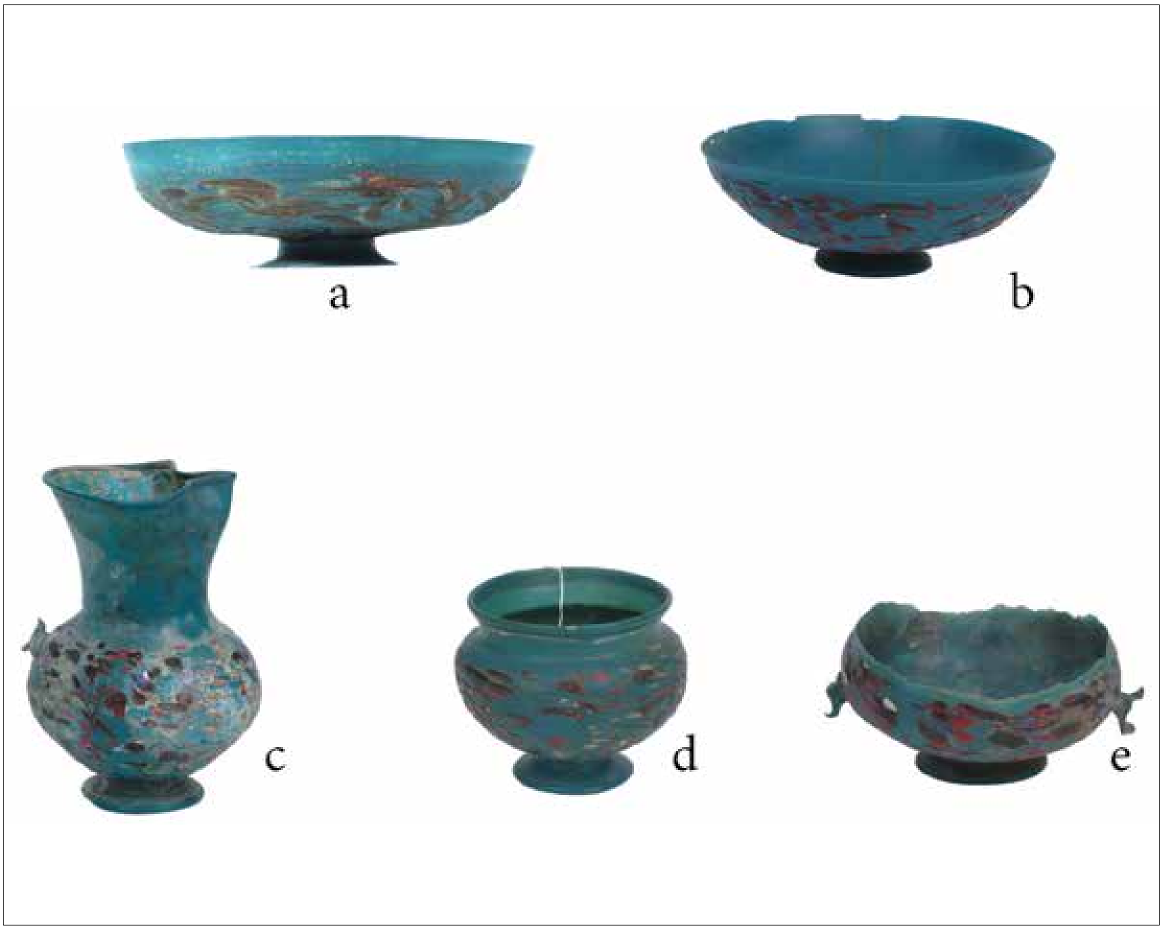

Fig. 6: Translucent turquoise glass: a) h mm 42; b) h mm 37; c) h mm 117; d) h mm 72; e) h max mm42 (a: Photo: Diego Angelucci; b-e: © University of Zadar. Photos: Vid Barac).

capital of the Empire and so Venetian glass was also traded in order to supply their houses.[20]

A limited bibliographic survey of archaeological glass found in the Balkans located some objects similar to specimens from the wreck: for example, a speckled cup found at the Fortress of Beograd,[21] a bottle with six vertical channels from the Turkish Fortress of Fethislam[22] as well as hemispherical lamps with small handles at the monastery of St. Nicholas in Kuršumlija (Central Serbia).[23] Concerning Istanbul, goblets with the stem moulded into the shape of a lion's head, and with white canes irregularly applied on the surface, are common among the glass finds from the Marmaray Sirkeci excavation.[24] At Saraçhane, disk-shaped and dome-shaped window panes, as well as a cupping glass, were found.[25]

Fragments of tubular lamps are also of great interest. They look quite similar to a group of *cesendelli* described in the well-known order made in 1569 by the Great Vizier Mehmed Paša Sokolović to Marcantonio Barbaro, the Venetian ambassador at the Sublime Port. The order was placed to supply lamps to a mosque and a seraglio he intended to build. The dispatch that Barbaro reported to the *Signoria* was accompanied by drawings, one of which represented a

20 For example see: Canav-Özgümuş 2012, 330.

21 Han 1985, 261, fig. 1b, 16th c., City Museum of Beograd. A speckled fragment of an unidentified object, perhaps a small bottle, is listed among the glass found at Saraçhane: Hayes 1992, fig. 155, no. 21.

22 Han 1985, 272, fig. 4b, National Museum of Negotin, 17th c.

23 Dated from the 12th to late 17th century, unpublished (E. Zečević, pers. comm.).

24 Özgümuş 2010, 131.

25 Hayes 1992, figs. 156 to 159.

cesendello. A certain number of the requested lamps were plain; others were to be decorated with *redeselli* i.e. with *filigrana* canes.[26] Various scholars have related this description to particular lamps at the Topkapi Saray Museum, which are covered with white, red and blue canes, possibly *a retortoli*.[27] Similar to the fragments from Koločep is a *cesendello* at the Victoria & Albert Museum.[28]

It is known from written sources that both coloured and *calcedonio* glass were present among the Venetian glass exported to Istanbul as early as the second half of the 15th century. In particular, *calcedonio* should be emphasized, as Venetian merchants hoped to sell it in Turkey at three times the original cost.[29] This fact may have stimulated the production of flasks that aimed to imitate the colour and shape of the Venetian examples.[30] Finally, turquoise seems to have been the preferred colour among Ottoman glass dated to between the 16th and 17th century.[31]

Final remarks

As most of the cargo remains underwater, the full extent of the glass present is as yet unknown. However, based on excavation work to date, the glass cargo was clearly a significant part of the ship's mission.

The origin of the ship cannot be determined solely on the composition of the cargo: additional data is available through the accurate study of the hull, equipment and armaments. The objects recovered from this ship shed new light on the glass trade in the Mediterranean during the 17th century, and on the role played by the Republic of Dubrovnik, thus providing incentive to conduct further systematic archaeological and historical research.

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26 Charleston 1964; Charleston 1966, 19-20, fig.5; Han 1973, 173-174; Han 1983, 260.

27 We are indebted to Stefano Carboni for the information related to the specimens at the Topkapi Saray.

28 Museum number C. 19-1965: Charleston 1964, 168; Charleston 1966, 26, note 12; Rogers 1983, pl. 62, 4; Carboni 2007, 343, cat. no. 164-65. We are grateful to Reino Liefkes for helping to identify the object.

29 Carboni 2007, 344, cat. no. 168, based on Zecchin 1987, 242-243.

30 Carboni remarks that some flasks with long necks, perhaps of Turkish production, could also imitate *calcedonio* glass: Carboni 2007, 344, cat. no. 168. For example see Rogers 1983, pl. 64, 1-3.

31 Özgümuş 2010, 127-129; Canav-Özgümuş 2012, 329-330, fig. 8-10.

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OCULI (CROWN GLASS) FROM ARCHAEOLOGICAL EXCAVATIONS IN THE DUBROVNIK REGION

This paper focuses on the finds of *oculi* (crown glass or round window glass) from archaeological excavations in Dubrovnik (Ragusa) and the region in general. The excavations took place between 2007 and 2011 with finds discovered at the following sites: the Benedictine Monastery of St. Mary (St. Marija) of Kaštel, the Church of St. Stephen (St. Stjepan) in Pustijerna (the historic centre of Dubrovnik), the Cathedral of St. Blasius (St. Vlaho) in Ston and the Benedictine Monastery of St. Mary (St. Marija) on the island of Mljet.[1] The finds represent fragments of round window glass made in different colours and hues (green, purple, yellow, grey and white). The oculi vary in size (from ca. 10 cm - ca. 15 cm) and belong to the period between the 14th and the 16th century. Partial analyses results of the oculi will also be presented in this paper.

All fragments belonged to the windows of monasteries and churches. In addition to their use in sacral buildings, oculi were used for the windows of public and private buildings. Since Dubrovnik had its own glass production industry in the late Gothic and Renaissance period, round window glass is not a surprising find for this region and one can suppose that many of these oculi can be attributed to domestic production.

Dubrovnik was the most important glassmaking centre in the Balkan region in the period from the 14th to the 16th century. Apart from glassmaking, the Dubrovnik Republic was also developed in other areas: goldsmithing, painting, the textiles industry, the chemical industry and metallurgy, all of which were important government projects.[2] The Republic stimulated the development of arts and crafts and searched for talented and skillful glassmakers from abroad (Venice and southern Italy) to aid Ra-

1 Apart from oculi which belong to late Medieval and early Modern Age, the same archaeological sites gave lots of other glass finds which belong to various production centers and can be dated to the period between the 10th-12th and the 19th-20th century.

2 Roller 1951.

gusans in glass production development and to teach native people the same skills.[3]

Since many sacral and public buildings were built in the 14th and the 15th century in Dubrovnik, the need for oculi became extensive.[4] The use of oculi was frequent in church architecture in the Balkans during the late Middle Ages and it is well known that Murano workshops were not the only source of this type of glass.[5] There are many sites throughout the eastern Adriatic coast which are sources of oculi: Umag,[6] Zadar,[7] Gnalić,[8] Split,[9] Lopud,[10] Ston, Mljet, Konavle, Dubrovnik,[11] Kotor[12] and Bribir in the Adriatic hinterland;[13] and Belgrade, Banja, Prijepolje and Hilandar in the Balkan hinterland.[14]

It is known via archival data that Dubrovnik had both: the production of window glass of a round shape or oculi, and the production of stained glass, which was window glass composed of pieces of different shapes and colours. Round window glass is often listed in archival data as *oculus*, *ogio*, *logio* and *oziza de vitro*. Oculi were produced in white or coloured glass. Windows were usually protected by copper or iron wire-netting. It is possible oculi became popular as the manufacture of oculi was much cheaper than the production of large window sheets.[15]

The workshops were situated in the north-eastern part of Dubrovnik, at Ploče near the Dominican monastery, and in the western part at Pile.[16] Several names of glassmakers who had an important role in the production of window glass were recorded in the Dubrovnik Archive.[17] The glassmakers who worked in the first half of the 15th century were Friars Petar, Petar Božiković-Natalis and Nikola.[18] All of them participated in the production of window glass intended for churches, monasteries and public buildings in Dubrovnik.[19] An interesting piece of archival information concerning the production of window glass states that the Small Council approved the construction of a small house near the Dominican monastery in 1418, which served as a glass workshop in which one friar

Fig. 1: Oculi fragments from the cathedral of St. Blasius in Ston.

Fig. 2: Oculi fragments from the Benectine monastery of St. Mary at Mljet.

3 Han 1979a, 7-10; Roller 1951, 137.
4 Han 1971a, 52.
5 Han 1975, 118.
6 B. Milošević and N. Bolšec-Ferri pers. comm.
7 Pešić 2006, 121.
8 Lazar and Willmott 2006, 72, 86, 144; Petricioli 1973, 91.
9 DeMaine 1979, 130, 136, M 53.
10 Han 1981a, 74.
11 From recent excavations.
12 Križanac 2001, 54.
13 Delonga 1987, 107, pl. XV/2.
14 Han 1972a; Han 1975, 122; Han 1981b, 178-181.
15 Han 1971a, 56-57.
16 Han 1971a, 42-46.
17 Han 1971a; Han 1979a; Han 1981a; Roller 1951, 137-139.
18 Han 1971a, 42-43, 45; Roller 1951, 137-138.
19 Han 1981a: 45-76.

Sample	Oxides - Mass percentage (%)																				
	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl	K_2O	CaO	Sc_2O_3	TiO_2	Cr_2O_3	MnO	Fe_2O_3	CoO	NiO	CuO	ZnO	As_2O_3	SrO	PbO
1	5.84	2.58	2.89	76.06	0.37	0.30	0.65	2.02	7.63	-	0.10	0.05	0.18	0.53	0.006	0.001	0.01	0.003	-	-	0.03
2	5.68	2.29	2.20	76.92	0.28	0.28	0.64	1.77	8.37	-	0.07	-	0.30	0.36	-	-	0.001	0.005	0.17	-	-
3	11.20	2.99	1.76	70.15	0.48	0.37	0.59	2.21	7.99	-	0.03	-	0.90	0.52	0.009	0.002	0.005	0.01	-	0.06	0.07
4	9.39	2.93	1.55	68.46	-	0.55	0.81	2.63	11.33	-	0.07	0.02	1.12	0.83	-	-	0.03	0.01	0.09	-	-
5	2.17	1.97	8.83	73.74	0.37	0.37	0.50	2.19	8.59	-	0.04	-	0.56	0.55	-	-	0.01	0.005	-	0.07	-

Table 1: Composition of glass samples.

worked (*frater magister fenestrarum de vetrio*). It is known that Friar Petar worked there from 1418 or 1422 until 1444.20 It is known from archival data on the production of oculi that from the second decade of the 16th century, the glassmaker Johannes Tambarlinus produced round window glass (*vetri tondi*) besides other glassware.[21]

The raw materials used in Ragusan glass workshops were provided by both Eastern and Western Mediterranean ports as well as by Italian cities.[22] Dubrovnik used similar raw materials and technology to Murano. The tools were provided by Venice and by other parts of Italy.[23]

In the beginning, Dubrovnik only had an intermediary role in the trade of glass products of Venetian origin, especially with regard to Venetian oculi intended for the Ottoman Empire.[24] However, in addition to Italian glass products, the Ragusans traded with native goods as well by exporting glass to the Balkan hinterland, Albania, Constantinople, Alexandria[25], southern Italy and Sicily.[26]

According to the stratigraphic context and analogies, these finds of oculi belong to the period between the 14th and the 16th century, and originate from excavations at churches and monasteries. The results of the analyses of five samples from these sites, using the Proton Induced X-ray Emission (PIXE) method, will be presented. The samples were analyzed at the Ruđer Bošković Institute in Zagreb.

In using the Proton Induced X-ray Emission (PIXE) technique, the elemental composition of the samples can be determined by measuring characteristic x-rays induced by proton impact. PIXE measurements were carried out using 2 MeV protons and the beam spot on the sample had a diameter of 3mm. Two detectors were used: the Silicon Drift Detector (SDD) was placed at 150° for the detection of low energy x-rays and the Si(Li) detector was placed at 145° for the detection of more energetic x-rays. To optimize the detection of higher energy x-rays (> 4 keV), a 360 µm thick Mylar film was inserted in front of the Si(Li) detector to attenuate low energy x-rays. The SDD configuration with 450 µm thick crystal and 8 µm Be window was optimal for the detection of low energy x-rays of importance so as to identify light elements. With two detectors, we were able to simultaneously detect all the elements present in the samples in mass concentrations higher than several ppm (part per million), starting from sodium to lead (referring to the periodic table of elements). The PIXE setup was calibrated with the use of thin mono-elemental Micromatter™ standards."[27]

The analyses have shown that these specimens are of plant ash glass. MgO is higher than 2% and Al_2O_3 is in the range of 0.5-3%, indi-

20 Han 1971a, 42-43.
21 Han 1971b, 220; Han 1972a, 201-202.
22 Han 1981a, 120.
23 Han 1975-1976, 88, 92.
24 Han 1973, 174-175.
25 Han 1973.
26 Han 1979b.

27 I wish to express my sincere gratitude to Iva Bogdanović Radović, PhD, for an explanation of the method.

cating Venetian-type glass,[28] apart from sample no. 5, which has a negligibly lower quantity of MgO and a much higher concentration of Al_2O_3.

The first site is the Cathedral of St. Blasius in Ston, which was built in 1345. This cathedral was expanded and richly ornamented in 1392, but collapsed in 1667 during a big earthquake. The second cathedral was built in 1708 and the third in 1875. The aim of the archaeological excavation carried out in 2007 was to excavate the 14th and 18th century cathedrals.[29] According to the stratigraphic context, the fragments of oculi (Fig. 1) can be dated to the last decade of the 14th century, as they were found in the layer of the second phase of the 14th century cathedral. The fragments belong to oculi which had diameters of 12-13 cm. These are tiny specimens with a slightly emphasized central part, a small navel and are of a green color with tiny air bubbles and iridescence on the surface. Two fragments are better preserved and represent part of the rim and central area, while two others are belong to the central thicker part. The analyses (Table 1.1) proved that the composition of one of these samples represents halophytic plant ash glass. Bigger SiO_2 and lower Na_2O concentrations than usual might have been caused by corrosion.[30] The content of MnO is very small and the green color of the glass was caused by Fe_2O_3.[31]

The second site of the finds of oculi is the Benedictine Monastery of St. Mary on the island of Mljet. The monastery was first built in a Romanesque style, and later on, in a Gothic and Renaissance style. Rare glass fragments found during this excavation mostly originate from the late-medieval and early post-medieval layers. During the archaeological excavations of the monastery undertaken in 2007 and 2008,[32] 20 fragments of oculi were found (Fig. 2) as well as different pieces of window glass in a stratigraphic layer belonging to the period between the 15th and 16th century. The diameters of these finds are ca. 10 - 12 cm. The fragments are transparent and mostly colourless with the addition of a few yellowish and one light grayish fragment. 11 fragments have partly preserved rims and several others only have the central part. There are tiny air bubbles in the glass and iridescence on the surface. The analyzed fragment (Table 1.2) is very similar to a previous specimen from the Ston Cathedral, which might indicate an origin from the same circle of workshops or source of raw materials. The fragments are alike concerning Na_2O and SiO_2, but this specimen has a lower concentration of Fe_2O_3 in composition. MnO and As_2O_3 are also present in lower quantities, thus indicating that their purpose was not to decolorize the glass.[33]

Fig. 3: Oculi fragments from the Benectine monastery of St. Mary in Dubrovnik.

Fig. 4: Oculus from the church of St. Stephen in Dubrovnik.

28 Šmit *et al.* 2009, 2541.
29 Milošević 2007.
30 Šmit *et al.* 2013, 9.
31 Jackson 2006, 88.
32 Milošević 2008.
33 Šmit *et al.* 2009, 2543-2544.

The following site is the Benedictine Monastery of St. Mary of Kaštel, situated in the centre of Dubrovnik, at the highest southern point of the town. It served as kaštel (ital. *castello*) in the early Byzantine period in the 6th century. The monastery was built in the 12th century and preserved the same function for centuries. After the Big Earthquake in 1667, the convent was renewed and later some adaptations were made to the whole complex as many different functions were added. Archaeological excavations were carried out in 2007 and 2008.[34] Among many glass finds, oculi were also discovered (Fig. 3) in the late medieval and early modern layers. At the end of the 15th and the beginning of the 16th century, the monastery was rearranged and therefore, the oculi may belong to this period. Regarding the finds, the convent must have had very diverse windows as the finds are of different sizes, thickness, quality, colours (greenish, purple, greyish, yellowish and white) and varying diameters from ca. 10-15 cm. Some of these fragments show a lower degree of manufacture i.e. the navels are more visible and the oculi are thicker and roughly made. However, there are also thinner pieces. Some have tiny air bubbles while others have a larger number of bubbles that are bigger in size. Traces of iridescence are also visible. The analyses confirmed that one of these samples (Table 1.3) has a larger quantity of Na than other samples. Fe_2O_3 has been recorded in the composition as well as a much bigger quantity of MnO, which caused the pink color of the glass.[35] The second sample (Table 1.4) showed a similar composition to that of a previous specimen regarding the majority of the elements. This is the only sample for which P is not recorded. A larger concentration of CaO was also measured. High Fe_2O_3 and CuO resulted in the green color of the glass. MnO was recorded in larger quantities, thus pointing to a decolorizing role.[36]

The last site is the Church of St. Stephen in Dubrovnik. This church was first mentioned in the 10th century by the Byzantine Emperor, Constantine VII Porphyrogennetos, in his famous book, *De Administrando Imperio*. The church was built at the end of the 8th century in the Pre-Romanesque period and was then expanded in Romanesque times. Additional modifications were undertaken in Gothic, Renaissance and Baroque styles. It was never rebuilt after the Big Earthquake occurred in 1667. The church was surrounded by a cemetery, which dates back to a period ranging from the 9th to the 16th century.[37] A well-preserved oculus (Fig. 4) was found in Grave 8, which served as an ossuary along the north church wall. It was found among other material thrown here following a series of burials during the transition from the Gothic to the Renaissance period, making the chronological context questionable. Other finds suggest that it might originate from between the 15th and the 16th century. The diameter of this light yellowish oculus from Grave 8 is 10.47 cm. The central part of the oculus is well-preserved while the exterior is only partially preserved. There are lots of tiny air bubbles in the glass and traces of iridescence on the surface. The analyses (Table 1.5) shows that the glass was made of mixed alkali sources; there are low concentrations of Na and K in the composition; and Al is recorded in much bigger quantities than in other analyzed samples. A small quantity of Fe_2O_3 is also present, which could influence the glass color, but it seems that the decolorizer MnO caused the lighter color of the glass. Trace elements are alike other samples. There are additional fragments from this site that might have belonged to the oculi, but the fragments are very small, which makes it difficult to determine their real function. The exception is a light greenish specimen, which has a diameter of 18 cm and might be an oculus fragment.

During the excavation of the Franciscan Monastery of St. Mary on the island of Lopud, undertaken in 2006, some glass fragments were found among which, one might be an oculus; only a little piece of the central part, and of a yellowish colour, is preserved. There are also a few finds which could represent oculi and are from the fortress of Falcon (Sokol) in Konavle;

34 Milošević 2009.

35 Jackson 2006, 88.

36 Šmit *et al.* 2009, 2543.

37 Topić *et al.* 2011.

they were discovered during the restoration of the fortress in 2011. The finds belong to the interior part of oculi and do not have preserved rims. They are thin and gracile, and are of a light grayish colour.

The Ragusan finds of oculi are of transparent white, purplish, greenish, yellowish and greyish colours. They take the form of a disk with folded rims. The oculi are thinner towards the rim while the central part is callous with a navel in the middle. A more callous central part may suggest it dates back to the 14th century,[38] although this could also be due to the lower level skills of the glassmaker. There are thinner examples that probably belong to the 15th and 16th century.[39] Since the external part of oculi were thinner, it was necessary to make it more resistant to fractures by emphasizing the rim, because it was more exposed to cracking than the central callous part.[40] These Ragusan oculi do not have ornaments as is the case with oculi from the Gnalić shipwreck, which have rosettes,[41] or with the finds of oculi from Belgrade, which are ornamented with radial ribs and have wavy rims.[42] The Ragusan finds have a navel in the middle; many of them have air bubbles and traces of iridescence. It was not possible to calculate the diameters of all the fragments since some of them do not have preserved rims, but diameters range from ca. 10-15 cm. It is known that in the first half of the 15th century, Dubrovnik workshops produced oculi of smaller dimensions with diameters of 10.9 and 11.5 cm,[43] but there are also original preserved oculi from Dubrovnik (found in the western part of the city - Pile) that belong to the 15th or 16th century, and are 16.2 cm in diameter.[44] Therefore, the dimensions of the Archive and Pile oculi mostly match those of recent specimens.

On the basis of the typological-stylistic characteristics of the finds - simple forms without additional ornaments, evidence of rough working, a very irregular central part, round and wavy lines issued by production, air bubbles, diversity in composition, unequal thickness of glass – it can be concluded that these oculi were produced in different workshops. The finds confirm archival data, which state that sacral buildings (monasteries, churches and cathedrals) in Dubrovnik had windows of round glass. Since Dubrovnik had developed its own glass production industry during that period, it is likely that some of these finds originate from Ragusan workshops. According to the results of glass analyses (Table 1) of all samples, it is possible to conclude that only two (one from the cathedral in Ston and the other from the monastery at Mljet) have a similar composition. The fragments from the Monastery of St. Mary in Dubrovnik are of a different origin, with one fragment containing a larger quantity of Na than all other samples. The last sample, from the Church of St. Stephen, has low quantities of Na and K, but also much more Al than all other analyzed samples. All of them represent plant ash glass of halophytic plants, apart from Sample 5, which is of mixed alkali sources. These finds originate from various workshops and are of a different date. Some of the oculi might be of Ragusan origin, but could also be from Italian or another European workshop.

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38 Han 1981b, 180.
39 Han 1971-1972, 152-153, fig. 120; Han 1972a, 194, fig. 2.
40 Han 1972a, 195.
41 Lazar and Willmott 2006, 72; Petricioli 1973, 91, fig. 22.
42 Han 1971-1972, 152-153, fig. 120; Han 1972a, 194, fig. 2.
43 Han 1972a, 195.
44 Han 1971a, 51, 56, fig. 5; Han 1972a, 195.

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FINN Claire

DRINKING GLASSES AND THE CONSTRUCTION OF IDENTITY IN THE 17TH-CENTURY DUTCH REPUBLIC

The 17th century Dutch Netherlands occupied a very singular position in the history of Europe. During a period commonly referred to as the Golden Age, the newly formed Dutch Republic, or seven United Provinces, took an unprecedented place by not only surviving as a non-monarchical political unit, but by thriving. After the overthrow of its Spanish rulers, the new country underwent significant changes to society and economy, and driven by advances in ship building, became a major player in the complex world trade network. This quickly developed with the establishment of colonies and the long distance exchange of international goods.[1] Internally, the Republic's increasing prosperity and social policies of relative tolerance permitted a population explosion, made up of an increasingly urban and diverse society. A breeding ground for art, philosophy and literature was created, as well as the drive for scientific, technological and agricultural innovation.[2] The victory over the Spanish blossomed into a nascent sense of Dutch identity. However, political upheaval also prompted necessary changes in local, regional and personal power,[3] which further led to the strengthening of inter-city and provincial rivalries.[4] Developments in personal and national prosperity, new worldwide connections and social vibrancy all altered the nature of material consumption, trade and production within the country, and supported the Europe-wide boom in consumption during the 17th century.[5]

This paper is the result of current research at the University of Sheffield, which aims to investigate the ways in which the use and meaning of material artefacts, particularly drinking glasses, were understood in the 17th century United Provinces. The breakdown of established medieval social and political hierarchies, increased prosperity at all levels of society and the flourishing of an artisan and merchant "mid-

1 Price 2000, 33.
2 Price 2000, 86.
3 Price 2000, 36.
4 Frijhoff and Spies 2004, 47.
5 Courtney 1997, 99.

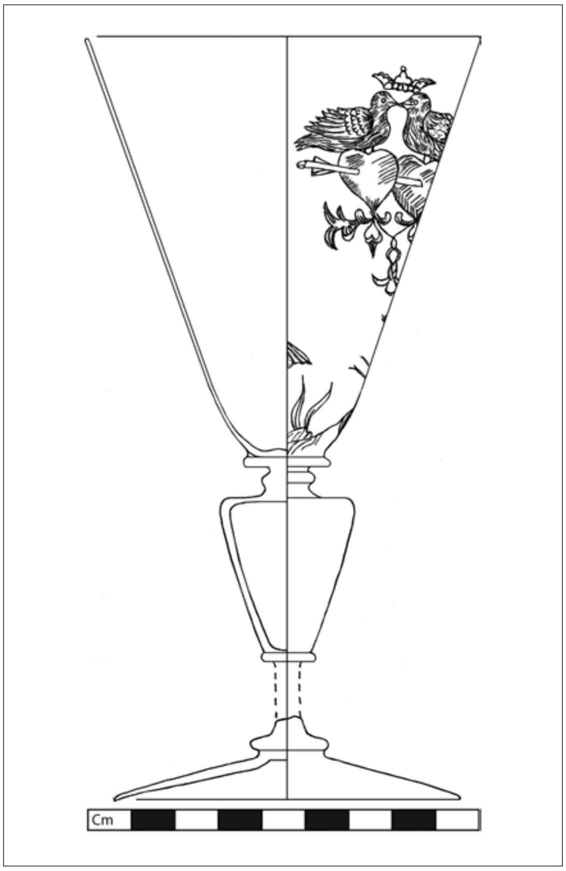

Fig. 1: Engraved wedding goblet from Torenstraat (Enkhuizen), showing two doves perched on pierced hearts.

dle class"[6] all created a socially insecure society, for which new identities had to be formulated.[7] Material culture played a key role in this identity negotiation, particularly luxury items, which became available to a wider cross-section of society, as the strict class boundaries which would have proscribed them no longer existed. The household sphere became the main stage for the communication and promotion of new identities through material culture.[8]

This paper will explore the relationship between the 17th century Dutch and their drinking glasses from an archaeological perspective, and explain the ways in which various types of glass vessel became important social communicators.

During the 17th century, glass, and particularly vessel glass, underwent a series of rapid material and stylistic changes. Over the past two centuries, potash vessels made in German or Low Countries forest glasshouses had become ubiquitous in the Netherlands. Vessel types, such as beakers and roemers, were in frequent usage in all households alongside plain and decorated soda glass beakers. In addition, Venetian and *a la façon de Venise* glass became a symbol of refinement and luxury while elaborately stemmed wine glasses and flutes retained their popularity up until the development of lead glass at the end of the 17th century.

However practical and obtainable glassware was during the 17th century, the ubiquitous usage of glass vessels went far beyond its physical and utilitarian qualities. Glass vessels, along with other luxury items, became an important part of communication between individuals or family units and the outside world. However, this communication was fraught with social and personal anxiety. The Dutch had an uneasy relationship with luxury, a theme explored by several scholars.[9] The sudden prospering of the United Provinces and the dramatic increase in personal fortune created a populace with the need to express its place in the new society, and with the means to do so, through luxury material culture. However, long-held religious and cultural indoctrination against the dangers of excess held a strong power over the minds and emotions of the Dutch people. Excess and luxury were linked in the contemporary Dutch mind to the Catholic extravagances of Spanish rule – and crucially, a key aspect of Dutch identity was Calvinism. In some ways, the desire for luxury was partly a reaction to centuries of oppression by the Spanish. The sudden increase in disposable wealth and the Dutch people's "longing for luxury"[10] was therefore, constantly pained by an ethical guilt. This guilt tinged contemporary writings and artworks, which reflected on the consumption of food, drink and material objects. As a consequence, immoderate alcohol consumption became a contentious issue, as a tradition of excessive indulgence at carnivals and weddings clashed with a fear of the *over-*

6 de Vries 1994, 101.
7 Courtney 1997, 99.
8 Weatherill 1996, 16.
9 See Schama 1987; Gaba-van Dongen 2004.
10 Gaba-van Dongen 2004, 193.

vloed, an impious gluttony that was thought to lead to immorality, violence and sin.

Despite these fears, which were aimed as much at the purchase of exotic and luxury items as at feasting and alcohol, the desire for luxury goods, such as porcelain, artwork and *façon de Venise* glassware, was strong. It can be argued that glass held a specific place in the mentality of the consuming Dutch during the 17th century and played an important role in interpersonal communication as well as the expression of personal and a nascent Dutch identity. Despite alcohol and luxury items both being viewed to be a demonising influence, glassware was still considered a suitable vehicle for demonstrating aspects of personal identity, political statements, religious iconography and as gifts for important ceremonial occasions.

Some expressions of identity through glassware are reasonably overt, such as the engraving or enamelling of vessels with coats of arms, names and dates. A large number of these engraved vessels still survive in museum collections, but fragments also continue to be recovered archaeologically.

An engraved goblet from Torenstraat in Enkhuizen is decorated with pierced hearts and doves, common symbols for romantic love on vessels often commissioned as gifts for newly married couples (Fig. 1).[11] The glass is also decorated with the symbol of a bear. The cesspit where this vessel was found belonged to Zacheus de Jager's household, and this glass with its pictorial pun related to the name of his wife, Margaret van Beresteyn, has been identified as a gift that was intended to celebrate their wedding or engagement.[12]

Engraved glasses were items often commissioned and given as personalised gifts, as was the case with other items of an exotic nature or more common kitchenware. Gift exchange was an important aspect of social interaction during the Netherlands' Golden Age and one that was closely linked to hospitality, alcohol consumption and the marking of certain rites-of-passage, such as births, engagements and weddings - all

11 Ostkamp 2004, 117.

12 Duijn 2010.

Fig. 2: A berkemeier-style beaker engraved with a love song in French. Excavated from Walsteeg (Utrecht).

occasions linked with excessive alcohol consumption.[13] Other decorative themes found on engraved glassware included popular Dutch themes like hunting and fishing,[14] poems or love messages,[15] as well as symbols of religion.[16]

Engraved glasses were being used to express several different emotions and associations. As well as engraved glasses being popular gifts in their own right, poems were often commissioned to record specific events - and in many cases the two were combined.[17] A glass excavated from Walsteeg in Utrecht displays a love poem in the form of a song (Fig. 2). The glass might have been used to express affection in a very personal manner, or in fact be a depiction of a more impersonal romantic ideal. Other aspects of identity and affiliation are displayed on glasses with typical Dutch scenes or religious imagery, both popular decorative elements in other artistic spheres. Despite the fraught relationship between the Dutch and luxury items, and even more pertinently with alcohol, drinking glasses are still apparently considered a

13 Thoen 2007.

14 Ostkamp 2004, 134.

15 Thoen 2007, 88.

16 For example; Rauws 2003.

17 Thoen 2007, 88.

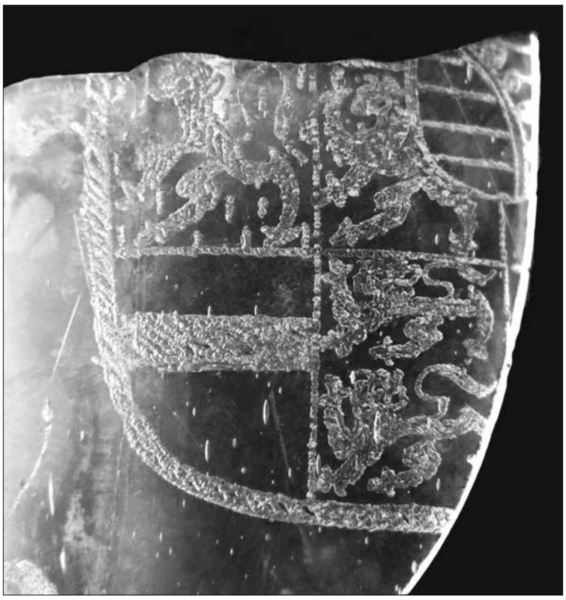

Fig. 3: Detail of engraving on a flute glass, depicting a coat-of-arms. From the Ursulaklooster (Delft).

suitable medium to judge the alignment of their owners with a specific set of Dutch values.

Coats-of-arms and heraldic symbols displayed on drinking-ware were all part of the promotion of personal, group and political identity (Fig. 3).

A roemer excavated from Bloemstraat in Alkmaar is engraved with the coats of arms of the House of Orange - clearly a statement of political affiliation. A similar vessel in the collection of the *Historisch Museum Arnhem* has the coats-of-arms of the Seven United Provinces of the Republic engraved around its bowl, suggesting again an emergent sense of united Dutch identity that was more overarching than local divisions. In fact, alcohol and drinking vessels became an almost ritualised symbol for group identity, in the form of highly ostentatious and elaborate "guild beakers". These large and often purely ornamental cups, which normally appeared in silver or gilded silver, are masterworks of craftsmanship, often decorated with the names of guild members and a variety of symbolic imagery. The ideal of the drinking glass is condensed into a symbol of group identity, pride and belonging. This interaction between groups and drinking vessels is frequently shown in "Guild Paintings" such as *The Celebration of the Peace of Münster, 18 June 1648 in the Headquarters of the Crossbowman's Civil Guard,* by Bartholomeus van der Helst, c. 1649 (Rijksmuseum, Amsterdam). The painting depicts individuals passing around a large silver gilt guild-beaker. While guild vessels are often entirely made of metal, gold and silver were also used to deliberately compliment and contrast with the glass. Dutch museums and collections often contain a specific type of artefact; "cup-holders," which are highly decorative silver and gilt stands topped by ordinary forest glass vessels, such as roemers. One of these vessels is also depicted in *The Celebration of the Peace of Münster*. Here, the very simplicity and commonality of the glassware is exalted by the exaggerated ornamentation of the metal stand.

Indeed, there are several instances in which glass and glass artefacts become symbols for refinement rather than decadence. Gaba van-Dongen[18] suggests that it is the very fragile nature of glass and its inability to be repaired if broken that makes it so attractive. Glass seems to be accompanied by a sense of pride. More than just a utilitarian and functional item, glass becomes a medium of artistic expression and a demonstration of craftsmanship and skill. This is apparent in the success of the Low Countries' *façon de Venise* industry during the 17th century. While the acquisition cost associated with locally made glassware rather than imported items might also have been a factor, it also seems that the nature of such vessels, in the form of Dutch imitations, was also important. It appears there was a certain pride in the crafting of a "home grown" product that reflected the quality of Venice, but in an entirely Dutch fashion. In fact, certain types of Venetian glassware may have been specifically produced for a Dutch export market,[19] such as the popular flute glasses and tall stemmed goblets, which were targeted at the highly fashionable Dutch who wore large ruffs.[20]

A similar fascination with the appearance and nature of glass is also noticeable with the popularity of glass vessels in contemporary

18 Gaba van-Dongen 2004, 205.
19 Gaba van-Dongen 2004, 197.
20 Mees 1997, 13.

paintings. Thousands of still-life and domestic scenes in addition to portrait paintings all contained depictions of opulent and plain drinking glasses. The glass was considered to be proof of an artist's skill; the vessels themselves were used as metaphors for elegant simplicity or ostentatious wealth, fragile vulnerability or as portents of approaching death.

The existence of glassware decorated with coats of arms and dates, as well as phenomena such as *gildbekers* and the importance of glasses in gift-giving, all point to a culture where glass is a key interpersonal communicator. This can also be seen in the continued use of over-sized vessels, often called "welcoming glasses", throughout the 17th century. Medieval dining was characterised by the communal serving of food from shared platters and a large common drinking vessel that were passed from person to person. The change from communal dining to a more personal focus – with individual plates, drinking cups and the introduction of forks - is often heralded as the indicator of change from the medieval to the modern table. However, impractically large glass vessels, beakers and roemers have been excavated from several 17th century Dutch assemblages (Fig. 4) – one notable example is the large ice-glass beaker found at Langestraat in Alkmaar. This vessel has a volume of seven litres[21] and would have been nearly impossible to lift if filled.

These vessels are clearly not practical items for everyday use. While some, like the larger roemers, may have been actually used for certain ceremonial occasions, such as to welcome important guests or during particular social rituals, many of the remainder would have been most unwieldy when filled and almost certainly impossible to drink from. These items would have represented to their contemporary viewers an ideal of hospitality and alcohol consumption that was based on the sharing of family good fortune and communal enjoyment of bounty. Taken to such extremes, the glass is no longer a practical object, but a symbol for community and household interaction with guests.

Fig. 4: A large beaker excavated from Ursulaklooster (Delft).

During the 16th century, *pasglasen* or "passing" glasses, designed to be filled with beer and passed between drinkers, were popular in most of Europe. A German engraved glass in the *Osterreichisches Museum für angewandte Kunst* in Vienna (Inv nr: GL357) records a drinking game related to these glasses, which were often decorated with horizontal rings. The object of the game was to drink down to each next line or measure in one swallow, before passing the cup to the next drinker.[22] While often roughly made and probably not elite items, these vessel types would have been particularly prominent in a household assemblage due to their size. They continued to be popular well into the second half of the 17th century (Fig. 5).

21 Willmott 2002, 36.

22 Laan 1994, 99.

The ritualization of drinking and alcohol consumption, encapsulated by the aforementioned large and elaborate drinking vessel types, can also be seen in the production of miniature vessels (Fig. 6). These have been identified as both children's toys and ornamental doll's house furniture.[23] The ritual nature of drinking ware in each case is interesting; in the case of children's play items, children are being taught at an early age to emulate the behaviour of adults around them, and to adopt and endorse the habits of social interaction associated with drinking and household hospitality.

Doll's houses are different from children's toys in that they were mainly produced for an adult audience and became highly prestigious and expensive ornaments. The doll's house became a work of art in miniature, a model representation of the perfect Dutch house, along with items of elite furniture and kitchenware. The doll's house became a microcosm for the high standards of the house it stood in. The inclusion of drinking items fashioned from glass, ceramic material and metal within these houses both reflects and emphasises the important role of drinking and its accompanying material culture to the nature of the Dutch household. Vessels make up a fundamental part of the fabric of the house.

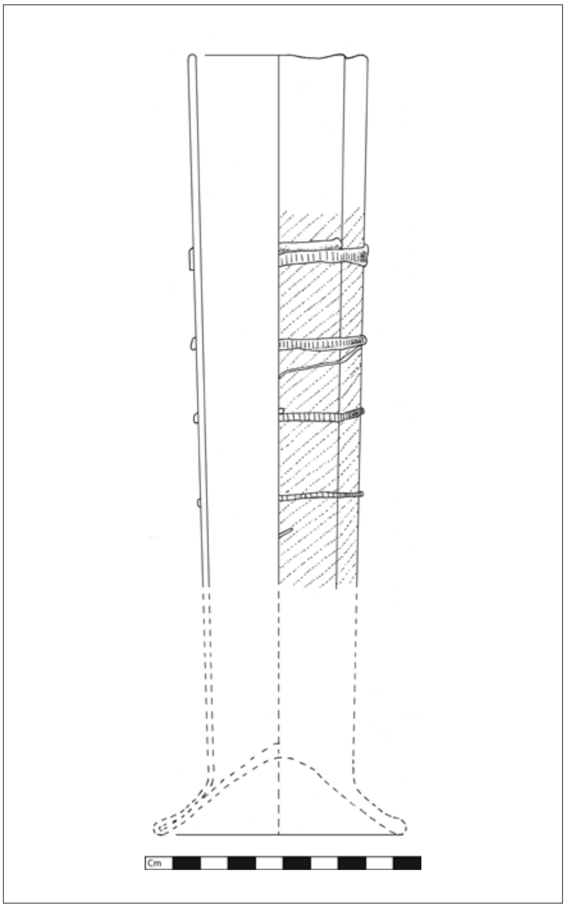

Fig. 5: A Stangenglas or passing glass, excavated from the Wolters Noordhoof Complex (Groningen).

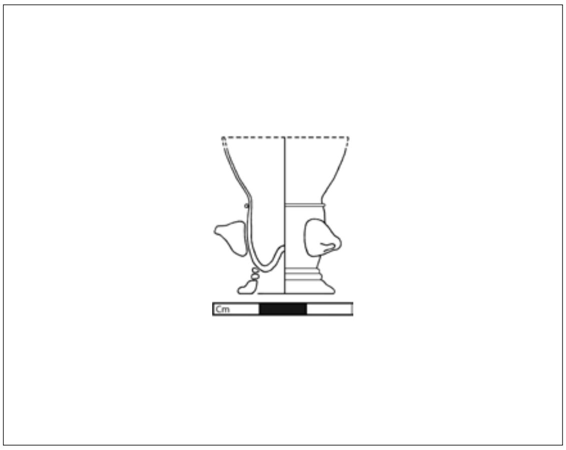

Fig. 6: Miniature roemer-style drinking glass from Walsteeg (Utrecht).

Conclusion

Using the examples discussed, this paper has attempted to explain the ways in which glass drinking vessels and alcohol consumption played a key role in negotiating interpersonal messages and roles during the 17th century. Glass vessels were used to communicate social or political belonging as well as to express more intimate emotions of religious devotion or personal love. Vessels represented a number of ideals connected with artistic skill, hospitality and gift obligation. Excavated household assemblages show that glass made up the majority of household drinking vessels and even appeared to be favoured over other elite vessel types, such as porcelain cups. Most importantly, drinking glasses came to be used to express a unique sense of "Dutchness" through the use of engraved coats-of-arms, Dutch vessels styles and the investment in the Low Countries' *façon de Venise* industries.

23 Bitter 2009.

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GLASS BEADS FROM THE BARROW GRAVE IN THE GREATER MOSCOW AREA DATED FROM 17TH AND 18TH CENTURY

In 2008, the Institute of Archaeology, based at the Russian Academy of Sciences (Moscow), performed a salvage excavation in the Solnechnogorsk district of the Moscow area. An isolated barrow grave was discovered in the course of the excavation near the village Kholmy. This isolated grave was not part of any barrow grave group. Two female graves were found inside.[1] In grave 2, identified as the burial site of a 20-year old woman that has been dated to the 17th or 18th century, 878 glass beads were collected.

Presentation of the beads

The chemical composition of the beads was studied by optical emission spectrography in the Laboratory of Archaeological Technology at the Institute for the History of Material Culture of the Russian Academy of Sciences in Saint Petersburg by A. Yegorkov (Table 1).

The bulk of the glass beads are seed beeds (840 specimens). Most seed beads (704 specimens) have a flattened spherical shape while the rest are cylindrical (136 specimens; Fig. 1). Bead diameter ranges from 2 to 4 mm. Over half of the beads are 3 mm in diameter (477 specimens or 54.3%) and over a quarter are 2.5 mm in diameter (231 specimens or 26.3 %).

The beads are purple (Fig. 1.1), green (Fig. 1.2), white (Fig. 1.3), yellow (Fig. 1.4), turquoise (Fig. 1.5), indigo (Fig. 1.6), colorless (Fig. 1.7) and red-brown (Fig. 1.8). Slightly over half of the beads are purple (445 specimens or 50.7%) and nearly 20% of the beads are green (152 specimens or 17.3%). Slightly over 10% of the beads are made of white opaque glass (97 specimens or 11%). Yellow and turquoise beads account for 5 - 6% (56 specimens or 6.4% and 49 specimens or 5.6%, respectively). Indigo and colorless beads account for close to 2% (18 specimens or 2.1%, and 14 specimens or 1.6%). Red-brown opaque glass beads are in a minority (9 specimens or 1.1%).

1 Khizhnyakov 2009, 14-15; Zots (Zakharova) 2011, 407, fig. 2.

Purple, white, colorless, red-brown and indigo specimens are the largest beads in the study. The majority is 3 mm in diameter while white and purple beads are up to 4 mm in diameter. Green and turquoise beads are smaller with a predominant diameter of 2.5 mm.

All seed beads are made from drawn tubes – and all from single-layered tubes, except the red-brown beads, which are made of the double-layered variety. They have an almost colorless core covered by a layer of red-brown glass. Tubes were chopped into bead lengths using the following procedure: a bundle of tubes would be placed on a frame with a sharp steel cutter, the ends of the tubes projecting at a desired length, before being chopped by the cutter. This job required considerable skill, thus splitters were held in very high regard and were extremely precise.[2] Segment ends were sharp and to make them rounded, the tube segments were placed into a metallic drum with a mixture of damp lime, powdered charcoal and sand. The drum was then heated and rotated in a furnace until the segment ends became rounded. Thereafter, the beads were cooled, washed and dried.[3] However, when rolling in a sand-filled drum, the surfaces of the beads lost their shine. To counter this effect, beads were polished by mixing them with a fine polishing powder e.g. burned ferric oxide (crocus) or alum earth.

The study showed that indigo (Table 1.853-23), colorless (853-24), red-brown (853-25), turquoise (853-27), white (853-29) and purple (853-30) beads are made of glass that was melted using the ashes of desert plants. The colorless and turquoise beads contain a low concentration of calcium oxide (4.3% and 3.8%, respectively). For other beads, this percentage ranges from 8% - 11%. Indigo glass was colored with cobalt oxide, purple glass was colored with manganese oxide and turquoise glass was colored with copper oxide. Red-brown glass was colored and opacified with colloidal copper oxide. Antimony oxide was used as an opacifier for white opaque glass while manganese oxide was used to decolorize colorless seed beads.

2 Petukhov 1901, 586.

3 Karklins 1993, 27.

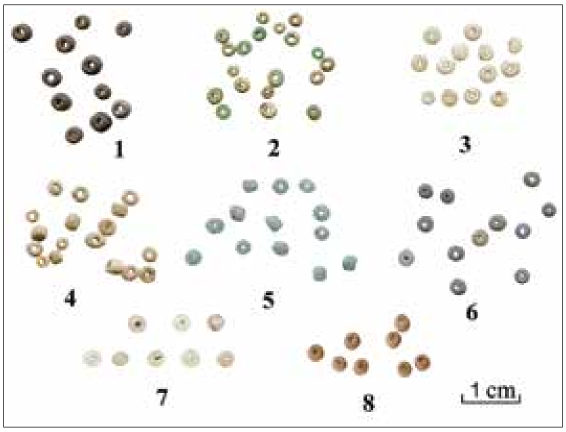

Fig. 1: Seed beads from the barrow grave near the village Kholmy: 1 – purple, 2 – green, 3 – white, 4 - yellow, 5 – turquoise, 6 – indigo, 7 – colorless, 8 – red-brown (photo by D. Ozherel'ev).

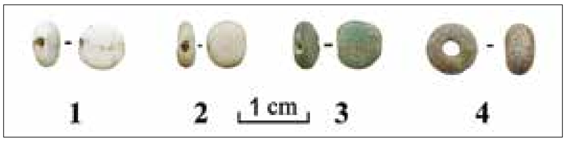

Fig. 2: Beads from the barrow grave near the village Kholmy: 1 – flat oval beads of white opaque glass, 2 – flat oval beads of gray opaque glass, 3 – flat oval beads of transparent blue-green glass, 4 – flattened spherical bead (photo by D. Ozherel'ev).

Green beads were made of leaded glass that was melted using the ashes of temperate zone plants (Table 1.853-28). The low content of alkaline earth points towards the possible use of specially treated ash – in other words, potash. The glass was colored with copper oxide.

Yellow beads were made of alkali-free leaded glass colored with lead oxide in combination with iron oxide (Table 1.853-26).

Beads of white, yellow, turquoise and indigo glass (100 specimens) similar to those found in the barrow grave were discovered during excavations in the Russian city of Yaroslavl in a 17th century building, which was dated by a hoard of silver coins from the time of Alexis of Russia (92 coins) and by red clay vessels from the 17–18th century.[4]

Of the beads discovered in the barrow grave, seed beads made from double-layered red-

4 For the traditional manufacture of seed beads in India, see Nenna 2007 and in Venice today, see www.glassway.com; Faradzheva 2008, 56, 106.

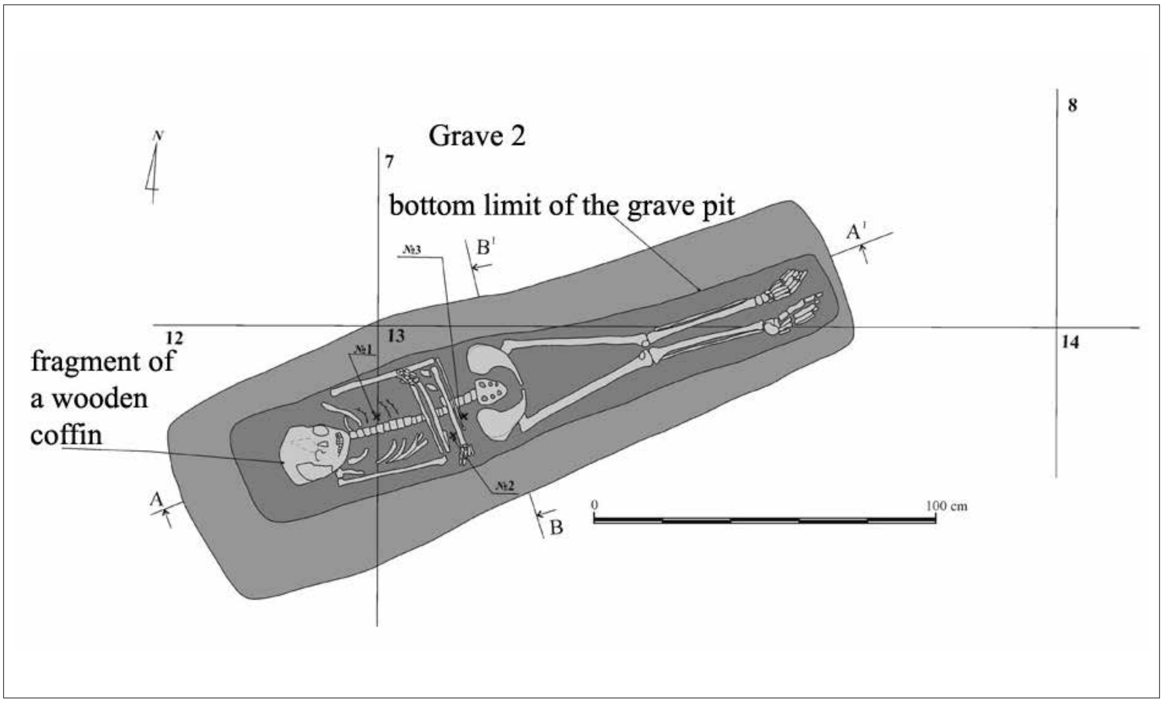

Fig. 3: Isolated barrow grave near the village Kholmy. Grave 2 (after: Khizhnyakov 2009, 14-15; Zots (Zakharova) 2011, 409, fig. 5).

brown tubes are of considerable interest. The same double-layered beads were found among Canadian Indians. They have been dated to a period between the 17th and the first half of the 18th century.[5] A bead from a tube covered with a layer of red-brown glass was found in Moscow in layers originating from the 17th century.[6]

The production of seed beads is known to have been located for a long time on the island of Murano in Venice (from the High Middle Ages until the 19th century). The main clients of Murano beads came from Africa and America.[7] From the 17th century, Venetian beads made from semi-finished tubes were produced in Northern European factories, for example in Amsterdam, the Netherlands.[8] Dutch beads were also supplied to the New World, Oceania and Siberia (through Arkhangelsk and Veliky Ustyug) in exchange for gold, gems, spices and furs.[9]

5 Kidd 1970, pl. IVa2-4

6 Vexler and Likhter 2008, 67, fig. 3. Petukhov 1901, 586-587.

7 Petukhov 1901, 586-587.

8 Petukhov 1901, 586-587. Karklins 1993, 29.

9 V. d. Sleen 1972, 108-110; Ščapova 1998, 160.

Seed beads made of glass melted using the ashes of desert plants can be attributed to Venetian glassmaking. Venetians were known to have used sodic ash for glass melting.[10] Consequently, these seed beads are indigo, purple, red-brown, turquoise, white and colorless. Additionally, it can be considered that these beads were produced in the Netherlands from Venetian semi-finished tubes. This is indicated, for instance, by the two-layered red-brown bead found during excavations at *De Twee Rozen* (The Two Roses) glasshouse (1657-79) in Amsterdam.[11]

Green seed beads made of glass that was probably melted using potash can be considered a product of Dutch workshops. It is known that plant ash from the moderate continental zone was used as a raw material for all European glassmaking north of the Alps.[12] Lead in this composition can be considered an additive that was used to reduce the cooling rate of molten glass. Lead also reduces the melting temperature and softens the glass. These properties render

10 Verità 1998, 131.

11 Gawronski *et al.* 2010, 118, no. 7.2.3.

12 Verità 1998, 131.

the leaded glass appropriate for manufacturing from semi-finished products. This suggests that the production of semi-finished tubes and green seed beads from these tubes was performed at different workshops.

The production location of yellow seed beads made of alkali-free lead-glass is difficult to pinpoint with accuracy. It may be associated with European and in particular, Dutch bead factories.

The next group contains flat oval beads with concave sides (37 specimens; Fig. 2). Most of these beads are made of white (14 specimens; Fig. 2.1) and gray (6 specimens; Fig. 2.2) opaque glass. A smaller number (17 specimens) is produced from transparent blue-green glass (Fig. 2.3). Their body width ranges from 6-8 mm. These beads are made by individual winding followed by marvering.

Similar flat beads made by winding have been found among the Canadian Indians, dating back to the 17th century.[13] The beads are also similar to those manufactured from semi-finished products at the Moscow bead workshop on Yakimanka Street and which have been dated to the mid-18th century.[14]

The blue-green (Table 1.853–21) and white (853–22) flat beads were made of glass melted using the ashes of temperate zone plants. It is possible that specially treated ash - potash – was used for the white beads. The blue-green glass is colored with copper oxide while the white opaque glass is opacified with arsenic.

The manufacture of these beads can probably be associated with European, possibly Dutch, production from the 17th century when bead production from tubes co-existed with winding.[15] With regard to green seed beads, the presence of lead in blue-green and white beads can be explained by the production of these beads from semi-finished products.

Another glass bead found in the barrow grave has a flattened spherical shape (Fig. 2.4). Its body diameter is 7 mm. It is made of a transparent indigo glass tube through serial winding. The tube was rolled on a so-called grid, which is thought to have consisted of a wooden frame strung with parallel wires after which, the tube was chopped into pieces. To polish them, the pieces were placed into a pot containing ashes, which was then heated and slowly allowed to cool. This bead can also probably be attributed to a Dutch import of the 17th century.

Position of the beads in the burial and reconstitution of the beaded object

The described beads were found in one of two graves (grave 2), which was the burial site of a 20-year old woman (Fig. 3). 63 amber beads were found along with glass beads in the grave. Therefore, the location of the beads in the grave requires consideration.[16]

A single bead of transparent indigo glass was found by the chest to the left of the spine (Fig. 3. no. 1, depth 306 cm). It may have served as a fastener or button that was used to hold together the funeral clothes or a burial shroud.

Most of the beads were found by the waistline of the woman, to the right of the spine, under the bones and close to her right elbow (Fig. 3. no. 2). The 63 aforementioned amber beads were also found there. This cluster of beads had three layers.[17] The first layer, at a depth of 298 cm, had 45 amber beads lying in three parallel lines, placed close to one another. The second layer, located at a depth of 299 cm, was comprised of two unequal rows of 18 amber beads. Three parallel rows of glass beads were found nearby at a distance of 1 cm from each other. The rows of beads consisted of pairs of alternating purple and white glass beads. A third layer was found underneath the second, at a depth of 299–301 cm, and contained three parallel rows of flat oval glass beads (37 specimens).

Next to this cluster, at a depth of 302-304 cm, another cluster of beads of different colors was discovered, closer to the spine and by the

13 Kidd 1970, pl. WIIa1-3.

14 Cf. article by Likhter, Vexler, Sudarev in this publication, 512.

15 V. d. Sleen 1972, 111, pl. VIII, 101-102.

16 Khizhnyakov 2009, 14-15; Zots (Zakharova) 2011, 408-409, fig. 5.

17 Zots (Zakharova) 2011, 408-409. Orfinskaya 2011, 416-417, fig. 12.

Fig. 4: Young women and a girl wearing festive clothing. Voronezh Province, 1908 (after Sosnina, Shangina 1999).

Fig. 5: Kosnik. Middle Volga Region, late 19th-early 20th century. Zvenigorod Museum of Arts, History and Architecture; Pool of Traditional (Etnographical) Fabrics. KP 11930. (I would like to thank A. Alexeev for allowing to use the photograph).

left hand (Fig. 3, no. 3). The beads were lying around and under a signet-ring of lead-tin alloy.

Yet another cluster of 63 yellow, green, indigo, purple and white beads at a depth of 304 cm was found underneath the second cluster (Fig. 3, no. 3). Beads with a copper alloy ring and a fabric insert were discovered along with a button of copper alloy. The hole inside the beads had remains of linen threads while between the beads were the remains of linen fabric.

This stratigraphy of finds makes it possible to suggest that the amber and glass beads as well as seed beads were part of a multilayered object.

The hairstyle of the buried woman was possible to reconstruct thanks to the fact that her hair remained intact. The woman had a single braid coming down the spine.[18] In addition, the interred woman had fragments of headwear: a headband consisting of a narrow tape, which had another, wider tape over it. The wider tape covered the forehead completely, passed underneath the hair above the ears and was tied on the nape of the neck. Such headwear, which left the top of her hair exposed, was traditionally worn in Russia by young unmarried women. In contrast, married women wore headwear that fully covered their hair and would style their hair into two braids or a bun.[19] Young women had their braids adorned with special ornaments, the so called *kosnik* (from Russian 'kosa' for braid; Fig. 4). These adornments gained currency throughout the territory inhab-

18 Orfinskaya 2011, 416-417, fig. 12.

19 A 40-year old woman with such a hairstyle was found in another grave (grave 1) of this barrow grave (Orfinskaya 2011, 412, 414, fig. 1).

Reference number	853-21	853-22	853-23	853-24	853-25	853-26	853-27	853-28	853-29	853-30
Colour	blue-green	white	indigo	color-less	red-bro-wn	yellow	turquo-ise	green	white	purple
SiO_2	base	base	base	base	base	base	base	base	base	base
Na_2O	0,3	1,3	17	17	18	0,03	18	0,1	15	16
K_2O	6,8	4,4	2,8	3,2	3,6	-	4,8	2,7	3,9	4,8
CaO	8,9	0,9	8,0	4,3	8,5	0,5	3,8	0,6	11	10
MgO	0,5	0,1	1,0	0,9	1,9	0,1	1,2	0,1	2,2	2,8
Al_2O_3	0,3	0,1	0,5	0,5	1,1	0,1	0,5	0,1	1,2	2,2
Fe_2O_3	0,2	0,2	0,5	0,8	1,7	0,7	0,6	0,2	1,5	1,8
MnO	0,1	0,05	0,04	0,3	0,4	-	-	-	0,2	5,1
TiO_2	0,07	0,06	0,1	0,1	0,1	0,04	0,06	0,01	0,1	0,1
PbO	27	33	-	-	0,2	43	0,06	33	-	0,09
SnO_2	0,03	-	-	-	0,04	0,03	0,02	0,01	-	0,01
CuO	0,7	0,2	-	-	0,8	-	1,2	0,5	-	-
CoO	-	-	0,03	-	-	-	-	-	-	-
Sb_2O_5	0,04	0,07	-	-	0,4	0,07	0,07	0,03	2,8	-
Ag_2O	-	-	-	-	-	-	-	-	-	-
NiO	-	-	0,04	-	0,01	-	0,02	-	0,01	-
As		+								

Table 1: Data of the emission spectrum analysis of glass beads from the barrow grave near the village of Holmy.

ited by Russians. *Kosnik* is a complex decoration which included glass beads, seed beads, bugles, glass and mother-of-pearl buttons, metallic rings or signet rings, and textile ribbons (Fig. 5). A bronze or leather ring-holder and metal signet ring were used to hold together strings of beads that consisted of a beaded rigid leather or textile base that was decorated with textile ribbons and tassels made from beads and seed beads. The location and the layout of the beads studied at the burial site suggest that they may have been part of such braid ornaments and belonged to the interred woman.

The burials in barrow graves are characteristic for Russia from the 10th to the 13th century, the Christian method of burying the dead in earthen graves not being commonplace for the time, particularly in the Moscow region. Burial in a barrow grave is truly unique for the period between the 17th and the 18th century. However, the creators of this grave followed the burial rites common for barrow graves with precision. It is unclear how the rules of barrow grave construction could have been preserved with no continuous tradition of building such structures. The degree to which the beliefs of barrow grave creators corresponded with those of Christianity is still also undecided.

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TRACES OF GLASS BEAD PRODUCTION IN 18TH CENTURY MOSCOW

In 2002, during the excavation carried out by the Archaeological Research Center of the Moscow Department for the Protection of Monuments in Zamoskorechye (Bolshaya Yakimanka str., bld. 22), a large pit (no. 41) was found in the western part of the excavation area in squares A, B, C-6-9 at layers 7-11. It appeared to be a foundation pit of a 17th-century building, filled with a variety of debris from a recent historical period. Starting from the -130 cm level of the pit filling, a spot consisting of burnt furnace fragments and baked clay has been traced. At a lower point, -160 to -180 cm, remains of burnt wooden planks were also discovered. The pit was observed to a depth of -240 cm.

In addition, stove tiles from various historical periods and large amounts of glass work, mostly beads, were found in this pit.

The oldest tiles (green glazed) are dated from the 1670s to the early 18th century. The most recent (decorated with Dutch style paintings of rural landscapes on a white background), belong to the 1740s-1780s.[1] The painted tiles are part of the same set.

Ceramics and tiles filling the building pit (Pit 41) are dated from the second half of the 18th century; the accumulation of beads and tiles was caused by dumping debris into the pit during the second half of the 18th century.

Glass finds and related tools

The discovered beads are mostly spiral- and round-shaped, having been made using a winding method. Besides the beads and their fragments, some shapeless glass remnants, glass threads and glass drop fragments were also found (Fig. 2) as well as fragments of hollow spheres with traces of metal inside. Many beads contain the marks of technological procedures, such as obtrusive thread ends, rough necks and offset mandrel perforation. There are visible deep cavities on both the beads and shapeless fragments of glass. A fragment of iron rod (0.75 cm diameter) with some blue- violet glass adhering (Fig. 3) and an iron rod (0.16 cm diameter and 3.3 cm in length) were also found in the assemblage (Fig. 4). Additionally, there were

1 Maslikh 1976, 23.

some similar rods of a smaller diameter (0.11-0.23 cm and 0.35 in one case) with one to three beads wound around them (Fig. 5).

Glass bead manufacture

The winding method of glass bead manufacture was recreated and modeled by researcher T. Gam.[2] Liquid glass is collected onto an iron rod called a punty. Then the glass edge is picked up by a smaller diameter stick and a bead is formed by whirling the stick and winding glass thread around it (Fig. 6). When dealing with glass flat ingots, rather than liquid glass, the ingots were pre-heated in pans usually made of iron before using the same techniques. Excess collected or half-stuff glass that was insufficient to form a bead was thrown away while the remains had the shape of drops or threads. Glass that was in contact with the punty exhibited metal imprints.

The description of this technique gives us a basis for interpreting our findings. Since there were no signs of glass production from the raw materials, but a large number of glass pieces, it can be assumed that we are dealing with the manufacture of beads from the glass chunks. From research reported in literature,[3] it is known that raw glass had the shape of flat ingots. The glass pieces can probably be considered glass chunks. The glass drops and threads, semi- spheres with thin walls and traces of metal inside, are most likely the remains of collecting glass on the punty. The fragment of iron rod with adhered glass also remained on the punty while the thinner metal rods were used for bead winding. Beads worn on some sticks can be considered as unfinished products. In addition, it can be assumed that some of the findings are spoiled products or items unsuitable for use, for example those with swollen mandrel perforations and wide cut-through holes perpendicular to the mandrel perforations. The schematic relationship of the categories is shown in Plate 1. Apart from the evident spoilage, there are also beads with various manufacturing defects.

2 Gam 1990; Gam 1993.

3 Schapova 1989, 111.

Colours of the beads

There are various colours of glass with the following having been identified: beige, white, turquoise, yellow-green, green, brown, reddish-brown, olive, purple, blue-grey, grey, blue-green, blue-violet and violet. There are also some items of vaguely dark, brown or olive colour.

The colour of a few fragments cannot be identified at all, because of their poor, damaged state. Items have been categorised by the colours blue-violet, green, yellow-green and olive, which are presented in categories showing the entire manufacturing process: glass chunks, finished products, waste and distorted products. There is no doubt that the beads of those colours were made at this particular place. Other colours are represented only by beads.

To ensure whether the beads are connected with the entire assemblage, they were analysed on the basis of their colours and flaws. Among the colours described above, turquoise, blue-green and grey are represented only by beads with no manufacturing flaws. All beads of these colours were presented in one example. It can be presumed that they appeared in the assemblage accidentally while beads of other colours are apparently connected with the assemblage.

Chemical composition (Fig. 1)

To analyse the chemical composition,[4] different categories of different colours were selected for glass chunks, threads and beads. Blue-violet, green, yellow-green and olive glass colours are attributed to the K-Ca-Pb-Si type; while beige, brown and white are of the K-Ca-Si type. Analysis of the white bead showed low levels of all major glass ingredients (analysis no. 748-14), probably caused by its poor, damaged state. It can also be noted that white and brown beads differ from the others by their badly preserved glass.

4 Glass emission spectrum analysis carried out at the Laboratory of Archaeological Technology IHMC RAS by A.N. Yegorkov, D.Sc.

Analyze №	Colour	Name	Na2O	K2O	CaO	MgO	Al2O3	Fe2O3	MnO	PbO	SnO2	CuO	CoO	Sb2O5	AgO	TiO2
748-14	White	bead	0.00	2.50	0.60	0.40	0.50	0.40	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.01
748-15	Brown	bead	0.10	15.00	13.00	0.40	0.50	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
748-16	Blue-violet	bead	0.30	13.00	5.60	0.20	0.50	0.20	0.10	10.00	0.00	0.00	0.0800	0.03	0.00	0.1
748-17	Green	bead	1.00	7.00	7.40	0.50	0.60	0.10	0.10	16.00	0.00	1.00	0.00	0.04	0.00	0.09
748-18	Yellow-green	bead	0.70	7.00	11.00	1.30	1.60	0.70	0.20	16.00	0.00	0.80	0.00	0.05	0.00	0.3
748-19	Olive-colo(u)red	bead	0.70	7.00	8.70	0.90	1.40	6.50	0.10	4.70	0.00	0.00	0.00	0.00	0.00	0.2
748-20	Brown with blue patina	Glass remnant	0.10	3.00	18.00	0.50	1.60	1.40	0.30	0.70	0.00	6.70	0.00	0.00	0.01	0.2
748-21	Green	thread	0.20	4.50	7.10	0.50	1.00	0.07	0.08	5.60	0.00	0.60	0.00	0.02	0.00	0.1
748-22	Blue-violet	thread	0.20	5.70	6.30	0.20	0.60	0.10	0.10	2.00	0.00	0.00	0.0500	0.02	0.00	0.04
748-23	Green	Gathering end	0.50	7.30	8.70	0.50	0.80	0.20	0.10	13.00	0.00	1.20	0.00	0.03	0.00	0.07
748-24	Green	Gathering end	1.30	9.40	6.00	0.70	1.60	0.20	0.10	20.00	1.20	0.06	0.00	0.06	0.00	0.1
748-25	Blue-violet	Glass remnant	0.20	6.40	7.40	0.80	1.30	0.30	0.20	5.60	0.00	0.02	0.00	0.02	0.00	0.1
748-26	Green	Glass remnant	0.50	7.80	11.00	0.70	1.00	0.30	0.10	13.00	1.30	0.03	0.00	0.03	0.00	0.06
748-27	Blue green	cane	2.50	6.40	14.00	6.70	4.00	1.00	0.00	0.10	0.40	0.00	0.00	0.00	0.00	0.02
748-31	Colourless	Stick with thread	10.00	3.00	2.20	0.60	0.80	0.30	0.40	0.50	0.00	0.00	0.00	0.02	0.00	0.06

Fig. 1: Results of glass emission spectrum analysis, carried out by A.N. Yegorkov, D.Sc., Senior Research Associate Laboratory of Archaelogical Technology IHMC RAS.

Fig. 2: Glass threads.

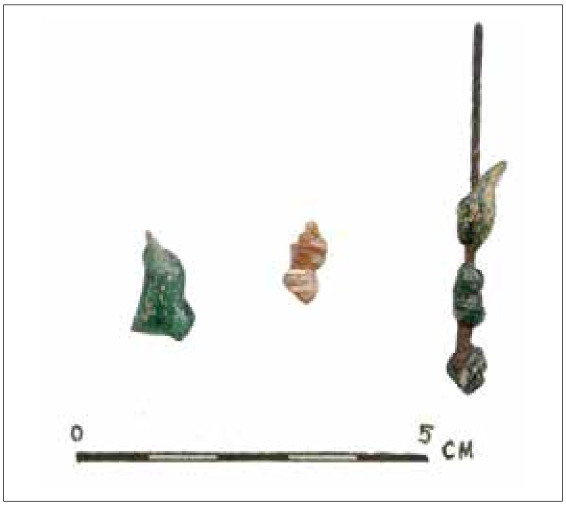

Fig. 3: Iron rods from one to three beads wound on them.

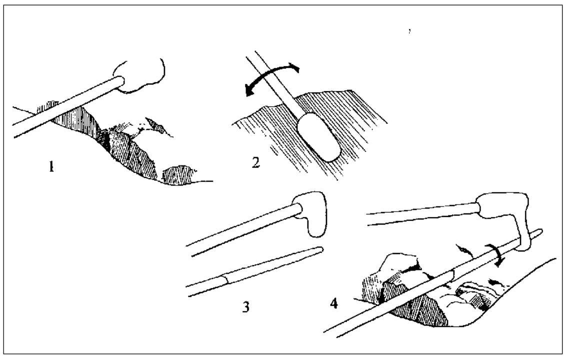

Fig. 4: Winding method of glass bead manufactory (by T. Gam): gather on a punty (1), rolling of a gather (2), punty with a gather and rod (3), winding of a bead (4).

BEAD SHAPE (Fig. 5)

The shape of the beads, both as finished and unfinished products, were taken into account. However, some bead fragments were excluded as their shape was impossible to determine.

Rounded-shape and mostly oviform beads prevail over others; sometimes their threads wound so roughly that the shape becomes spiral. It is interesting that apart from those found in the assemblage, there were no other spiral beads known in Moscow. There were also some small amounts of faceted and flat beads.

Bead sizes were ordered by diameter in accordance with J. Callmer's division.[5] Bead diameter ranges from 0.5 to 1.3 cm, with beads of a diameter of 0.6-0.8cm absolutely dominating the group – classified as large in a group of micro-beads. The perforations are usually very narrow: 0.1-0.2 cm.

A comparison of colours and shapes shows that all colours have the same sets of shapes. Significantly, spiral-shaped beads are represented everywhere. Likewise, size ratio matches all the colours of the beads.

Chemical composition and technology

To analyse the chemical composition[6] different categories of different colours were selected (glass chunks, threads, beads). Blue-violet, green, yellow-green and olive glass colours are attributed to the K-Ca-Pb-Si type, brown and white are of the K-Ca-Si type. Analysis of the white bead showed low levels of all the major glass ingredients (analysis no. 748-14).

As previously noted, the beads were made by a winding method. However, bead edges are usually rough, which may indicate they were separated by breakage. Taking this into consideration, it can be concluded that the beads were not made individually, but with a serial winding technique. The technique reflects how a few beads were wound on the same rod, thinning out at the joints; subsequently, the beads were then separated where they thinned out. This may explain the presence of a small number of twinned beads (Fig. 5). The spiral shape can probably be considered a production flaw, because it is rough and unmerged turns of the thread are usually obtained when working with semi-cooled glass. Molding of faceted and flat beads probably required special molding tongs.

5 Callmer 1977, 35.

6 Glass emission spectrum analysis carried out at the Laboratory of Archaeological Technology IHMC RAS by A.N. Yegorkov, D.Sc.

The composition analysis shows the presence of two chemical types of glass: K-Ca-Pb-Si, and K-Ca-Si. Hence, it can be assumed that the half-stuff products the beads were made of are of different glass types. Glass of the K-Ca-Si chemical type was typical for Western European glassmaking from at least the early 2nd millennium AD. Primarily it was produced in German-speaking lands and connected to Slavonic countries. No later than the middle of the 17th century, the manufacture of colourless glass with this composition was mastered in Bohemia; it was named Bohemian or potash crystal.[7] In the 18th century, Russian factories also produced crystal engraved and polished glassware from the same composition of glass. Glass of the K-Ca-Pb-Si composition was also known under the name of potassium-lime-lead glass (semi-crystal or semi-lead glass).[8] The predominance of the K-Ca-Pb-Si type in the sampled glass might be connected with the fact that it was better suited for the production of wound beads. Adding lead to the glass mass lowers its viscosity and reduces the speed of molten glass cooling; as glass makers say, glass becomes "long".[9] Besides, glass of this composition is more resistant to various negative external influences. At that time, wood ash[10] was added as a source of alkali in the process of melting for both glass types.

Half-stuff products, waste and finished production in the observed assemblage are represented by a concurrent set of colours. This suggests that, with a few exceptions, all the beads discovered were produced by a glass workshop that worked using half-stuff products of different compositions.

Nature of the workshop

It can be assumed that this workshop produced mostly flat and faceted beads (ovoid with slightly marked planes), even though they constitute a small percentage of the total number of beads found. Meanwhile, faceted specimens are represented mostly by fragments. Apparently, since the assemblage appears to be a dump where manufacturing waste was thrown away, production of the workshop was barely represented.

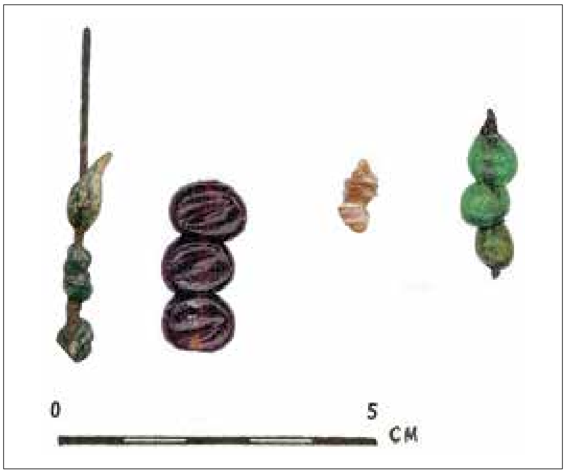

Fig. 5: Twinned beads.

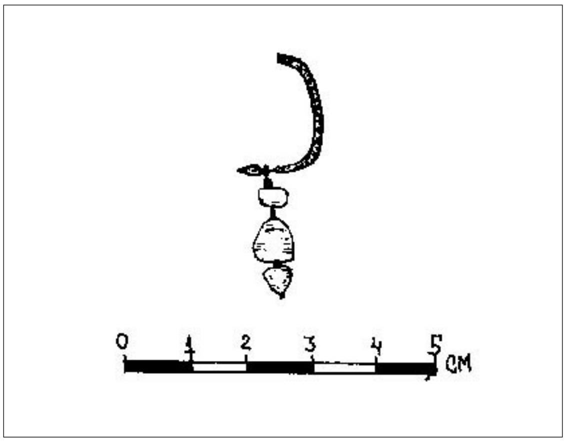

Fig. 6: Earring with beads.

Based on the analysis of production remnants and finished production, it is fair to say that we are dealing with a small workshop of where the production cycle was incomplete and where glass ingots were reworked into finished beads. In addition, it can be stated that glass used there was specifically designed for winding technique manufacture, and that production quality was high. Obviously, the glassmakers were not only able to liquefy glass ingots and produce simple products, but they knew the properties of glass and used them correctly. Unfortunately, we do

7 Asharina 1998. 209.
8 Glass work 1910, 278.
9 Zak 1947. 99.
10 The definition of ash type was made in accordance with T. Stawiarska's method (Stawiarska 1984, 24-27).

not have sufficient data to determine the place where glass ingots were produced. It is known that many glass factories at that time produced so-called potash crystal - glass of the K-Ca-Si chemical type - which was used for high quality glassware production. It can be assumed that the same factories produced potassium-lime-lead glass as well for sale among craftsmen who produced beads.

The existence of handicraft workshops that produced bangles and beads was mentioned in the 19th century by S.P. Petukhov, the chief technologist of the emperor's glass-works,[11] but so far, glass researchers only have information about large works.[12] The newly discovered assemblage provides the first archaeological proof of small glass workshop existence.

It is also interesting to note where the beads were sold. Generally, glass beads were not included in the necklaces of townswomen. Instead, beads produced at the workshop were probably intended for residents of surrounding villages. However, the beads can be associated with other examples of similar shape, also made by serial winding, which were found during archaeological research in other parts of Moscow. Flat grey-blue beads were found at excavation sites in Bolshoy Golovin (1995) and Kadashevskiy (1996) Lanes. Flat blue and red-orange beads were excavated during work undertaken in Protopopovskiy Lane, while a yellow-green faceted ovoid bead was discovered at Manezh Square (1993). Additionally, a blue-violet rounded ovoid bead was found in the course of works undertaken in Lukoviy Lane (1994). It was decorated with a white thread. It is also interesting to note the appearance of similar beads on metal earrings. One specimen shaped as a question mark, found in Kadashevskiy Lane, had a flat ellipsoidal blue-grey bead attached. Another, found in Lukoviy Lane, represents a fragment of a "Dvoichatki" (twining) type earring (Fig. 6); its ear wire has a metal strand coiled around it with three beads strung on its loose end: two of which are white and egg-shaped, the other green and ball-shaped.

There is no reason to assert that we are dealing with production from the same workshop. However, beads of this shape were certainly known and in demand in Moscow. Apparently the beads were used in the city, but not as a part of necklaces.

11 Petukhov 1901, 587.

12 Asharina 1998, 175-200.

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RAS – Russian Academy of Sciences
SA – Soviet archaeology
SPb – SanctPetersburg

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GRATUZE Bernard

LES PREMIERS VERRES «CRISTAL AU PLOMB» PRODUITS EN FRANCE PAR BERNARD PERROT: CONTEMPORAINS DE CEUX DE RAVENSCROFT?

Lors de l'exposition consacrée à l'œuvre de Bernard Perrot en 2010 à Orléans, un programme de recherches sur les productions de ce verrier orléanais a été initié par le Musée des Beaux Arts d'Orléans. Bernard Perrot est né en 1640 à Altare en Italie, et s'est établi en 1668 à Orléans. Sa verrerie, située rue Notre-Dame de Recouvrance, se consacrait, d'après les témoignages de l'époque, à des productions de qualité. La réputation de Bernard Perrot dépasse largement celle d'un simple maître verrier :[1] il a les honneurs à deux reprises de longs articles dans *Le Mercure galant* et il fait une communication devant l'Académie des Sciences au sujet de son invention du verre coulé en table. Il est aussi introduit dans le milieu scientifique de l'époque et fréquente Thoynard, Locke ou encore Hubin. Sa reconnaissance s'étend jusqu'à la cour de Louis XIV, et Bernard Perrot bénéficie de plusieurs privilèges royaux pour la production de verres de couleur ou de verre coulé en table.

1 de Valence 2010.

Etudes antérieures et nouveau corpus analysé

Les analyses réalisées sur les œuvres qui lui sont attribuées[2] ont montré l'extraordinaire inventivité et la grande capacité d'adaptation dont Bernard Perrot a fait preuve tout au long de sa carrière. En effet, il adopte les verres potassiques, typiques du Centre de la France, utilise les verres de cristal pratiquement simultanément à leur création officielle, attestée en 1674 en Angleterre, et un siècle avant l'introduction industrielle de ce verre en France.[3] Enfin, il crée ou adopte une nouvelle recette de verre rouge translucide à l'or contenant de l'arsenic.

De prime abord, les résultats des analyses obtenus sur ces verres attribués à Perrot peuvent laisser perplexe. La multitude de compositions chimiques qu'ils révèlent donne l'impression d'être en présence soit de différentes productions, soit d'une production en constante évolution. Dans le premier cas, tous les objets analysés pourraient alors ne pas être exclusive-

2 Biron *et al.* 2010; Biron *et al.* 2011.

3 Anonyme 2009.

ment de Perrot, mais provenir d'autres verriers contemporains. Dans le deuxième cas, il apparaît impossible de définir des caractères propres aux verres de Perrot. Les résultats obtenus ne permettent pas non plus de dessiner une possible évolution chronologique des compositions, étant donnée l'absence de datation précise des pièces étudiées.

Ces premiers résultats un peu ambigus justifiaient d'étendre cette recherche à d'autres productions de Bernard Perrot. La possibilité d'analyser deux autres types de productions de ce verrier nous a été donnée au cours de l'année 2011.

Les récents travaux de restauration entrepris sur la Cathédrale Sainte-Croix d'Orléans nous ont permis premièrement d'analyser des verres plats produits par Bernard Perrot.[4] Deux textes nous révèlent en effet la fourniture d'une partie des vitraux de cette cathédrale par Bernard Perrot. Le premier est publié en 1774 par Pierre le Vieil dans son Traité historique et pratique de la peinture sur verre (L'art de la peinture sur verre et de la vitrerie, Le Vieil, réimpression 1973). Il y mentionne en effet un compte arrêté entre son aïeul Guillaume le Vieil (qui fut à l'époque chargé de la réalisation des vitraux de Sainte-Croix) et Bernard Perrot. Ce document, daté du 3 septembre 1689, porte sur la fourniture de verre de couleur (rouge, bleue et verte) pour la fabrication des vitraux de la cathédrale Sainte-Croix d'Orléans. Le second est une lettre écrite en 1698 par Nicolas Thoynard à son ami le philosophe anglais John Locke. Il lui relate la fabrication par Perrot des verres de couleurs de la Cathédrale d'Orléans et lui fait part de l'offre de ce dernier de fournir de tels vitraux pour l'église Saint-Paul de Londres. Il ne sera pas donné suite à cette demande.

Concernant la nature des verres fournis par Bernard Perrot, on notera la remarque effectuée par Pierre le Vieil sur leur apparente mauvaise qualité. Il possédait encore en effet en 1774 deux tables de verres de couleur issus des ateliers de Perrot qu'il décrit ainsi "*Elles montrent affez par leur contexture d'un verre dur & épais, & leur furface ondée & raboteuse, combien l'Art de la Verrerie dans ce genre étoit déchu de l'état où il étoit dans le feizième fiecle.*"

Dans son ouvrage sur la cathédrale Sainte-Croix d'Orléans, l'abbé Georges Chenesseau[5] confirme bien qu'une partie des vitraux de la cathédrale d'Orléans a été commandée en 1687 à Guillaume le Vieil. Il précise cependant que suite à de nombreuses réfections, la totalité des verrières exécutées par le Vieil n'a pas été conservée et que seules subsistent à peu près entières les fenêtres hautes de la croisée, et plus particulièrement les deux roses. La restauration de ces dernières, en 2011 et 2012, nous a permis d'étudier un large corpus des éléments de vitraux de la rose du transept sud de la cathédrale.

Les recherches historiques sur la verrerie de Bernard Perrot, menées par Christian de Valence, ont permis récemment de localiser précisément l'atelier de Bernard Perrot rue Notre-Dame de Recouvrance. Nous avons pu ainsi étudier quelques éléments résiduels de verre issus de cet atelier. Le bâtiment dans lequel il se trouvait, qui a subi de profondes transformations dans le 3ème quart du XVIIIe siècle (extension et élévation), venait de changer de propriétaire et était en cours de rénovation. En accord avec l'actuel propriétaire et le Service Régional de l'Archéologie de la Région Centre à Orléans, nous avons pu y suivre les travaux effectués. Si aucun vestige de l'atelier n'a pu être mis en évidence dans le bâtiment, les travaux de piquetage effectués sur un mur de soutènement intérieur ont révélé la présence d'un bloc de verre et de fragments d'éléments de fours de verrier accompagnés d'une multitude de petits déchets de verre. L'élargissement de ce mur, postérieur à la période de fonctionnement de l'atelier, date probablement de l'élévation du bâtiment à la fin du XVIIIe siècle. Les documents notariaux du XVIIIe siècle retrouvés par C. de Valence font état, entre autres, de l'obligation de l'acquéreur du bâtiment de la verrerie de murer et combler l'accès aux caves se situant sous celui-ci. Il est donc fort probable qu'une partie des vestiges de l'atelier ait servi de remblai pour ce comblement et pour les travaux de construction et de consolidation effectués à cette époque. Les

4 Aubenton *et al.* 2011; Gratuze and Arles 2012.

5 Chenesseau 1921.

Rose du transept sud de la Cathédrale Sainte-Croix d'Orléans								
	vitraux bleus		vitraux verts		Vitraux rouges: feuillets rouges		vitraux rouges: feuillets incolores	
oxyde	moyenne	écart type	moyenne	écart type	moyenne	écart type	moyenne	écart type
Na_2O	2,45	0,89	4,54	0,19	4,36	0,29	2,94	1,85
MgO	0,94	0,34	1,40	0,07	1,78	0,11	0,95	0,76
Al_2O_3	1,04	0,06	0,94	0,04	0,86	0,15	0,70	0,43
SiO_2	58,3	1,4	59,2	0,5	53,9	0,8	58,2	2,2
P_2O_5	0,21	0,02	0,23	0,01	0,20	0,01	0,16	0,10
Cl	0,25	0,07	0,45	0,02	0,28	0,09	0,31	0,07
K_2O	9,79	1,21	8,56	0,22	4,07	0,71	10,26	2,48
CaO	4,83	0,81	6,35	0,32	6,83	0,32	4,29	2,82
MnO	0,22	0,01	0,12	0,00	0,16	0,10	0,19	0,12
Fe_2O_3	1,03	0,65	1,53	0,04	0,52	0,06	0,66	0,51
CoO	0,106	0,043	0,0045	0,0003	0,0014	0,0012	0,0051	0,0059
NiO	0,069	0,025	0,0082	0,0003	0,0065	0,0020	0,0053	0,0044
CuO	0,26	0,27	1,38	0,06	1,37	0,12	0,21	0,19
ZnO	0,055	0,052	0,218	0,018	0,901	0,432	0,057	0,049
As_2O_3	0,58	0,07	0,26	0,01	0,03	0,03	0,20	0,17
Sb_2O_3	0,18	0,03	0,12	0,01	0,05	0,01	0,10	0,06
PbO	19,4	3,0	14,4	1,0	24,4	1,2	20,5	6,4
Bi	0,0422	0,0256	0,0016	0,0001	0,0005	0,0005	0,0020	0,0021
UO_2	0,0034	0,0014	0,0002	0,0000	0,0001	0,0001	0,0003	0,0003
Fragments et déchets retrouvés dans un mur de l'atelier supposé de Bernard Perrot, rue Notre-Dame de Recouvrance à Orléans								
	Verre verdâtre		Verre jaune pâle opaque		Verre blanc opalescent		Verre bleu	
oxyde	moyenne	écart type	moyenne	écart type	moyenne	écart type	moyenne	écart type
Na_2O	4,29	1,74	2,05	0,73	3,13	0,13	4,52	0,21
MgO	1,36	0,81	0,88	0,27	0,57	0,07	1,70	0,28
Al_2O_3	2,47	0,49	2,19	0,00	1,75	0,35	1,64	0,39
SiO_2	61,8	3,4	66,7	1,2	59,7	1,2	60,8	1,6
P_2O_5	0,23	0,08	0,42	0,33	0,12	0,04	0,33	0,02
Cl	0,62	0,26	0,49	0,27	0,70	0,11	0,53	0,26
K_2O	8,69	2,29	6,87	0,64	7,36	0,59	7,05	0,18
CaO	5,59	2,22	4,82	1,73	3,72	0,61	8,00	0,40
MnO	0,32	0,17	0,14	0,06	0,16	0,02	1,08	0,07
Fe_2O_3	0,71	0,12	1,61	0,11	0,67	0,20	0,92	0,16
CoO	0,0035	0,0018	0,0012	0,0002	0,0036	0,0020	0,089	0,012
NiO	0,0033	0,0011	0,0026	0,0014	0,0035	0,0014	0,059	0,007
CuO	0,018	0,008	0,094	0,055	0,029	0,005	0,055	0,005
ZnO	0,018	0,008	0,017	0,001	0,017	0,002	0,029	0,006
As_2O_3	0,42	0,41	0,88	1,04	1,60	0,28	0,38	0,08
Sb_2O_3	0,26	0,10	1,98	0,64	0,34	0,04	0,25	0,03
PbO	12,8	5,2	10,6	0,8	19,2	2,4	12,2	2,5
Bi	0,0007	0,0004	0,0003	0,0001	0,0010	0,0006	0,0195	0,0042
UO_2	0,0002	0,0001	0,0005	0,0002	0,0002	0,0001	0,0029	0,0006

Tableau 1 : compositions moyennes (et écart types) des verres de Bernard Perrot retrouvés dans l'atelier de la Rue Notre-Dame-de-la-Recouvrance et prélevés sur la rose du transept sud de la Cathédrale Sainte-Croix d'Orléans. Teneurs en pourcentage massique des principaux oxydes mesurés par LA-ICP-MS.

fragments de verre et de four retrouvés dans le mur ont donc de fortes chances de provenir de l'atelier de Bernard Perrot. Les résultats issus de leur analyse ont été comparés à ceux obtenus sur les œuvres attribuées à Bernard Perrot et sur les vitraux de la rose de la cathédrale.

Les vitraux de la rose du transept sud de la Cathédrale Sainte-Croix d'Orléans

Deux méthodes d'analyse ont été utilisées pour cette étude. La première, la spectrométrie de fluorescence X, a été mise en œuvre au sein des locaux de la société Vitrail France (Le Mans) sur une large sélection de panneaux de verre. La seconde, la spectrométrie de masse à plasma avec prélèvement par ablation laser (LA-ICP-MS), effectuée à l'IRAMAT-CEB (Orléans), a permis d'étudier des petits prélèvements effectués sur des vitraux sélectionnés lors de l'étude par fluorescence X.

Près de 140 échantillons de verre (vitraux de la rose et échantillons conservés dans les collections du Musée d'Orléans) ont été étudiés par spectrométrie de fluorescence X. A partir de ce corpus, une trentaine d'échantillons ont été sélectionnés pour être analysés par LA-ICP-MS.

Au premier abord, les observations visuelles sur l'état de certains des éléments des vitraux viennent confirmer les remarques établies par Pierre le Vieil sur les verres utilisés par son grand-père : la plupart des verres bleus et verts et, dans une moindre mesure, les verres rouges, ont en effet une surface ondulée. Ils présentent, sur une face pour les verres bleus, et parfois sur les deux faces pour les verres verts, un aspect irrégulier (présence de cratères, verre 'bouilli'). On notera ici que, par rapport aux verres bleus et rouges, les verres verts sont décorés d'une grisaille qui implique de les recuire. De larges déformations, et ce qui peut être interprété comme étant l'empreinte d'une sole du four, sont observables sur la plupart d'entre eux. Ces irrégularités de surface ne sont par contre pas décelables sur les verres jaunes, qui ont reçu à la fois une grisaille et une application de jaune d'argent.

Les résultats obtenus sur ce corpus (Tab. 1) montrent que :

- sur vingt-six pièces de verre rouge analysées, vingt-trois sont en verre au plomb et trois sont en verre calco-potassique. Les verres au plomb sont tous des verres rouges au cuivre à structure classique à deux feuillets : un feuillet de verre rouge d'environ 100 à 200 micromètres d'épaisseur, plaqué sur un verre incolore de 1,5 millimètre d'épaisseur,
- parmi les treize verres verts étudiés, douze sont au plomb et un est en verre calco-potassique. On notera que ce dernier n'est pas décoré de grisaille comme il se devrait, il provient probablement d'une restauration récente,
- sur les cinquante-neuf verres bleus analysés, quarante-neuf sont en verre au plomb. Les dix autres verres peuvent être répartis en quatre groupes chimiques. Les caractéristiques du smalt (cobalt) employé pour leur coloration[6] montrent que certains correspondent à des verres modernes, alors que d'autres pourraient avoir été mis en place par Guillaume le Vieil. Ces derniers ont en effet des compositions chimiques proches de celles de la majorité des verres incolores de la rose,
- la majorité des verres incolores et jaunes étudiés (les verres jaunes sont des verres incolores peints au jaune d'argent sur une face), trente-trois sur trente-six, sont de type HLLA (high lime/low alkali).[7] Ils forment un groupe homogène en ce qui concerne les teneurs en chaux, potasse, manganèse, fer, strontium et rubidium. Les trois autres verres s'apparentent à des verres plus récents.

On observe ainsi que la quasi-totalité des verres rouges, bleus et verts étudiés sont des verres plombo-calco-potassiques, renfermant entre 13 et 30 % d'oxyde de plomb, alors que les verres incolores ou jaunes sont des verres calco-potassiques de type HLLA. On notera aussi la présence quasi systématique de faibles teneurs en arsenic et en antimoine au sein des verres plombifères.

Les résultats obtenus mettent aussi en avant une forte hétérogénéité de composition des verres au plomb. Pour les vingt-six verres rouges analysés, on peut ainsi identifier six sous-groupes

6 Gratuze *et al.* 1996; Gratuze and Arles 2012.
7 Schalm *et al.* 2007.

Fig. 1 : A droite, exemple d'état de surface des verres verts au plomb de la rose du transept sud de la Cathédrale Sainte-Croix d'Orléans : on observe la présence de cratères dus probablement à une cuisson des grisailles à une température trop élevée pour ce type de verre. A gauche, déchet constitué de briques et de verre fondu retrouvé à l'intérieur d'un mur de l'atelier supposé de Bernard Perrot, rue Notre-Dame de Recouvrance à Orléans.

de feuillets rouges et quatre sous-groupes de verres supports incolores. On observe de même une très grande variabilité de composition pour les verres au plomb bleus (cinq groupes) et verts (trois groupes). Cette forte variabilité s'oppose à la grande homogénéité de composition rencontrée pour les verres incolores de type HLLA de la rose. Elle vient confirmer les résultats obtenus lors de l'étude réalisée sur les pièces attribuées à Bernard Perrot, qui concluait que ses productions présentent des compositions très diverses.[8] Cette variabilité traduit probablement le fait que Bernard Perrot n'utilise pas de recette précise, mais fabrique ses verres en ajoutant de l'oxyde de plomb à du groisil. Les compositions changeantes de ce dernier influent alors fortement sur celles des productions de l'atelier.

On notera aussi la grande similitude de composition observée entre la composition du verre de la couche incolore d'un des verres rouge de la rose, et celles des portraits en verre de Louis XIV et du duc d'Orléans, fameuses œuvres de Perrot (Orléans A.7162 et Louvre OA.11378, no. cat 111 et 114).[9]

Concernant l'aspect des verres verts, on peut faire l'hypothèse que Guillaume le Vieil, habitué aux verres calciques de son époque, a appliqué le même protocole de cuisson aux verres incolores de type HLLA et aux verres verts de Bernard Perrot. Or, ces derniers sont à base de fondant plombifère, ils ont donc des caractéristiques thermiques différentes de celles des verres calciques incolores (températures de fusion, de ramollissement et de travail plus faibles). Il est ainsi fort probable que la cuisson de leur grisaille a été effectuée à une température trop élevée, ce qui a engendré leur déformation et leur aspect bouilli.

Les verres de l'atelier de la rue Notre-Dame de Recouvrance

Vingt fragments de verre, découverts dans un mur de soutènement situé dans l'ancien atelier supposé de Bernard Perrot, ont été analysés par LA-ICP-MS. Parmi ces verres se trouvent quatre fragments bleu cobalt, deux jaune pâle opaques et deux blancs opalescents. Les autres fragments sont de teinte verdâtre ou incolore. Comme dans le cas des objets et des vitraux,

8 Biron *et al.* 2011.
9 Biron *et al*. 2010.

les résultats obtenus sont caractérisés par une grande variabilité. Les teneurs en oxyde de plomb mesurées varient de 0,3% à 21 % (Fig. 1). La composition de base du verre correspond à celle de verre calco-potassique à fortes teneurs en soude. On observe la présence de faibles quantités d'arsenic et d'antimoine dans tous les verres, comme cela a été observé pour les vitraux.

On notera plus particulièrement que :

- les verres bleu cobalt étudiés présentent des compositions similaires à celles des vitraux de la cathédrale, ainsi qu'à celle d'un verre bleu cobalt au plomb présent sur une petite statuette d'Eros (no. cat. 62),[10]

- les verres jaune pâle opaques contiennent de fortes quantités d'antimoine (1,5 à 2,3% de Sb2O3),

- les verres opalescents présentent de fortes teneurs en arsenic (1,3 à 1,9 %) et ont des compositions proches de celle de l'aiguière du musée d'Ecouen (ECL 86026 no. cat 46).[11]

Ces échantillons s'inscrivent donc totalement dans la gamme de variabilité des compositions rencontrées pour les autres productions de Bernard Perrot, à savoir les vitraux et les objets qui lui sont attribués. Il y a donc de fortes probabilités pour que ces échantillons proviennent bien de l'atelier orléanais de Bernard Perrot.

Conclusion

Les résultats obtenus sur les trois ensembles de verres attribués à Bernard Perrot (œuvres de musées, vitraux de la Cathédrale Sainte-Croix d'Orléans et déchets de l'atelier de la rue Notre-Dame de Recouvrance à Orléans) mettent en évidence une large production de verres au plomb par ce verrier. On observe cependant une grande variabilité de composition au sein de cet ensemble, qui traduit probablement le fait que Bernard Perrot fabrique ses verres en ajoutant des quantités variables de plomb à du groisil. Cette variabilité ne reflète probablement pas une progression chronologique mais plutôt une évolution constante des recettes et des compositions des matières premières employées par Perrot. En effet, si l'on fait l'hypothèse que les vitraux de la Cathédrale Sainte-Croix on été produits sur une courte période entre 1687, date de la commande des vitraux à Guillaume le Vieil et la fin de l'année 1689 date de la facture publiée par Pierre le Vieil, on observe que leurs concentrations en plomb varient entre 13 et 30%, et qu'ils correspondent à de multiples fusions de compositions fort différentes.

Si l'on compare les compositions de cet ensemble d'objets avec celles des verres au plomb produits au cours de la même période par Ravenscroft[12] et l'atelier de verriers hollandais de Groningen,[13] on observe que les verres de Bernard Perrot sont plus proches des productions de l'atelier de Groningen que de celles de Ravenscroft. Les verres de Ravenscroft sont en effet essentiellement plombo-potassiques, contrairement à ceux de Perrot et de Groningen qui ont des compositions calco-alcalines beaucoup plus variables.

La production des vitraux au plomb de la Cathédrale Saint-Croix d'Orléans, et probablement aussi des portraits à la fin des années 1780, montre donc que Perrot a, à cette période, une bonne maîtrise de la fabrication et de la mise en œuvre du verre au plomb. On peut donc supposer que les premières productions de ce type de verre par Perrot remontent pratiquement à la même période que celle de Ravenscroft, au cours des années 1770. On observe ainsi que les productions de Bernard Perrot s'inscrivent pleinement dans celles du courant de verriers alchimistes du 17e siècle.[14]

10 Biron *et al.* 2010.

11 Biron *et al.* 2010.

12 Brain and Dungworth 2009; Moretti and Zecchin 2009.

13 Muller and Stege 2009.

14 Kerssenbrock-Krosigk 2008.

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THE GLASS COLLECTION OF KING FERDINAND II OF PORTUGAL – ASSEMBLING THE PUZZLE

The purpose of this paper is to present the results of a research project, which is being carried out in order to understand how such a distinct collection arrived in Portugal in the mid-19th century. The commission circuits, the links with the House of Saxe-Coburg and Gotha and its connection with Ferdinand II's group of stained-glass panels will be revealed once the following is taken into consideration: 1) records in the archives of Ferdinand II's Private Office; 2) secondary sources 3) information on the glass composition obtained through non-destructive techniques such as energy-dispersive X-ray fluorescence (EDXRF).

This project brings together Parques de Sintra – Monte da Lua, entrusted with the management of Pena Palace, and the research unit Glass and Ceramics for the Arts (VICARTE) from Universidade Nova de Lisboa.

Introduction

This paper aims to present the preliminary results of a joint project between Parques de Sintra – Monte da Lua, SA and VICARTE, which was established to undertake research on the glass collection of King Ferdinand II of Portugal. Three major issues will be addressed: the identification of objects in the original collection of Ferdinand II; the study of the collection in the context of the House of Saxe-Coburg and Gotha collections; and the challenges of identifying the production centres of the objects.

Ferdinand II of Saxe-Coburg and Gotha

Ferdinand of Saxe-Coburg and Gotha (1816-1885), king-consort of Portugal by marriage to Queen Maria II, played a major role in the cultural arena of Portugal in the 19th century. His actions as patron of the arts and industry, his concern for the protection of historical heritage and his frequent acquisitions of artistic objects for his personal collection led to some considerable achievements.[1] During his lifetime, he assembled all kinds of paintings, ceramics, furniture, silverware and glass. Among these, Ferdi-

1 For more information about King Ferdinand II, cf. Teixeira 1986.

nand's interest in glass is the most noteworthy, which is attested by both his commissions of stained glass and the creation of a Glass Room in the main royal palace of Lisbon, the Necessidades Palace.

Ferdinand II and Glass

Evidence for King Ferdinand's fondness for glass is indicated by: 1) his decisions that led to the protection of extant stained glass windows 2) his commissions of new panels 3) the acquisitions for his collection. By supporting the restoration of the Batalha Monastery, Ferdinand guaranteed the preservation of the largest and the most ancient group of stained glass in Portugal, dating back to the mid-15th century. Concerning commissions for new panels, Ferdinand had panels for the window facing the chapel altar in Pena Palace produced in Nuremberg.[2] In addition, it is almost certain that he was behind the decision to introduce stained glass windows in the chapel of Sintra Palace during the restoration works of the 1860's.[3] Finally, as a private collector, Ferdinand assembled a group of isolated stained glass panels dating from the 14th to the 19th century, which is the widest in scope of European stained glass to be found in Portugal.

Concerning glass objects, Ferdinand owned a collection of ca. 200 pieces in Necessidades Palace that were on display in a room, named in documentation as the Glass Room.[4] The inventory of the contents of the palace after the King's death in 1885 lists the objects in the room, which allows us to understand the extent of the collection. By 1910, when the Republic was established in Portugal and the room was sealed, the collection had increased to 272 pieces, which suggests that the King's taste was shared by his successors.[5] In 1956-1957, this collection was scattered throughout the National Museum for Ancient Art in Lisbon, Pena Palace and some other locations.[6] There was never a Glass Room inside Pena Palace, but there was a showcase in a hallway where some important pieces were displayed. According to an inventory of 1887, ca. 45 glass objects[7] were in the showcase,[8] among them an opal glass beaker with Tritons and Nereids (PNP1182) that, thanks to the work of Olga Drahotovà, is dated to the 1680s and is known to come from the Buquoy workshops of Gratzen in Southern Bohemia.[9] In the same

Fig. 1: Tazza, possibly 17th century. Venetian or a la façon de Venise, h.7,5 x Ø27cm, Pena Palace, acc.n.PNP279.

2 Teixeira 1986, 311.

3 There is evidence of restoration works in the chapel of Sintra National Palace during the 1960s (cf. SIPA 1990-2011, PT031111110006). Furthermore, Pena Palace holds a collection of 37 stained glass panels from the 19th century that match the dimensions and number of windows of that chapel.

4 Obras d'arte começando pela porta d'entrada (...) 1886.

5 Arrolamento do Palácio das Necessidades 1910.

6 The inventory records of the glass collections of Pena Palace and the National Museum of Ancient Art hold supporting documentation with lists of the pieces transferred from Necessidades Palace in 1956/1957. The National Museum of Archaeology in Lisbon also has 15 objects that were transferred from the Necessidades Palace in 1947. The objects are: MNA35002, 35003, 35004, 35005, 35006, 35007, 35008, 35009, 35011, 35012, 35013, 35014, 35015, 35018, 35295. It is known from the Necessidades Palace inventory of 1886 (cf. reference 5 above) that Ferdinand had ca. 20 Roman excavated glass objects in his collection; however, no direct relation can be established with the pieces in the National Museum of Archeology. Finally, there are also three objects in Queluz Palace (PNQ36A, PNQ37A, PNQ38A), which originate from the Necessidades Palace.

7 The materials are not always identified, which means there is a margin of error in this number.

8 Moveis existentes no Palácio da Pena em Cintra 1887.

9 Drahotová 2008, 79-83.

Fig. 2: Flask, 18th century (second half), Marinha Grande, Portugal, h. 21,5cm, Pena Palace, acc.n.PNP293.

showcase, there was also a *tazza,* which is a fine example of Venetian mastery of the *filigrana* technique (PNP279, Fig. 1). It is the quality of such pieces which leads to the first question of this paper: Which objects did the collection consist of?

Ferdinand's glass collection – a preview

From the inventories of 1886 and 1887, it is known that the original collection comprised of around 250 objects. According to the same documents, there were Venetian, Bohemian, Iberian, German and ancient Roman glass pieces. There are, however, two obstacles in expanding our knowledge of Ferdinand's collection. Firstly, many of the attributions made by the author of the inventories may be erroneous while extensive misinterpretations are likely to have occurred. Secondly, due to the very laconic descriptions, many of the objects referred to in the inventories cannot be identified. To overcome this hindrance, we crossed the inventories of 1886, 1887 and 1910 with the extant pieces in Portuguese museums and palaces. As a result, we were able to identify some of the pieces that were added to the collection during Ferdinand's lifetime.

From these objects, it is worth highlighting pieces that are representative of the diversity of the collection. Within the group of Venetian or *a la façon de Venise* production, the references of the Pena Palace inventory to a small bottle with wings, a pink *copo* and a basin with wedges correspond almost certainly to the objects PNP282, PNP280 and PNP279 respectively.[10] In the Glass Room of Necessidades Palace there were two enamelled tazze and five salvers, which should be among those displayed today in the National Museum of Ancient Art: MNAA970 Vid and MNAA974 Vid; MNAA964 Vid, MNAA969 Vid, MNAA971 Vid, MNAA975 Vid, MNAA977 Vid and/or MNAA976 Vid.[11] Concerning German glass, the most important pieces were kept in Lisbon during the King's lifetime; however, today the enamelled Humpen for instance, are kept in Sintra (PNP255, PNP256, PNP258, PNP261 as well as the enamelled beaker PNP265 and goblet PNP264).[12] There was also a group of objects with figurative shapes: a pistol (MNAA961), a trickglass (PNP272), a dove (MNAA952) and a barrel (PNP277) among others.[13] Iberian production was not forgotten and there are some examples from Coina and Marinha Grande in Portugal, and La Granja in Spain (such as PNP292, PNP293 (Fig. 2) and PNP290 respectively).[14] To conclude this preview of the collection, it is

10 Moveis existentes no Palácio da Pena em Cintra 1887.

11 Obras d'arte começando pela porta d'entrada (...) 1886.

12 Most references are very laconic, but numbers 831 and 832 specifically refer to "Duas jarras em forma de canudos com tampas e esmaltados a cores" (PNP255 e PNP256). Obras d'arte começando pela porta d'entrada (...) 1886.

13 Obras d'arte começando pela porta d'entrada (...) 1886; Moveis existentes no Palácio da Pena em Cintra 1887.

14 Moveis existentes no Palácio da Pena em Cintra 1887.

worth noting a group of objects that were kept in the Necessidades and Pena Palaces before 1910, but that do not correspond with the descriptions: the jar MNAA1002, the flask PNP618, the ruby-glass goblet PNP275 and the vase PNP1215.[15]

The glass collections of Ferdinand and Alfred

The glass collection of Ferdinand has striking similarities with the collection of his second cousin Alfred III, Duke of Saxe-Coburg and Gotha, an unsurprising fact given their common family background. Ferdinand was a descendant of Francis, Duke of Saxe-Coburg-Saalfeld, and a first cousin of Queen Victoria and Prince Albert. Ferdinand was also the first cousin of Ernest II and the second cousin of Alfred, Duke of Edinburgh, later known as the III Duke of Saxe-Coburg and Gotha. These close family relations are particularly revealing with regard to the reasons underpinning the king-consort's interest in collecting. In fact, there are at least three other great art patrons and collectors among his relatives (Ernest, Albert and Alfred) while similar patterns of collecting practices can also be recognised. In 2006, a conference in Coburg revealed the strong connections that can be identified between the collections of the House of Saxe-Coburg and Gotha and that of Coburg and Windsor.[16] Photography, prints, weapons, ceramics and glass are common interests and the typology of Ferdinand's glass collection respects those same patterns.

A parallel has already been established by Anna-Elisabeth Theuerkauff-Liederwald between the collection in Coburg and the collection assembled by Felix Slade (1790-1868), today in the British Museum, as well as the role of Sir Wollaston Franks (1826-1897), who was Keeper of British and Mediaeval Antiquities and Ethnography at the British Museum from 1866, in the organization of Slade's collection and his relationship with Prince Albert.[17] It is very hard

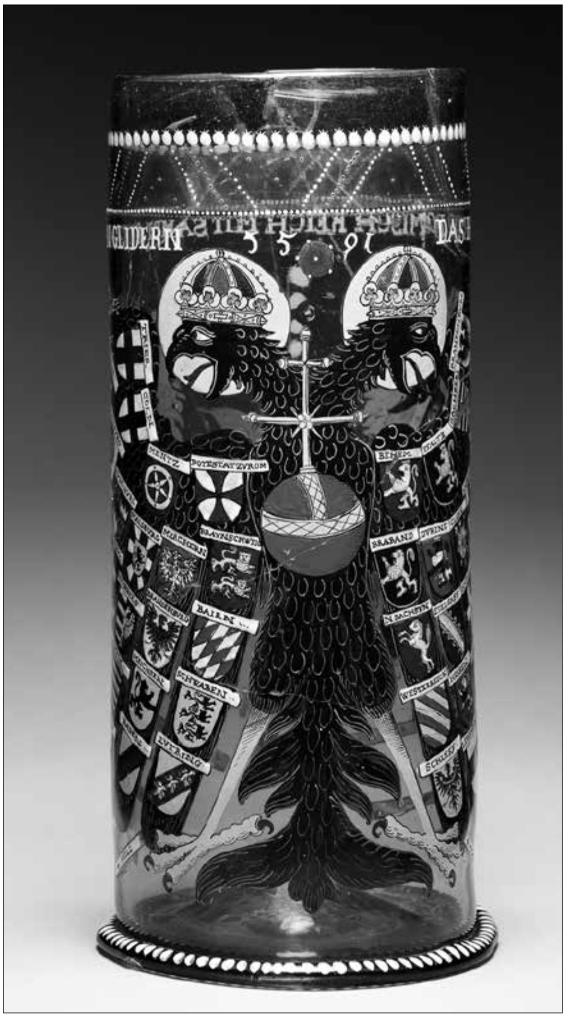

Fig. 3: Humpen, 1570-1590, Germany, h. 32,2 x Ø14,8cm, Pena Palace, acc.n. PNP257.

to believe that Ferdinand was unfamiliar with this network of events. Although considerably smaller in extent to that of his second cousin, Ferdinand's collection - regarded as an isolated group within a greater art collection-[18] is equally eclectic and discloses the collector's fascination for the form.

Like Alfred, Ferdinand assembled a wide variety of typologies in a single room, or show-case at the Pena Palace, which is reminiscent of the manner of a Wunderkammer. Unfortunately, there is no surviving picture from the Glass Room that reveals the display scheme. Neverthe-

15 Arrolamento do Palácio das Necessidades 1910; Arrolamento do Palácio da Pena 1910.

16 Bosbach and Davis 2006.

17 Theuerkauff-Liederwald 1994, 14-16.

18 No other group of works of art have a special designated space in the Necessidades Palaces, such as the Glass Room. Obras d'arte começando pela porta d'entrada (...) 1886.

Fig. 4: Humpen, 1864-1885, Germany, attr. Rheinische Glashütten AG, Ehrenfeld bei Köln, h. 55,3 x Ø16,2cm, Pena Palace, acc.n. PNP255.

less, the interpretation of the inventories and the extant objects allow a comparison between the pieces which, most probably,[19] belonged to Ferdinand's original collection and pieces from the Herzog Alfred collection. Therefore, Venetian pieces, or *a la façon de*, originating from all periods since the early 16th century can be found in both collections: enamelled tazze (MNAA970; HA284), milkglass tazze (MNAA997; HA721) filigree plates (MNAA964; HA535), goblets (MNAA1124; HA495), vases and flasks (MNAA1215; HA548 / MNAA1045; a.S.614) and small cruets (MNAA288; HA388) among many others. There are also several examples of Bohemian and German glass, which raises major interest due to the quality of the engraved (PNP268; a.S.302) and enamelled (MNAA1086; a.S.305) decoration respectively.[20]

Another reason to support the theory that Ferdinand was aware of his cousins' collecting practises is the time period when most acquisitions took place. Theuerkauff-Liederwald indicated 1865-1888 as the most credible period for Alfred to have made these acquisitions.[21] In the archive of the Private Office of King Ferdinand, several receipts have been found. At least 60 glass objects are mentioned, bought between 1859 and 1864.[22] This time period is very close to that of Herzog Alfred. Besides, the period when Ferdinand made these acquisitions is contemporary to the creation of the South Kensington Museum in London. This is an important fact, because the most striking characteristic of these receipts is that the majority belong to art dealers, who were also providing objects for the South Kensington Museum.

Commission circuits for Ferdinand's glass collection

In fact, the receipts were issued from ten different art dealers in five cities although the majority of the objects were bought in Lisbon (24). However, during a journey around Europe in 1863, Ferdinand made several acquisitions in Florence (8), Munich (7) and Paris (7). In Florence, Ferdinand brought Venetian gob-

19 We would like to stress that there are many other excellent objects, which originate from the Necessidades Palace that may be relate to King Ferdinand, but the descriptions do not allow a direct connection to be made.

20 The accession numbers refer to the collections of the National Museum of Ancient Art in Lisbon, Pena Palace in Sintra and the Veste Coburg.

21 Theuerkauff-Liederwald 1994, 17-18.

22 Archive of Fundação Casa de Bragança, Vila Viçosa, Núcleo D. Fernando II: Doc. Avulsos, Maços 402, 1863, and Envelope 1863-1867, 5ª Sala; Contas e Documentos de Sua Magestade a Países Estrangeiros, Maço 3, 1863; Livro de Documentos de Despeza september – December 1862, February and April 1863, January and September 1864.

lets to Tito Gagliardi and several *tazze* to Antonio Rusca. According to Mark Westgarth, Tito Gagliardi is known to have made several visits to London to sell art objects to the South Kensington Museum during the 1860s.[23] In 1859, Antonio Rusca sold objects to the same museum through his director, Henry Cole (1808-1882).[24] In Munich, Ferdinand bought cut glass objects from A. S. Drey. According to the same author, Henry Cole considered Drey one of the most renowned art dealers in the city during from the 1860s-1870s.[25] Finally, Luis-Auguste-Alfred Beurdeley (1808-1882) presents an interesting link to Ferdinand in light of the Portuguese king-consort's purchase of seven Venetian objects in Paris. Beurdeley was one of the most famous cabinetmakers in Paris, supplying furniture for many European royal families, including the Garde Meuble Imperial of Napoleon III. One of his many clients was the Duke of Nemours[26] whose wife, Victoria of Saxe-Coburg-Koháry, was Ferdinand's own sister. The temptation to relate Luis-Auguste-Alfred Beurdeley to Ferdinand through his sister is great; however, no document exists to support this idea.

The following year, King Ferdinand acquired an entire art collection in Dresden although its provenance is unknown. The list of objects includes Venetian glass, Flemish sandstone jugs, porcelain, sculpture, stained glass and silverware. The Venetian glass group comprises 16 pieces. In addition, two other pieces were bought in Dresden: a large glass (*copo*) with the Prussian Coat of Arms and a smaller one representing a Roman triumph. The latter two correspond most certainly to the goblets MNAA43 and MNAA44, today in the National Museum of Ancient Art.

Independent of our research results into the places where Ferdinand bought these objects; it is also relevant to know where they were produced. In order to answer this last question, it is necessary to analyse the materials.

23 Westgarth 2009, 106.
24 Westgarth 2009, 159.
25 Westgarth 2009, 89.
26 Lébard 1965.

Analysis of glass composition by micro-EDXRF

Preliminary chemical characterization of glass objects was undertaken very recently by non-destructive multi-elemental analysis by energy-dispersive micro X-ray fluorescence spectrometry (μ-EDXRF). These non-destructive techniques were performed using a portable spectrometer Amptek, equipped with an X-ray tube Mini-X, Ag X-ray source and a detector X 123SDD. Measurements were carried out directly on the surface of the objects without any previous preparation. Each fragment was measured at three different points on the surface while only a single measurement was taken at each point. The measuring conditions were the following: voltage 15 kV; intensity 15 μA; and live time 300 s. WinAxil analytical software was used for the quantification of major and minor element oxides and the fundamental parameter method was combined with calibration using the glass standards CMOG C, B and D.

The study started with the analysis of the Humpen, because certain dating issues required investigation.

Throughout the 16th century, the regions of Franconia, Bohemia and Thuringia specialised in the production of these types of object, reflecting the role of beer in Germanic culture; indeed, these beakers were intended to be shared by several guests. Humpen were generally manufactured with potash glass (Waldglass) and bore a greenish tone. Nevertheless, many glassblowers were trying to achieve a more clear glass, closer to the Venetian colour, and so by the end of the 16th century and the beginning of the next, a potash greyish glass was obtained. During the 19th century, revivalist movements saw in Humpen a symbol of the national culture and reproduced many 16th and 17th century models. 19th century examples were often of deliberately low quality and were generally given a greenish tinge in order to replicate the colouring of the Waldglas.

In the collection under study there are several Humpen dating from different periods.

Humpen PNP257 (Fig. 3) exhibits several characteristics that may allow dating to be attributed to the end of the 16th century: a greyish tone, schematic representation of the holy empire eagle and painted in very dark enamel. According to the literature, these are characteristics of Humpen produced between 1570 and 1590 in Bohemia.[27]

However, other Humpen present different characteristics, which raises some doubts concerning the relation between the inscribed date and the date of production. For example, they have too many bubbles that look like a deliberate attempt to produce objects with a certain degree of imperfection.

Finally, Humpen PNP255 (Fig. 4) has several features that allow us date it from the 19th century. Firstly, it is an element of a pair while during the 16th and 17th century, unique pieces were produced. Moreover, the lids are made in one piece whereas two parts were normally used to produce lids in the 17th century: the cover and the handle. Finally, the greenish tint of the glass points to an attempt to obtain green Waldglass[28] on purpose.

From the results obtained, all glass may be classified as potash glass and high-lime low-alkali glass. The glass of the analyzed samples contains SiO_2 from 53.5 wt% to 64.1 wt%, K_2O from 7.6 to 24.3 wt%, $Na_2O + MgO$ from 1.2 to 2.7 wt% and CaO from 11.8 to 17 wt%. It was possible to see that 19th century Humpens have a lower potash content a and higher silica content, while a higher amount of potassium oxide and a lower silica content were found in the objects dated from the 18th century. However, these results are only the first step in this study and therefore, further analyses are necessary. The results obtained were not conclusive, and so it is very important that these are compared with other results acquired for different collections. Unfortunately, to the best of our knowledge, no results on glass composition used to produce Humpen have yet been published.

Final considerations

The study of a diverse collection such as the one owned by King Ferdinand II reveals how broad and multidisciplinary the approach must be. Therefore, this project has brought together art history methodology and conservation studies in order to have a more comprehensive historical interpretation of these objects. Nevertheless, the study also demonstrated how scant our knowledge still is with regard to the chemical composition of objects from other collections; knowledge that is necessary in order to establish a pattern for European glass pieces produced during the Early Modern Age - in particular glass used for the production of Humpen.

27 Saldern 1965, 66.

28 During the second half of the 19th century, Rheinische Glashütten AG, Ehrenfeld bei Köln produced several revival glass pieces with similar characteristics to the object PNP255.

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RATAJ Jože

THE GLASS INDUSTRY IN THE REGIONS OF CELJE AND KOZJANSKO FROM THE MID-17TH CENTURY TO PRESENT DAY

The glass industry in the regions of Celje and Kozjansko has a noteworthy tradition, the development of which may be primarily attributed to the availability of wood. Wood was used not only to fuel muffle furnaces, but also to produce potash, which was then one of the most important raw materials in the production of glass. Due to this, glass and charcoal production were the most fundamental industries to take advantage of the lush forests located in largely inaccessible areas. The finds of late medieval glassware fragments are evidence that, in this region as well as elsewhere, Forest glass (or *Waldglas)* - aptly named due to its production in factories known as glasshouses - was well established. In the production of Forest glass, potash, itself derived from wood ash, was added to quartz sand. Products made from such glass were opaque and have a greenish-brownish tint due to the presence of metal oxides in the raw materials.

In the Slovenian part of Styria, the glass industry was mainly concentrated in two areas: Pohorje and the regions of Celje and Kozjansko. The history of the glass industry in Pohorje was thoroughly chronicled by Franc Minařik in his fundamental work, "*Pohorske steklarne*" (1964)[1] and Valentina Varl in "*Pohorsko steklo – steklo z dušo*" (2006).[2] In addition to the works indicated above, numerous articles are also available in professional publications.

The Celje and Kozjansko regions, on the other hand, were mostly ignored. To complement the elementary information recorded in the publication of Johann Slokar, entitled "*Geschichte der österreichischen Industrie und ihre Förderung unter Kaiser Franz I.*" (1914),[3] Hanns Guss published an article in the *Zeitschrift des historisches Vereins für Steiermark* in Graz in 1978,[4] which also provided the first systematic study performed on the subject.

The article encouraged many individuals to begin the orderly examination of glassmaking. The result was a series of articles by Vilko

1 Minařik 1964.
2 Varl 2006.
3 Slokar 1914.
4 Guss 1978.

Ivanuša,[5] Mitja Cimperšek,[6] Mateja Kos[7] and Jože Rataj.[8]

In the 17th and 18th century, glassmaking was not only considered an industry, but also an art (*Ars vitraria*). Several important factors contributed to the development of the glass industry, but the most important is surely the abundance of wood in the forests of Pohorje and Kozjansko. Here, as the glass industry developed from the mid-18th century onwards, manufactured products were of a superior quality. Glasshouses in the area were founded by the aristocracy on its own land, for which they did not require special permission, because glasshouses were considered an integral part of a feudal lord's domain. After the abolishment of feudalism, glasshouses were leased by the aristocracy. Most commonly, glasshouses were founded on the basis of concessions, which were granted by the authorities. In this period, numerous new glasshouses were founded by glassmakers, who ensured the provision of the required quantities of wood through special agreements concluded with the aristocracy. Townspeople also established glasshouses in a similar fashion.[9]

Fig. 1: Glasshouse Straža.

Fig. 2: Glashouse Rakovec around 1840.

Glasshouses founded by monasteries, such as the one at the Žiče Charterhouse near Slovenske Konjice, held a special status. This glasshouse was erected on the estate of the Žiče Charterhouse and was simultaneously the largest consumer of glass products made in its own glasshouse.[10] The mid-18th century saw the establishment of many new glasshouses. Their life expectancy was primarily dependant on the size of the surrounding forests, which provided the raw materials required for their operation.

Glasshouses in Slovenia were primarily occupied with the production of green-coloured stained glass as well as colourless glass. It is evident from reports of preserved glass products and fragments found at locations where glasshouses once stood, that milk and multi-coloured glass was also produced. In the 18th and 19th century, glasshouses were also engaged with the production of more complex products, along with simple glassware - their efforts being on a par with the rest of Europe. However, at certain glasshouses during this period, production was limited to the blowing of utilitarian green-coloured glass products. The production process in glasshouses which were later extended, or which were already designed as larger plants, was complemented by more complex techniques, such as the addition of glass at the hot end of the furnace. Products were also polished, cut and engraved.

Two glasshouses were already located on Slovenian territory by the 17th century, namely the glasshouses at Žetale in the Macelj forest and at the Žiče Charterhouse. The glasshouse located in the Macelj forest, northeast of Žetale, was erected on the property owned by the House of Eggenberg. The House of Egg-

5 Ivanuša 1960.
6 Cimperšek 1986.
7 Kos 1991.
8 Rataj1994.
9 Rataj 2005.
10 Zelko 1984; Minařik 1964.

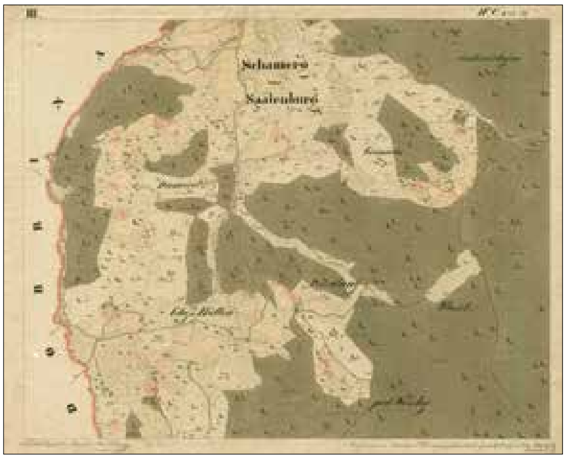

Fig. 3: Franciscan Cadastral, location of the glasshouse in Hrastje.

Fig. 4: Glasshouse in Loka pri Žusmu.

enberg also possessed glasshouses located on their estates in southern Bohemia. Later on, these territories passed into the possession of the House of Schwarzenberg. In 1624, Hans Ulrich Eggenberg purchased the Gornji Rogatec estate, which was then divided by his son, Johann Anton, between his own two sons: Johann Christian, who assumed possession of the territories of Moravia and Bohemia; and Johann Seyfried, who inherited estates in Styria.[11] The brothers concluded an agreement on the 30th June 1665, which also included glass production facilities in the Macelj forest. A clear indicator of this agreement is the letter sent by Johann Eggenberg to his brother, Johann Christian, in Krumau, southern Bohemia. In the letter, he mentions the death of the glassmaker at Macelj and asks his brother to dispatch to him a new master, capable of producing quality white glass while referring to favourable working conditions. The master dispatched by Johann Christian was named Pankratz Piebl (also Puebler),[12] who had previously held the position of master at the Bavarian glasshouse in Duschlberg (in 1688 and from 1692–1701) as well as at the Habelsperg glasshouse (1690), the Sonnenschlag glasshouse in Upper Austria and the glasshouse at In der Eich, owned by royalty.[13] From there, he left for Žetale in Rogatec. His son, Josef Puebl, had acquired an old glasshouse previously owned by the House of Schauregger, located on the border with the Thallerberg domain. These names were the first to be associated with the glasshouse located within the Gornji Rogatec estates. It is also interesting to note that the information provided by Ignac Uhl, the Rogatec (Strmol) estates caretaker from 1811, stated that glass had already been in production for 150 years at the Gornji Rogatec estates.

The Gornji Rogatec glasshouse was succeeded by the Dobovec glasshouse, which commenced operation in 1710. The latter was constructed when the estates were owned by the House of Leslie. Carl Cajetan Count Leslie married Marija Theresia Josepha, the daughter of Count Eggenberg.[14] This glasshouse had already started production during the period of introduction of the Teresian Cadastre. According to the Cadastre, the value of the ancient beech forest surrounding the glasshouse was estimated to be 1500 guldens while the glasshouse itself generated only 629 guldens of income. In the period when the Dobovec glasshouse was operational, Johann Blasius Schurey was the estates manager. Between 1758 and 1762, he was involved in a judicial dispute with Valentin Voith, the resolution of which took place in the royal chambers in Vienna.[15]

In addition to the aforementioned glasshouses located within the Gornji Rogatec estates, a glasshouse along the border river Sotla also existed and was listed in archival docu-

11 Guss 1978.

12 Roth 1976.

13 Rataj 1994.

14 Guss 1978.

15 Guss 1978.

ments as the Log glasshouse. It was primarily concerned with the production of mineral water bottles. This is supported by data for 1773, when the stock of mineral water bottles totalled 114,000.[16] The bottles were used to hold water from nearby mineral water springs in the vicinity of Rogaška Slatina. The glasshouse employed 25 loggers and 40 glassmakers.[17] The raw materials were supplied from within the vicinity and also produced the required amounts of potash by itself. The glasshouse was granted provincial privileges due to the quality of its products. Due to extended production, the glasshouse faced a shortage of wood in the area. Consequently, Windischgrätz purchased forests on the other bank of Sotla from the House of Drašković.[18] This meant that a substantial amount of wood was delivered from Croatian forests. In the mid-19th century, a major competitive glasshouse appeared. Using lignite to power its furnaces, it was constructed behind the Croatian border at Straža near Rogatec by Michael von Poschinger from Theresienthal in the Bavarian Forest.[19] This glasshouse finally sealed the fates of every small primitive glasshouse in the area.

On the other side, on the edge of Pohorje, the Žiče Charterhouse glasshouse was also operational. Two glasshouses were constructed here although the date production commenced remains unknown. In studying the history of the Žiče Charterhouse, Štefan Zelko discovered that the first glassmaking records date back to the 17th century. These records show that a glassmaker was godparent to another person (1641). By the following year, information already existed about the children of three glassmakers. Consequently, civil registers have kept track of glassmakers since 1750.[20] Why a glasshouse was constructed within the monastery estates is often a matter of debate. The reasons for this were mostly utilitarian since glasshouses were involved in the production of glass panes, vessels for food and liquids, apothecary containers and even laboratory glassware. The glassware yielded additional funds for the monastery. The first glasshouse was supposedly operating until 1700 with a large stock of glassware recorded in its 1699 inventory, including glass panes, bottles, drinking vessels, metal cap bottles and "Angsters." The second glasshouse was erected by Johann Christian Tattenbach, prelate of the Žiče Charterhouse. This glasshouse operated until approximately 1764 and employed seven glassmakers and workers who produced potash, which is included in the 1699 inventory. Several renowned glassmakers were employed at this glasshouse, such as Johannes Guny, Thomas Sablitsch, Michael and Nicolaus Glitschwert, and Martin Eysner, who later moved on to work at other glasshouses in Pohorje or within the Celje region.

Michael Giltschwert was also the first glassmaker involved with the old Vitanje glasshouse in the 18th century. Not much is known about the old Vitanje glasshouse although plenty of information is available regarding its successor at Rakovec above Vitanje, which operated from 1781 until 1874. Here, the Krško diocese had sold the forests to Jožef Dienersberg, who was succeeded by Raimund Nowackh.[21] In his period, the glasshouse was granted provincial privileges and thus became one of the largest in the area. Benedikt Vivat, who later owned glasshouses in Pohorje, was also raised at the Rakovec glasshouse.[22] During the time the glasshouse was owned by Rajmund and Ignaz Nowakh, it was awarded medals for its quality products at the Inner Austrian exhibitions in Klagenfurt during 1838 and in Graz during 1841. In the middle of the century, ownership of the glasshouse was transferred to Joseph Mathias Wokaun, who then abandoned the glasshouse in 1874 and sold the forests to Count Thurn. The glasshouse relied on its own quartz sources, producing its own potash and decorated glass products at its workshops.[23]

In the heart of the Kozjansko region, two glasshouses were operating in the middle of

16 Cimperšek 1982.
17 Orožen 1951.
18 Ivanuša 1960.
19 Cimperšek 1986.
20 Zelko 1984.
21 Minařik 1964; Varl 2006; Kos 1991.
22 Varl 2006.
23 Šorn 1984.

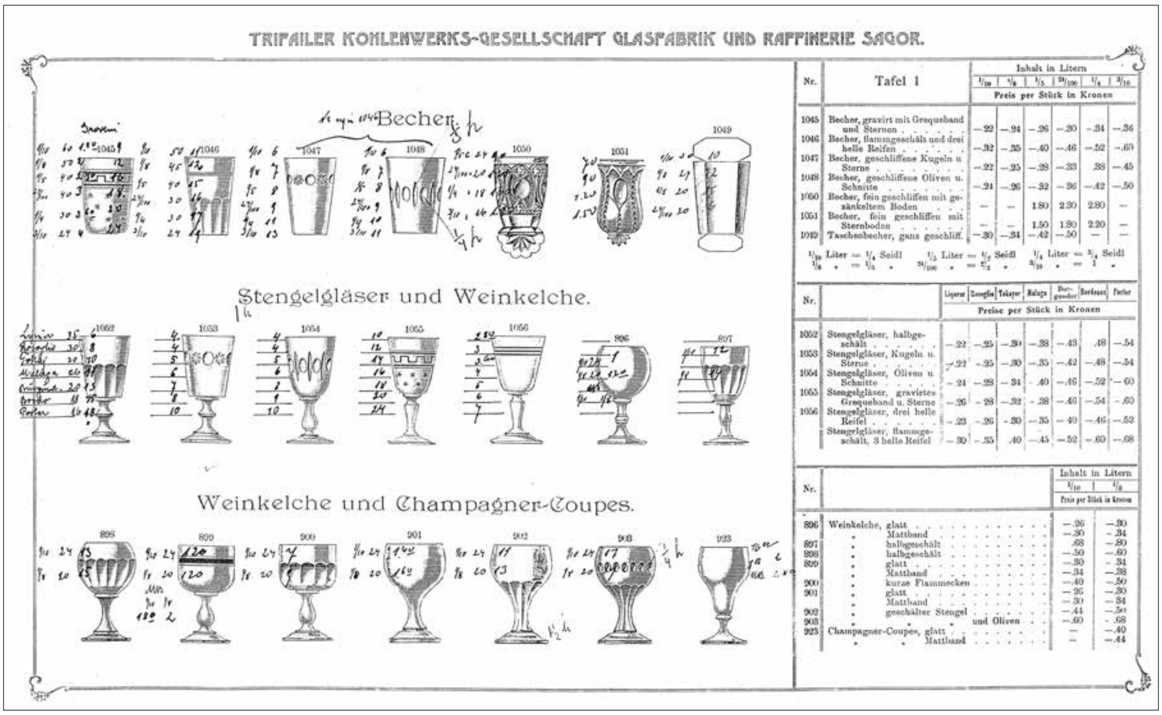

Fig. 5: Catalog of products of glass factory in Zagorje ob Savi, 1896.

the 18th century. They were constructed by the owner of the Kozje and Sevnica estates, Jacob Anton Freyherrn von Wintershofen. These two glasshouses are referred to in the Teresian and later in the Franciscan Cadastre, as well as in numerous archival documents. In 1754, four glassmakers were recorded in the registers of the Kozje Parish while twenty years later, seven were listed.[24] After the death of Wintershofen, his debts were made public and so his estates were auctioned. They were subsequently purchased by his son-in-law, Alois Gallenfels. Around 1788, the glasshouse was relocated to the edge of Lisca, above the Gračnica Valley, near Jurklošter and became the predecessor of the still operational Hrastnik glass factory. It was owned by Karl von Azula, Franz Grohmann and the last Jurklošter glasshouse owner, Edward Heider, who relocated the facilities to Hrastnik in 1860. Raw materials were produced in the Gračnica Valley while potash was delivered from the neighbouring Žusem estates. Numerous litigations took place due to the insufficient delivery of the prepaid potash.[25]

24 Cimperšek 1986; Rataj 1997; Rataj 2005; Guss 1978.

25 Ivanuša 1960; Guss 1978; Rataj 2005.

The glasshouse at Svetli dol, located below Svetina and which was constructed by the owner of the Novo Celje mansion, Johann Carl von Gaysruck, operated almost at the same time between 1753 and 1773.[26] Today, the only evidence of this glasshouse is the small church, dedicated to the patron saint of glassmakers, St. Florian. It was at this glasshouse that master Valentin Voith worked between 1758 and 1762. Two more glasshouses operated to the west of Celje, namely at Liboje and Ojstrica, near Tabor. The Liboje glasshouse was the first to use coal to power its furnaces by the end of the 18th century. Both glasshouses were owned by members of the House of Friedrich, which also possessed the last major glasshouse in the 19th century.[27]

Johann Friedrich, the owner of the Ojstrica and Liboje glasshouses, requested the construction of another glasshouse at Loka on the Žusem estates in 1836.

His request was based on the fact that in the past, three glasshouses had already operated in the area. The existence of these glasshouses on the Žusem estates is evident from the Teresian and later from the Franciscan Cadastre.

26 Orožen 1971.

27 Orožen 1951.

The first glasshouse had supposedly already been erected in 1738 and remained operational until 1754. After the death of Countess Maria Isabelle Gräffin von Petaz, née Reisig, an inheritance inventory containing records of payments to glassmakers and tin moulders until 1738, was drawn up on 21 September 1739. The inventory listed a glasshouse located within the estates that was considered as good as shut down due to the immediate vicinity of the glasshouses at Rogatec, Kozje and the Žiče Charterhouse. The inventory also contains records of a stock of 228 glass panes, 66 mineral water bottles and glassmaking tools. The other glasshouses within the area were located at Hrastje and Dobrina. After commencing the construction of the Loka glasshouse, Johann Friedrich concluded an agreement with Count Harbuval Chamara on the felling of nearly 450ha of forests in order to supply the glasshouse with raw materials.[28] Friedrich leased the glasshouse to Joseph Gotscher, a master who had arrived from Haida. After his death, the glasshouse was purchased by Leopold Fieglmüller, who had arrived from Upper Austria. According to reports by the Chamber of Trade and Commerce of Styria, it was during this period that the glasshouse flourished the most: in the beginning of the 1860s, it employed a total of 180 workers and was considered one of the largest in the country.[29] The glasshouse included eight crucibles, its own grinding workshop and even employed its own sales agent in Trieste. Its products were sold in Naples, Lombardy, Sicily and the Levant. Its annual production totalled as much as 40,000 guldens.[30] The most notable glassmakers who arrived from the territory known today as the Czech Republic included Valentin Keller, Ferdinand König, Edward Star, Wenzel Abez,and members of the Kisslinger family. Quartz sand was supplied from Ligist, near Voitsberg, and they produced the required potash themselves. The glasshouse shut down its furnaces in 1886. Its fate was sealed when coal was introduced as furnace fuel and after the Vienna-Trieste railway was constructed. A few years before its closure, Leopold Fieglmüller, along with his brother Joseph, built a small glasshouse in Olimje near Podčetrtek.[31]

At the start of the 20th century, only the glasshouses in Hrastnik and Zagorje ob Savi, which ceased production in 1926, remained operational. After the latter was closed, the Sv. Križ glasshouse in Rogaška Slatina was founded, which is today, along with the Hrastnik plant, the only operational glasshouse in Slovenia.

Like the glasshouses in Pohorje, the glasshouses in the regions of Celje and Kozjansko produced mineral water bottles, glass vessels for storing medication, food and drinking as well as lighting equipment, glass dishes and dinnerware, glass panes and other glass products. The more refined products were decorated by means of cutting, grinding, engraving, enamelling and symmetrical paintings. The decorative elements were usually artistic or were craft-specific. Sometimes the decorations illustrated national characteristics while at other times, certain motifs were requested by clients. The products intended for everyday use had mostly smooth surfaces. They were strictly utilitarian and aesthetically simple yet their designs remain exquisite, even today.[32]

28 Cimperšek 1986; Rataj 1994; Rataj 2005.
29 Guss 1978; Rataj 1994; Rataj 2005.
30 Slokar 1914; Rataj 2005.
31 Cimperšek 1986; Ivanuša 1960; Rataj 2005.
32 Štular 1975; Štular 1983; Rataj 1994.

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CHINESE PICTORIAL SCREENS. AN INVESTIGATION OF 19TH CENTURY GLASS CANE PANELS

The collection of the Corning Museum of Glass includes four East Asian panels that are presumably of Chinese origin and are made of two rectangular sheets of assembled thin glass canes that sandwich two paper cut-outs of polychrome watercolor drawings. Although nearly identically made, the panels differ in their iconography and size. The largest depicts a scene of glass blowers working at the kiln (CMoG acc. no. 2010.6.26, Fig. 1), the second largest shows a domestic interior scene (CMoG acc. no. 82.6.11, Fig. 2), and a pair of smaller panels displays decorative motifs of a bird on a flowering branch (CMoG acc. no. 80.6.9 A, Fig. 3) and a landscape (CMoG acc. no. 80.6.9 B, Fig. 4), respectively.[1] Each one was probably made for a table or room screen (paravents), or for lantern shades. They may also have originally been placed in a solid wooden frame with carved, gilded or inlayed decoration, with a foot or base to display them upright and allow them to benefit from the daylight illuminating the painted depictions. To date, the authors are unaware of any similar glass cane panels. However rare, these artifacts do show remarkable similarities in visual effect to thinly carved slates of hardstone as well as painted panels of porcelain and ivory, of which numerous examples were decorated in the 19th century.

Art historical context

These unusual works of art seem to originate from a time when both China and Japan had mastered their own stylistically hybrid, but predominantly East Asian glass objects in the second half of the 19th century,[2] following the reintroduction of glassmaking by European Jesuits in China during the late 17th century and the opening of Japan to the West in the 1860s that led to the importation of Western glassware and eventual successful imitation thereof. Remarkably, these panels illustrate the manufacture of vertical planes, a genre rarely executed in Asian workshops where, for example, the produc-

1 The largest and most recently acquired panel was first published in Knothe 2011, 26-27.

2 Knothe 2010, 201-216.

Fig. 1: Chinese, probably nineteenth century, 64.8 cm × 28.5 cm. Corning Museum of Glass, acquisition number 2010.6.26.

tion of stained and assembled window panes only seems to have taken place since the late 19th century and never reached the virtuosity and pictorial richness of the highly celebrated church windows manufactured in Europe since late Medieval and Gothic times.[3] In the East, by comparison, windows were typically translucent and colorless whereas the frame itself could be filled in with a trellis and architectural decoration in carved wood or geometric stonework. Unlike stained glass windows, these forms of embellishment exemplify treatments that often symbolize the transition between the inside and outside of a building and create a link to, for example, manicured bamboo or fruit trees planted close to the outside of a window opening, thereby partially concealing it to bring nature closer to the interior. The interior therefore, profits from light filtered through leaves rather than through polychrome depictions of window panes.

The importance of the glass cane panels of the Corning Museum lies in their relationship with the East Asian domestic interior. The sizes of the two larger specimens suggests that these were possibly made for table or room screens, whereas the two smaller examples may have served the same purpose or originated from a lamp or lantern shades. Their construction suggests that the panels were meant to be displayed upright given that their polychrome compositions are brought to life by illuminating them simultaneously from their face and reverse sides, as the front light pronounces the detailed elements and the back light enhances the volume of each composition. Furthermore, their detail seems to indicate that all four panels are meant to be seen up close in order to fully appreciate the quality and whimsical iconography of their carefully drawn scenes.[4]

As previously observed with the making of skillfully carved and incised cameo glass vessels, the well-trained hand of the stone carver on glass was undoubtedly responsible for the multicolored relief-carved pieces. At the same time, the omnipresence of the long-practiced tradition of hardstone carving may have stylistically influenced the translucent effect of the glass cane panels that seem to make reference to the pictorial qualities

3 The University of Hong Kong's art museum preserves Chinese examples of late 19th and early 20th century stained glass of predominantly simple geometric designs and primary colors.

4 Some back-lit panels may have been used in the back-drop decorations for theatre stage settings. However the detail in the present examples seems to indicate a close-range display as their depictions would not be recognizable by more physically distant spectators of a theatre or music performance.

Fig. 2: Chinese, probably nineteenth century, 35 cm × 45 cm. Corning Museum of Glass, acquisition number 82.6.11.

Fig. 3: Chinese, probably nineteenth century, 11.5 cm × 6.5 cm. Corning Museum of Glass, acquisition number 80.6.9 A.

of carved jade.[5] Furthermore, thinly produced and delicately painted porcelain plaques and vessels related to and possibly were a model for the glass cane panes. In addition, much like nephrite stone, the method of incising ivory results in the contrast of lighter and darker 'scenes,' depending on the remaining thickness of the plank and its consequent transparency. These media profit from the slight translucency of the thin and pale colored stone or ivory and slimly made porcelain paste, effects that are achieved in the glass panels by sandwiching single sheets with opaquely painted gouache drawings between perfectly lucid layers of glass. Like the vessel glass, it seems therefore, possible that these panels also try to assimilate the long-appreciated qualities of the stone, ivory and porcelain into the lesser known, and now more experimentally used, medium of glass. The strength and three-dimensionality of the watercolor drawings is therefore remarkable, as well as the shine and visual effect of the tightly assembled glass rod layers that, depending on the incoming light, transmit or reflect the shine.

The diagonal arrangement of the glass canes creates a crosshatched design visually reminiscent of the texture of textiles. The pattern of the diagonal canes, however, varies from about 95 degrees in the largest panel to a mere 15 degrees in the smallest panel and so lacks the regular 90 degree layout of a woven cloth. Furthermore, the placement of the cut out drawings of the glass panels on the geometrical background is reminiscent of embroidered motifs on silk or woolen fabric that is partially covered with decorative images and exposes some of the supporting background material.[6]

Stylistically, the drawings make reference to scroll paintings. Both their iconography and lack of perspective follow the same convention. Whereas the smaller scenes almost appear as individual details of a larger arrangement, the two larger depictions assume the same painterly qualities of Chinese narrative compositions in which figures represented higher up within the scene form the background while those along the lower edge are made to appear closer to the viewer.

5 Knothe 2010, 201-216.

6 Among numerous other examples, The Metropolitan Museum of Art preserves a Chinese late 17th century silk tapestry (*kesi*) 'Birds among Flowering Branches against Clouds', acc. no. 18.124.10a, b, Rogers Fund 1918, that displays 'floating' motifs across the material.

The glassmakers' panel is of particular interest, not only because it represents the craft responsible for the manufacture of the delicate screen panel itself, but because in both its contents and disregard for perspective, it is reminiscent of early Western representations of gaffers at work in Late Medieval Europe – which is assumed to be unintentional. The former idiosyncrasy is noteworthy for its depiction of mold-blown glass vessels, which was initially less common in Asia than in the West, but gained popularity in China through relief decoration on snuff bottles and in Japan through pattern molded glass (in imitation of cut glass). However, the latter parallel may be best illustrated by a polychrome painted illuminated manuscript page that recorded an early factory setup for the production of *Waldglas*.[7] In its own very distinct way, this panel illustrates a craft that – if less common in China – falls within the category of more variedly depicted and more widely disseminated pictures of the large Chinese industries of, for example, rice and textile production.

The depiction of the domestic scene, on the other hand, recalls countless similarly composed paintings of the Qing dynasty in which family and daily pursuits, such as handcrafts, reading and learning (the 'scholar's table' is depicted in the center of the panel) portray the occupations of the educated social elite. Here, both the restricted pallet of colors and the sparsely decorated interior are typical of this genre.

The significance of the bird and branch shown in the smaller panel lies in their symbolism: the commonly depicted bird, presumably a magpie, is perched on a flowering branch, probably on a plum tree, and typically signifies 'spring' and, by extension, 'hope' or 'good news coming'. The magpie is called joy bird (*xi que*) in Chinese and the five petals of plum blossom mean five blessings in Chinese culture.[8] Similar representations occur in painted, drawn and carved form, and they persist in their meaning to the learned Chinese. The landscape drawn on the second smaller panel is little distinctive. However, it relates to the long tradition and ever so repetitive execution of some of the unique natural scenery in the Middle Kingdom, and by extension, some of the mystical powers assigned to specific mountain ranges and bodies of water.

Fig. 4: Chinese, probably nineteenth century, 6.5 cm × 11.5 cm. Corning Museum of Glass, acquisition number 80.6.9 B.

It is worth noting that the four Corning panels fall into two very distinct if entirely different categories. The larger panels portray industrial and domestic endeavors whereas the smaller examples show commonly recognized symbols of beauty, mythology and faith, or simply put: a characterization of 'doing' or 'knowledge' and 'believing' or 'wishing'.

Construction

The technical examination focused primarily on the glass rods and the construction of the panels. Only very small areas of the painted paper cut-outs are exposed and it is difficult to examine them closely through the glass. All the panels are comprised of similar materials and are constructed nearly identically. There are two layers or panes of diagonally arranged thin glass rods that are held together along the outside edges with paper tape. Between the two panes of glass rods are paper cut-outs with gouache drawings (Fig. 5). There is another strip of paper tape between two layers of rods. The main technical differences between the panels are their dimensions and the alignment of the glass rods.

7 'Medieval Glassmaking', polychrome miniature from an illuminated manuscript of *Sir John Mandeville's Travels*, about 1420. British Library, MS Add. 24189.

8 The magpie is a symbol of 'happiness' as its singing foretells 'good luck' and 'happiness'. Plum blossom represents 'good fortune', 'prosperity' and 'longevity'.

Fig. 5: Detail of a corner of panel 2010.6.26. The missing rods reveal the paper between the panes of glass rods.

Most of the rods are hollow or partially hollow, indicating that they were drawn or pulled (Fig. 6). The rods of all the panels are remarkably similar in size with a diameter ranging from 0.3 mm to 1.0 mm. The rods in the two smaller panels are slightly thinner than the other panels, but still within this range. The glass rods are roughly aligned in a diagonal fashion in the pane. The direction of the diagonal is opposite on each pane so that together the panes create a crosshatched pattern. The angle of the diagonal differs on each panel and ranges from about 95-15 degrees.

The rods appear to be held together only along the edges with strips of glued paper on the outside surface of each pane, as well as between the two panes.

It is not clear how the paper cut-outs are held in place, but they may have been glued to the glass on at least one side. There are some discolorations on the backsides of the paper cut-outs that may be adhesive stains.

Compositional analysis

Compositional analysis of the glass rods from the two larger panels was done with a Bruker handheld XRF. The canes of the largest screen were made of Soda-Lime-Silica glass ($Na_2O:CaO:SiO_2$) while those of the panel depicting the domestic scene exhibit a chemical composition of Potash-Lime-Silica glass ($K_2O:CaO:SiO_2$). This data presumably suggests that the glass canes for these two panels are not derived from the same kiln, but are likely to have come from different workshops.

The smaller panels have not yet been analyzed.

Loose samples of the glass were also saved for future analysis.

Conservation treatment and observations about individual panels

All four panels were very dirty with dirt trapped between individual rods. The conservation treatments primarily consisted of cleaning the surfaces with saliva followed by a 50:50 deionized water and ethanol solution on cotton balls. This removed much of the dirt, but there were areas where the dirt was impossible to remove due to having become ingrained between the two layers of rods.

Only the treatment of the glassblowers' panel has been completed at the time of writing this paper, but the other panels have been cleaned and are undergoing further treatments.

The glassblowers' panel

Besides being very dirty, the glassblowers' panel also had very fragile and crumbling edges that needed to be stabilized. The paper strips around the edges of the panel had deteriorated, making the edges very fragile. In some places, there is only a remnant of paper left on the tops of rods with no connection to the rest of the paper. The glass along the edge is also very fragile and small fragments of glass and paper fell off whenever the panel was moved.

To consolidate the edges, a 15% (w/w) solution of B-72 in acetone with a small amount of ethanol was applied with a soft brush. For further protection, strips of thick Japanese tissue were placed around the edges, like an envelope. The strips are 2.5 cm wide and folded lengthwise along the center. On the short sides of the panel they were about 1 cm longer than the panel on either side and were folded over to the back side of the panel. The tissue was saturated with acetone and a 30% solution of B-72 in acetone was applied on top. Weights were used to hold down the Japanese tissue until the B-72 set.

In addition, there were some loose, broken and missing rods as well as stains on the paper. The loose and broken rods were rejoined with B-72 adhesive where possible, but none of the missing rods were replaced. The stains on the paper could not be accessed for treatment.

Finally, the panel was reframed between two sheets of Plexiglas to stabilize it during handling and to protect it from dirt. Using clear Plexiglas® on both sides allowed the light to pass through and the panel to be viewed from the back. A 5 mm strip of volara (closed-cell polyethylene foam) was used to protect the edges.

It is interesting that the details of the cut-outs are still very visible from the backside of this panel although they are not as sharp as on the front. This is not the case with the other panels.

The panel with the domestic scene

The panel with the domestic scene was also very dirty and had some missing and broken rods. However, this panel had previously been restored and reframed. Unfortunately, the frame did not have a front cover, so dirt still accumulated on the surface. The back of the frame (a pane of sheet glass) did keep the backside of the panel somewhat cleaner than the front. Previous repairs included the replacement of missing sections of rods with new rods. The replacement rods are slightly thicker than the original rods and the glue has yellowed somewhat.

The old frame was removed, because it did not fully protect the panel and was not an original part of the piece. Half of the process has only been completed. Unfortunately, removing the frame is more complicated than originally thought. There is no easy way to remove the back of the frame, which means the sides have to be cut away. So far, two of the sides have been removed. During the removal process, the glass canes were protected with low-tack tape. The following steps were needed to finish the treatment: the removal of the rest of the frame, the cleaning of the back side, the consolidation of the paper edges where needed and the re-

Fig. 6: Photomicrograph of an edge of panel 2010.6.26 showing the hollow area in the center of the glass rods and the layering of paper and rods.

framing of the panel using the same technique as with the glassblowers' panel.

The small panels

The two small panels were also very dirty and had a few broken and missing rods. Due to the missing rods, one of the panels had lost some of its rigidity, making it a little floppy on one end. Each one also had an area where the paper cut-outs had worked their way through the rods and now stick out. These panels have had some treatment in the past although not as extensive as the panel with the domestic scene. The edges on these panels have been stabilized with a cloth tape over the paper tape.

So far, the two small panels have only been cleaned. To finish treating these panels, the paper cut-outs will have to be straightened and re-inserted while the rods will need to be stabilized. Since there are only a few missing rods in each panel and they contribute much more to the overall stability of the objects than with the other panels, replacement rods may be necessary. Some testing also needs to be done to see if it is possible to remove the cloth tape. It is clear that there is paper tape underneath the cloth tape. It would be desirable to expose it if this can be done without causing further damage. Finally, special housing or frames need to be made for the panels to protect them from further damage and dirt.

Conclusion

These glass cane panels are rare and complicated objects. More research needs to be done to satisfactorily attribute and date them. We plan to do XRF analysis on the remaining two panels and intend to do SEM-EDS analysis on glass from all of the panels, which we hope will provide additional information on their origin and age as well as production methods.

Finally, we are hoping to uncover similar objects to compare with our panels and are making an open request to contact us if anyone chances upon panels similar to those described in this paper.

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LE CIRVA UN OUTIL DE RECHERCHE ET D'EXPÉRIMENTATION AU SERVICE DE L'ART CONTEMPORAIN

Depuis 26 ans maintenant, la France s'est dotée d'une structure performante permettant aux créateurs de tous horizons (plasticiens, architectes, designers) de venir se confronter au travail du verre. Ce centre accueille depuis 1986, à Marseille, dans une ancienne manufacture, une multiplicité d'artistes. Il met à leur disposition des techniciens qualifiés et des installations adaptées. Sous la direction de Françoise Guichon puis d'Isabelle Reiher, le Centre Internationale de Recherche sur le Verre et les Arts Plastiques (CIRVA) poursuit une politique artistique et de recherche ambitieuse. Pour autant, si des réalisations étonnantes sont sorties de ces ateliers comme les travaux de Gaetano Pesce, Ettore Sottsass, Georges Rousse, Guiseppe Penone ou encore Gilles Barbier, sa fondation, en 1983, ne devait rien au monde de l'art contemporain. Le Cirva est né pour ainsi dire deux fois. A Aix en Provence d'abord par la volonté des verriers indépendants français. A Marseille ensuite pour devenir le centre d'art qu'il est aujourd'hui.

Les annees quatre-vingt, un tournant dans la reconnaissance du verre artistique

L'exposition *New-Glass et verre français contemporain/art et industrie* qui se tient au musée des Arts décoratifs de Paris du 8 avril au 5 juillet 1982 est l'occasion d'un bilan. Cette manifestation itinérante, initiée par le Corning Muséum (New York) en 1979, est utilisée par Yvonne Bruhammer, conservatrice au Musée des Arts décoratifs de Paris, pour faire un point précis sur la création française dans ce domaine si spécifique. Alors qu'aucun créateur hexagonal ne participe à l'exposition originale, trente artistes sont invités à Paris pour dévoiler leurs réalisations. Ils incarnent alors cette renaissance – au regard d'un riche passé symbolisé par les noms d'Émile Gallé et Maurice Marinot – qui s'amorce timidement à l'aube des années 1970, grâce aux actions conjuguées d'Éloi Monod puis de Louis Mériaux.

Groupe informel à ses débuts, cantonné dans le giron de l'artisanat et des métiers d'art, cette première constellation cherche rapidement à exister sur le plan institutionnel et artistique. Si une certaine reconnaissance se précise avec l'amorce d'un marché national concomitant à l'ouverture de galeries spécialisées, il manque toujours, aux yeux de ces acteurs, une légitimation des parcours et des engagements validée par l'état. Le changement de présidence et de gouvernement est l'occasion de faire entendre leur voix. Les verriers français, très actifs font valoir leur singularité et leurs difficultés propres. Cette pression ce concrétise par l'annonce de Jack Lang, lors du vernissage de l'Exposition *New-Glass et verre français contemporain/art et industrie,* de quinze mesures pour une relance de la politique du verre et du vitrail en France dans trois directions ciblées; la formation, l'aide à la création et la diffusion.

Si toutes les mesures ne concernent évidemment pas les verriers indépendants - une large place est ainsi faite au vitrail et à la patrimonialisation - trois d'entre elles, parmi les plus importantes, les intéressent directement. Il s'agit de la "mission d'étude et de réflexion sur la création de filières spécifiques de formation et de recherche artistique sur le verre" confiée à Jean Biaginni, de la "relance d'une politique d'achats publics sur l'enveloppe de quatre millions de francs consacrée en 1982 aux acquisitions d'œuvres contemporaines" et de la "création d'un centre du verre au musée des arts décoratifs de Paris [...], centre [qui] sera à la fois un musée du verre, un centre de documentation et de recherche, une instance de consultation pour les pouvoirs publics" confiée à Yvonne Bruhammer, conservatrice au musée des arts décoratifs de Paris.

Le centre international du verre a aix en provence (cirva)

La création du centre international de recherche sur le verre à Aix en Provence répond au départ à des attentes bien précises : comblé le retard de la France tant dans les domaines de la formation, de diffusion que de la création. La notion de l'apprentissage, fondamentale, a toujours été au centre des préoccupations des différents acteurs du verre et en particulier des manufactures.

La fondation du CIRVA doit donc combler un manque. L'implantation de la structure se fait à Aix en Provence dans une région ou la plupart des acteurs du verre d'alors travaillent et vivent. Les élus locaux convaincus de la justesse du propos participent largement au financement. Pour autant, la création du CIRVA à Aix en Provence n'est, au départ qu'une etape. L'ambition avouée est alors de proposer un modèle qui pourra être décliné par la suite dans les différentes écoles d'art de l'hexagone – sur l'exemple des ateliers de céramique – afin d'assurer un maillage de l'apprentissage du verre artistique.

Le calendrier originel prévoit une montée en puissance étalée sur trois années et deux axes sont envisagés, la recherche et la création d'une part et la formation proprement dite d'autre part, l'idée étant de faire cohabiter des spécialistes du matériau, des plasticiens désireux de produire un projet spécifique et des étudiants ayant fait le choix du travail du verre de manière ponctuelle ou permanente. L'ambition première du CIRVA est bien de lier l'apprentissage et la création – sous toutes ses formes – autour d'un matériau particulier qui est le verre.

A peine créé, le CIRVA doit faire face à un vrai paradoxe. Alors qu'il se veut un lieu dédié aux arts plastiques, design ou architecture, son existence est directement liée à l'émergence des verriers indépendants dans les années soixante-dix c'est-à-dire à un certain type d'artisanat. Pour contourner le problème, et suivant la terminologie et les combats de l'époque, une distinction est faite entre un artisanat purement utilitaire et des métiers d'art. Le rapport précise que la "la plupart [des] créateurs [du verre] s'est tout d'abord située dans la catégorie des artisans créateurs d'objets contemporains, objets tout d'abord liés à l'art de la table et aux arts décoratifs. Ces pratiques du fait des changements de mentalités et des mutations culturelles et économiques récentes se sont progressivement déplacées vers des problématiques plus adaptées à la contemporanéité."[1] légitimant par là la production de ces créateurs.

1 Biaginni 1982-83, XIV, 3.

Le centre international du verre et des arts plastiques (CIRVA)

La nomination en 1985 de Françoise Guichon comme directrice du CIRVA marque un tournant décisif et un changement notable d'orientation de l'établissement. Alors que son implantation à Aix en Provence semblait actée, d'abord à l'intérieur de l'école des beaux arts de la ville et plus tard dans des locaux dédiés, le CIRVA s'installe à Marseille en juillet 1986. Si en terme de distance ce déménagement n'est pas spectaculaire il préfigure une modification radicale de politique comme l'indique à la fois la transformation du nom – dorénavant Centre International de Recherche, non plus sur le verre à Aix-en-Provence, mais sur le verre et les Arts plastiques – et les déclarations de Françoise Guichon : "Mettre l'outil verre à la disposition des artistes […] Il s'agit pour nous [non pas] de former des artisans verriers et des artistes verriers, mais de créer les conditions d'une rencontre entre le monde des arts plastiques et celui du verre." [2]

"Le 11 juillet le CIRVA […] s'installe à Marseille dans une ancienne manufacture de vêtements des années 20 : 1400 m^2 rénovés qui doivent abriter de vastes ateliers de travail (four de fusion et de thermoformage, travail à froid, émaillage, acide) des espaces de documentations et de recherche ainsi qu'une galerie d'exposition."[3] En abandonnant Aix en Provence pour Marseille, le CIRVA perd son statut d'école pour celui de centre d'art.

Françoise Guichon justifie ainsi le tournant et légitime son parti pris : "Curieusement ce verre omniprésent […] a été très peu pris en compte par les artistes de notre temps. Son travail difficile, rebutant, spécialisé, en a laissé l'entière maîtrise à l'artisan, au technicien et à la recherche"[4] et elle poursuit : "Donner à ce matériau la possibilité d'être exploré, différencié, qualifié par la pensée de l'artiste, c'est nous rendre sensible et intelligible une partie de l'univers concret et mental qui est en train de naître et dont le verre offre aux artistes comme aux scientifiques un modèle manipulable."[5] Le rapport entretenu par les artistes vis à vis de cette matière est effectivement pour le moins paradoxale et ambiguë. Une lecture attentive des œuvres du XX[ème] siècle et des éléments qui les constituent nous dévoilent un large éventail d'utilisation du verre. Mais si les créateurs en font un grand emploi, cet usage prend rarement en compte le façonnage de la matière et les étapes de sa transformation.

Le CIRVA, un laboratoire

Matériau exigeant, l'accès au travail du verre à chaud est souvent malaisé pour ne pas dire presque impossible en certain cas. Ces contraintes multiples – fabrication, mais aussi exposition – le rendent à la fois peu visible et difficilement éligible. À une interrogation sur le travail du verre de Jean-Michel Othoniel, Jean-Luc Olivié donne cette réponse : " je pense qu'une question importante à se poser est" : est-ce que la démarche d'Othoniel avec le verre aurait eu lieu s'il n'avait pas eu l'occasion de rencontrer le CIRVA? "Selon moi, ce n'est pas du tout une évidence […]."[6] Cette affirmation du conservateur du centre du verre du musée des Arts Décoratifs de Paris peut s'appliquer à bon nombre d'artistes. Elle démontre également toute l'importance prise par la structure dans ce domaine spécifique. Si quelques personnalités – comme Emmanuel Saulnier ou Patrick Neu – croisent le verre après un lent processus de maturation – faisant du travail de la matière une étape obligée de leur problématique artistique – d'autres se confrontent à lui simplement parce qu'ils y sont invités

Détaillant la façon de faire du C.I.R.V.A, Isabelle Reiher, sa directrice, explique : "[le centre] fonctionne de manière identique depuis sa création. C'est la directrice qui fait les choix. […] Il n'y a aucun critère écrit, car cela serait tout simplement impossible. Par contre ils sont constamment réfléchis [et] sont fait en fonction de la qualité générale d'un travail et de la perti-

2 Girard 1986, 54.
3 Ibidem.
4 Guichon 1987, 8.
5 Ibidem.
6 Seraille 2004, 48.

nence de ce dernier en dehors du verre. […] Il y a [ensuite] l'appréciation de ce qu'un travail, une démarche pourraient promettre avec un tel matériau. En connaissant toutes les difficultés, c'est une sorte de transposition mentale que nous faisons. [Il y a également] la position des artistes dans le monde de l'art."[7]

Ce type de procédure implique évidemment l'acceptation de l'artiste. La première tâche du centre, par l'intermédiaire de sa directrice, est donc de convaincre un monde de l'art peu soucieux du matériau. Il lui faut souvent faire tomber les nombreuses réticences et persuader les plasticiens du bien-fondé de l'entreprise.

L'exemple de Jean Michel Othoniel

Né en 1964 à Saint-Étienne, Jean-Michel Othoniel est aujourd'hui largement reconnu pour des réalisations ou le verre tient une place majeure (*Le Kiosque des Noctambules*, 2000, Paris ; *Le Petit Théâtre de Peau d'Âne*, 2004 ; *Le Bateau des Larmes*, 2004). Pour autant, Sans attirance particulière pour le verre, c'est bien l'opportunité de travailler au C.I.R.V.A. – avec le dessein de retrouver l'obsidienne de Lipari – qui l'amène à infléchir son œuvre. La découverte de ce matériau lors d'un séjour à Naples lui donne en effet l'idée, dans la continuité de son travail d'alors, d'envisager l'idée d'une transformation voir d'une transmutation. Invité une première fois au C.I.R.V.A. à un moment où l'artiste n'en concevait pas le bien-fondé et la pertinence, il revient quelques années plus tard vers le centre (1990) en proposant ce projet.

La réalisation des objets est complexe. Pour autant, à Marseille, il n'existe aucune contrainte, sinon celle que s'impose l'artiste lui-même. Pour recréer l'obsidienne, Jean Michel Othoniel peut conduire sa réflexion en toute quiétude et réaliser le nombre d'essais qu'il juge utiles : "(…) Le C.I.R.V.A. qui n'est au final dédié qu'à cette idée : la recherche. C'est un outil unique qui n'a pas vraiment d'équivalent même à l'étranger. C'est un endroit ou les créateurs peuvent faire des recherches sur les formes, les couleurs les techniques."[8] Si le facteur économique est important – le coût du travail est assumé par le centre qui reçoit en retour une partie des œuvres réalisées par ses soins – il n'explique pas tout. L'autre particularité du C.I.R.V.A., dans un domaine lié à des traditions précises et un savoir-faire qui semble immuable, est de proposer aux artistes un dialogue avec le verrier. Si ce dernier met des compétences pointues à la disposition d'un tiers, il est également capable sinon de les oublier du moins les réinterpréter pour répondre aux exigences d'une création singulière.

La production de l'obsidienne est laborieuse et difficile. Aux termes de deux années de recherches, seul trois prototypes sont réalisés. Le C.I.R.V.A. ne disposant pas de fours nécessaires, il délègue la fabrication proprement dite à Saint-Gobain. Si la recréation de l'obsidienne de Lipari passe nécessairement par un travail du verre, cette dimension est largement minimisée par l'artiste. Les objets, dont Jean-Michel Othoniel assume les imperfections, sont proches dans leurs formes et symboliques des œuvres de souffre et de cire réalisées dans ces années.

Au regard de la production d'œuvres en verre de Jean-Michel Othoniel, il est paradoxal de constater le faible nombre d'objets directement réalisés au C.I.R.V.A. Si l'artiste y poursuit bien des recherches (*Obsidienne*, *Kiosque de Noctambules*), le centre n'a pas toujours les capacités de conceptions exigées. Son importance dans la trajectoire de Jean-Michel Othoniel se situe ailleurs. D'une part la durée des séjours, qui lui permettent de penser des projets complexes sans contraintes temporelles. L'expertise, ensuite, qui l'autorise à explorer, prospecter et fouiller des directions inhabituelles. Enfin, l'entregent qui l'amène à rencontrer les lieux de productions nécessaires. Jean-Michel Othoniel va ainsi multiplier les collaborations. Avant un deuxième séjour au centre qui le voit créer une de ses réalisations majeures (*Le Kiosque des Noctambules*, 2000), il s'attache à découvrir d'autres lieux et de nouveaux possibles du verre. Il collabore ainsi avec des verriers américains (Brooklyn) ou avec ceux de Murano (atelier Salvieti, sur les

7 Isabelle Reiher pers. comm.

8 Jean-Michel Othoniel pers. comm.

conseils du C.I.R.V.A.). En dehors des réalisations – *Le Grand Collier-Cicatrice* (1997), *Le Collier Ouvert* (1997) – exposées ensuite à la Peggy Guggenheim de Venise (1997), l'artiste retient les grandes différences entre les structures : "Je n'ai pas du tout le même rapport avec les verriers. À Venise nous sommes plus dans un lieu de production que dans un lieu de recherche. À Murano la notion de rentabilité est très difficile à oublier. L'idée de prototypage, d'expérimentation est beaucoup plus restreinte que dans un lieu comme le CIRVA."[9]

Le Kiosque des Noctambules, installé à la station Palais Royal-Musée du Louvre, et inaugurée le 30 octobre 2000 est une commande de la RATP pour célébrer le centenaire du métro de Paris. Sollicité, avec d'autres artistes, Jean-Michel Othoniel démarre sa réflexion dès 1996. Elle aboutit au fil du temps, du travail, des interrogations et des rencontres au projet d'une entrée monumentale. De la même manière que lors du premier séjour le C.I.R.V.A. intervient essentiellement dans le domaine de la recherche et du prototypage. Jean-Michel Othoniel étudie avec eux la faisabilité du projet et surtout soumet aux verriers du centre l'ensemble des contraintes auxquels il doit répondre – en particulier en terme de sécurité. La fabrication est ensuite laissée à des ateliers dont c'est la véritable vocation : "le *Kiosque des noctambules* a été réalisé à Murano selon les indications du C.I.R.V.A. et du centre de recherche sur le verre de Murano. Ces deux entités ont travaillé ensemble à la mise au point du projet. Nous avons ensuite confié le soufflage à un artisan de Venise qui pouvait répondre à toutes les contraintes techniques imposées par ces deux centres de recherche."[10]

Si Jean-Michel Othoniel, aujourd'hui, emploie et interroge le verre dans ces œuvres, il le doit en grande partie à cette possibilité de le découvrir, de le comprendre et de le qualifier qui lui fut offert par le C.I.R.V.A. : "[il] a été le déclencheur de mon désir de travailler avec le verre, à utiliser un matériau versatile, et de mon envie d'en comprendre les limites."[11] Le prototypage du *Kiosque des Noctambules* comme la préparation de l'exposition à la fondation Cartier – Cristal Palace (2003) – point d'orgue de cette collaboration, sont à ce sujet exemplaires.

Conclusion

De quelque manière qu'on l'aborde, l'art du verre est un art de la contrainte. Ce n'est évidemment pas le seul matériau qui impose une façon de faire et un outillage spécifique. Toutefois, ces exigences particulières sont à prendre en compte lorsqu'il s'agit de création. Le travail du verre n'est pas lisible à la seule lueur des objets réalisés, il circonscrit également des lieux précis de fabrication qui ne manquent jamais de fasciner ceux qui les découvrent. Les moyens engagés comme la complexité de la mise en œuvre obligent la construction d'endroits spécifiques. Être client d'une manufacture – c'est-à-dire payer l'heure de fabrication – ou assumer la charge d'un atelier spécialisé n'a pas le même impact que de travailler au C.I.R.V.A. en qualité d'invité. Construire un four, le faire fonctionner, louer un technicien et mobiliser une partie de l'entreprise pour une production a un coût. En assumer partiellement, pas du tout ou totalement la responsabilité entraîne, de manière directe ou indirecte, des façons d'être et de faire.

9 Ibidem.

10 Ibidem.

11 Thomes 2007, 78.

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GLASS, A MATERIAL INDICATOR OF HUMAN ADVENTURE: A HOLISTIC VIEW

Introduction

This essay is lovingly dedicated to a material that has remained tied to human history for millennia. Glass has always been and shall continue to be – consciously or subconsciously – admired for its beauty, versatility, seeming simplicity and elegance. Even so, as is the case with so many other things that have crept into our everyday lives, people tend to take glass for granted and give little thought to its nature, history and evolution - after all, ignorance is considered bliss. However, the inquisitive nature of a scientist is not so easily quenched. This article aims to spark the interest of whoever may be interested in this beautiful material. Through examining the history of glass we shall uncover underlying themes relating to the evolution of available technologies, the circulation and trade of artefacts (and people), the interaction of the glass manufacturing process with the environment as well as with health (occupational diseases of those involved). These considerations will allow a fuller appreciation of this multifaceted material and most importantly its complex relationship with human culture.

Glassmaking

The study of glassmaking is by no means an easy task. When samples are found during an excavation, their description and chemical composition forms only one part of the picture, whereas research should contain a range of data in order to be effectively combined with other studies. As once mentioned chemical analysis affords one of the most direct way of studying ancient glass. It is well known that the first archaeological samples analysed were Roman glass fragments from two centuries ago.

Glass in the context of ecology

When trying to integrate glass in an ecological context, the Four Principles of the Science of Ecology should be taken into consideration: nature knows better, everything is connected to everything else (directly or indirectly through a net of paths), most materials are discarded at the end. Therefore, nature is generated between others and obsidian is an everyday used item. This kind of material was used as much any other material for millennia. This material is closely connected with our everyday life, with our special moments, with modern communication and instrumentation. It is used in the form of ordinary glass for drinking water or as expensive glass, such as for drinking cognac. It is used as material for window glass, traditionally produced with bovine eyes, as well as for self-cleaning glass, following modern procedures.

However, like many other materials, glass is finally discarded, but at the same time it is a material that can easily be recycled or reused in a better way. After all, glass can be considered a friendly material to the environment as generally, it is not a pollutant, as with every human action, there is an environmental cost.

The real environmental cost for glass production is energy. Even though glassmaking generally demands inexpensive raw materials, at the same time, it demands a lot of energy and unfortunately results in air pollution, as is the case with the evolution of glassmaking on the island of Murano.

Glass in every-day life

Through our eyes, glass should be considered a multidimensional material. It touches many aspects of our life and history such as: the study of psychology, environmental science, the immigration of specialized craftsmen, solving the problem of a lack of raw materials, the introduction of new technology, the minimization of energy production costs, as well as the undisputable and unbeatable tendency of man to make breathtaking and fragile art.

As known, the discovery of blowing glass resulted in glass objects entering every household and thus made glassware accessible to the masses. It is a psychological wonder why people choose different types of glassware, especially when it is of the same value, but it is a matter of pride for every household. It is also a great enigma what a psychic sees in a crystal ball when predicting our future.

Glass through time

It was once written that the history of Homo sapiens is the history of Homo Faber, thus emphasizing human ingenuity and man's resourceful mind from the beginning of existence. When we study the history of glass, it is like studying the history of man; they are moving together but not parallel, their paths crossing each other on a regular basis.

Major topic: transportation

Glassmakers are seeking better payment, better working conditions and cheaper raw materials. However, the principles of economy remain essentially the same. The question is what is more advantageous: to transport the final product to the consumer's center; transport raw materials together with the expertise of the specialists; or transport an intermediate product? Like obsidian, glass was transported either as an intermediate or final product. In ancient times, combined transportation took place, meaning that cargo was transported from the start point to the destination by different means of transport.

Early glassmaking: from mastering nature to first mass production

Even though natural glass obsidian was used since Palaeolithic times for the production of tools, weapons and objects of trade, man-made glass emerged much later; it is generally agreed to have originated in northern Mesopotamia prior to circa 2500 BC.[1] The development of core-forming was the technological breakthrough that produced the first glass vessels, and which thereby allowed glassmaking to become a fully fledged craft. The Egyptian conquests in Syria up to the Mesopotamian borders (ca. 1450 BC) led to Asiatic glassworkers being sent to Egypt

1 Moorey 1994.

(probably as prisoners) to establish a glassmaking industry there as well.[2] Later on, with the downfall of various Mediterranean kingdoms under the impact of invaders, there was no longer a market for the fine and expensively produced glass articles. There is almost a total absence of glass finds from the end of the 2nd and the beginning of the 1st millennia BC. Not until the resurgence of the great empires from the 8th to the 7th century BC was there again the necessary stability as well as the concentration of wealth and resources for the renewed production of glass. Yet glassmaking expertise must have continued somewhere, because the re-emergence of demand by the 8th century BC brought about the manufacture of articles using earlier techniques.[3] Since glass was still a luxury material at this time, the preservation of its manufacturing tradition denotes the almost mystical importance it held.

Around the turn of the millennium, glassblowing was invented, probably in the Syrio-Palestinian area. Glassblowing turned glass into a cheap commodity that could be mass produced and no doubt provided the stimulus for the proliferation of glasshouses throughout the Roman Empire. For the first time since its appearance as a manmade product, glass ceased to exclusively be a luxury. Rather, the styles became largely simple and functional and in fact, glass became more widely used for domestic purposes during the Roman period than in any subsequent time or place until the 19th century. Glass containers were particularly valued as shipping and storage containers, because they were light, transparent and reusable while they did not contaminate the contents with its taste. The luxurious nature of glass continued to be used for architecture in light of the discovery of clear glass (through the introduction of manganese oxide) in Alexandria around AD 100. Cast glass windows, albeit with poor optical qualities, thus began to appear in the most important buildings in Rome and the most luxurious villas of Herculaneum and Pompeii.

Mass production had a number of implications:

- large quantities of raw materials needed to be secured and/or transported
- large amounts of fuel were required and it was necessary to strike a balance with fuel required for other activities (metal working, naval construction)
- a large number of specialized craftsmen as well as auxiliary workers had to be employed.

Therefore, it becomes apparent how the banner of a unified empire helped to address these issues: with its conquests, trade relations, road building and effective political and economic administration, the Roman Empire created the conditions that enabled glassworking to flourish across Western Europe and the Mediterranean. Roman glass has even been found as far as China, to where it was shipped along the silk routes.

Medieval glass: different sources, different mindsets

Towards the year 1000, a significant change in European glassmaking techniques took place. Given the difficulties in importing raw materials, soda glass was gradually replaced by glass made using the potash obtained from the burning of plants. In Northern Europe, glassmaking tended to move away from the populous centres towards the forests, which supplied fuel for furnaces. The ash produced in glass furnaces substituted the ashes of marine plants, which were used almost exclusively as a universal fluxing agent in southern Roman glassmaking. This change to potash derived from the ashes of burnt trees, especially beech, led to a change in both the alkali and lime content of this glass - known as forest glass. The known glassmaking centres at this time were in Cologne, Liège, Namur, Amiens and Beauvais.[4]

In Southern Europe and the Mediterranean countries, glassmaking was largely confined to sites near the coast, such as Alexandria, Sidon, Damascus, Aleppo, Corinth, Aquileia, Murano, Florence and Barcelona. Apart from a differ-

2 Davison 2003, 18.

3 Davison 2003, 19.

4 Davison 2003, 30.

ence in manufacturing technology, production in the towns had other implications as well:[5] there were customers immediately at hand, especially those who were wealthy; there were churches and cathedrals with a demand for window glass; the towns provided communication and banking facilities; there was a tendency for innovation, such as the development of Venetian *cristallo*; and glassworkers' guilds could be formed to protect the interests of the industry. Venice became an important glass centre in the middle of the 11th century when glassmakers from Constantinople settled there to make mosaics for San Marco. By 1271, the first records of a local glassmakers' guild appear. Shortly afterwards in 1291, the glass furnaces were moved to the island of Murano to avoid the risk of fire in the city. Another reason for this move might have been connected to the need to exert a tighter control over the industry given that the glassworkers could be assembled in one locality. Glassmakers were highly regarded in Venice and the city records show that some became powerful and important men, ranking with nobility. One of the great abilities of Venetian glassmakers was their skill to manipulate the material. They acquired dexterity in controlling the molten material, which enabled glass to be produced with delicacy and with a degree of elaborate decoration. Such glassware was made for a wealthy and sophisticated market and outside Venice, would principally mean the European nobility.

First environmental implications and moving glassmakers

During the first half of the 16th century there was an influx of French glassworkers to Britain from Lorraine. It appears that they were highly unpopular at a local level due to the rate at which forests were destroyed, as wood was used to fuel their glass furnaces. Glassworkers were in competition with ironworkers for wood fuel; the latter however were static while the glassworkers, with their much lighter glass pots, could move on whenever local supplies of fuel were exhausted. Crossley[6] calculated that the furnace at Bagot's Park in Staffordshire (AD 1535) would use circa 130 tonnes of wood per month (i.e. 1.6 hectares of 15 year-old coppice). With the consumption of forests at such a rate, the British government became alarmed about the loss of trees for building ships for the navy and therefore, James I issued the Proclamation Touching Glass in 1615, which banned the use of wood for making glass.

By the early 17th century, coal started to be used as an alternative source of fuel. This encouraged the dispersal of French glassmakers from the south of Britain, which led them to settle in districts where coal was readily available. In 1567, a Lorraine glassmaker called Jean Carré obtained a licence for 21 years to set up a glasshouse in London in order to produce glass in the *façon de Venise*.[7] For this purpose, Carré imported several Venetian glassmakers and was the first manufacturer in Britain to use soda instead of potash as a source of alkali, possibly as a result of his Venetian contacts. When Carré died, one of his Venetian craftsmen, Jacob Verzelini, took over the licence. After his retirement, the monopoly to make glass in Britain passed through several hands until Sir Robert Mansell gained control in 1618.

Mansell was successful as he had acquired the patents covering the use of coal as fuel for firing glass pots. He established a number of glasshouses in England, which made glass using Spanish barilla (containing soda and lime) as a source of alkali as well as coal fuel and workmen from Altare in Italy. Mansell maintained control of the glass industry for about thirty years, but does not seem to have survived the Civil War or the Commonwealth (1640-1660). It was only during the Restoration of King Charles II to the throne that glassmaking began to flourish. In 1664, the Glass Sellers' Company was formed and from that date onwards, the glass trade was largely dictated by this company. Therefore, the trade changed in 100 years: from an industry based on individual semi-itinerant glassmakers

5 Davison 2003, 31.

6 Crossley 1967; Crossley 1972.

7 Davison 2003, 29.

to a properly organized and commercial enterprise controlled by a regular trade association.

From craft to industry

It was not until the latter stages of the Industrial Revolution that mechanical technology for mass production and in-depth scientific research into its relationship with the composition of glass began to appear in the industry. One of the forefathers of modern glass research was the German scientist Otto Schott, who used scientific methods to study the effects of numerous chemical elements on the optical and thermal properties of glass. He was responsible for the development of borosilicate glass that is highly resistant to thermal shock. Borosilicate glass produced by Corning Glass Works was given the brand name "Pyrex", a name that today still characterises the material in the English-speaking world. Another major contributor to the evolution of mass production was Friedrich Siemens. He invented the tank furnace, which rapidly replaced the old pot furnace and allowed the continuous production of far greater quantities of molten glass.

Towards the end of the 19th century, the American engineer Michael Owens invented an automatic bottle blowing machine, which only arrived in Europe after the turn of the century. By 1920, there were around 200 automatic Owens Libbey Suction Blow machines operating in the United States. In Europe, smaller and more versatile machines were also popular. In the production of flat glass, the first real innovation came in 1905 when a Belgian named Fourcault managed to vertically draw a continuous sheet of glass of a consistent width from the tank. Commercial production of sheet glass using the Fourcault process eventually got under way in 1914.

Therefore, glass established itself in everyday life during the 20th century as a mainstream material. However, scientific research continued to add to its versatile applications by devising even more 'exotic' types of glass. Fluoride glass is used as optical waveguides in either planar of fibre form. Chalcogenide glass has more widespread applications: infrared detectors, mouldable infrared optics (lenses) and infrared optical fibers. The physical properties of chalcogenide glass also make it ideal for incorporation into lasers and other active devices.

Glass: a material scientist's point of view

Even though our goal is not to digress from the specifics of the chemical or physical properties of glass, a brief introduction is necessary in order to understand the nature of glass and the context of its manufacture.

Glass consists of four principal components:

1. A former – to provide the network of atoms forming the matrix of the glass.[8] This is Silica (SiO_2), which in ancient times was added as crushed quartz[9] and from Roman times onwards, in the form of sand.

2. An alkali flux – to lower the temperature to a point at which the silica melts, making it achievable using currently available working temperatures. In ancient times, the ash of sodium/potassium-rich plants growing in arid areas around the Eastern Mediterranean provided soda (Na_2O) as flux. In Roman times, the mineral natron was used, a naturally occurring mixture of alkaline sodium salts sourced from the Wadi El Natrun area of Egypt. Post-Roman Islamic glassmakers reverted to using sodium and potassium-rich plant ash[10] while in Northern Europe, a method using ash from wood was developed to provide potash (K_2O) as flux. Calcium oxide (CaO) can also act as a flux.

3. A stabiliser - to stop the glass dissolving in water and increase corrosion resistance. The most effective is lime (CaO), but aluminum (Al_2O_3) and magnesium (MgO) can achieve this to some effect. These minerals may already be present in varying quantities in sand.

4. A colourant or opacifier - these can naturally be present in the glass due to impurities in the raw materials or can be deliberately added to the melted glass as minerals or slag from metal working processes. The most important contributions are from iron, copper, cobalt, manga-

8 Pollard and Heron 1996, 150.
9 Rehren 2000.
10 Schalm *et al.* 2004.

nese, tin, antimony and lead. Opacity can be due to bubbles in the glass or the inclusion of opacifying agents such as tin and antimony. The resulting colour and opacity from a given composition can also be controlled by the temperature and redox conditions inside the furnace.

Behind the looking-glass: the glassmakers

The primary aim of studying material culture is the understanding of the people behind it, recorded either as consumers or even more interestingly, as producers. Therefore, a small chapter should be dedicated to the glassmakers themselves: those already identified as prisoners, opportunists, craftsmen or entrepreneurs. The restriction of the secrets of glassmaking to certain specified families or craft communities has led to the perpetuation of glass terminology that has been handed down, not merely across generations, but throughout the centuries. Glassmakers along the Phoenician coast from the 1st to the 6th century AD used terms similar to those used in Babylonia in the 7th century BC and, following a study of 16th-century Italian glassmaking texts, Engle[11] suggested that some early European glassmaking families may have originated in areas where Aramaic was spoken. In addition, family names in Hebrew, Flemish, French and English have been studied with a view to tracing the relationships between glassmaking families given that they emigrated from Asia Minor through Sicily, Lombardy, the Rhineland and Lorraine to Britain.[12]

As a consequence of the supposed magical properties of glass and the technological secrets associated with its production, glassmakers were often granted a higher social status than was given to other craftsmen and at various points throughout history, special legislation was passed for their benefit. During the first phase of the Roman Empire, when the best glass was being made in Syria, Syrian glassmakers were regarded as Cives Romani (Roman citizens).[13] Another privilege, this time for glass vendors, existed in England in 1579, where laws were in force against rogues and vagabonds although 'glass men of good behaviour' were exempt from prosecution if they possessed a licence from three justices of the peace.[14]

Occupational diseases

On the other hand, one of the darker sides of the profession relates to the numerous health implications brought on by working in the glassmaking industry. The occupational diseases of glass craftsmen were an important field of medical study. The manufacture of glass entailed exposure that was probably carcinogenic to humans. Employment in the art glass industry exposed workers to definite and probable lung carcinogens such as silica, asbestos and lead.[15] Heat and noise were additional health hazards present in this work environment.

Asbestos has been present in tools and furnaces throughout the 20th century, when fibreglass and ceramic fibre glass material was used.[16] Long-term high-level exposure to inorganic arsenic was suggested to have increased the prevalence of hypertension and occupational exposure to lead was also associated with increased mortality from hypertension in lead battery and lead production workers. In summary, the higher prevalence of mortality from hypertension and the presence of occupational risk factors highlight the role of occupational exposure in the development of hypertension among glassworkers. Previous studies of glassworkers have also shown an increased risk for cardiovascular disease,[17] ischemic heart disease and cerebro vascular disease.

In conclusion, the complex work environment of art glassworks, so far, appears to pose unreported health effects for non-malignant diseases, specifically: hypertension, pneumoconiosis, lung and cardiovascular diseases, and diseases of the genitourinary system.

11 Engle 1973.
12 Engle 1974.
13 Davison 2003, 17.
14 Charleston 1967.
15 Steenland *et al.* 1996; Vainio 1997.
16 Baldacci *et al.* 1991.
17 Siemiatyki 1991.

Conclusions

The evolution of technology as well as the direct collaboration of scientists from different scientific fields has helped this mysterious material to rise to its current level of use in the arts and modern technologies. We would like to close by referring to the Ionic Thought – and specifically the term "Synalma" - meaning complete collaboration and respect among scientists for the ultimate benefit of scientific evolution.

Afterthoughts

Studying any aspect of material culture is quite a feat and glass is no exception. As millennia of production, consumption and distribution add up, it seems difficult to pick out the interwoven strings of historical, technological, sociological, economic and cultural threads. The recurring themes that were underlined in this article vary widely:

- The historical approach, involving an evaluation of the cultural background, through which glass manufacture and trade evolved
- The technological evaluation of the raw materials and their implications in the final product
- Ensuing environmental issues, energy consumption and sustainability of the glassmaking industry.
- The target market fluctuations, the changing character of glass: from luxury good to mainstream product and back to the elite.
- The movement of specialized craftsmen, the dissemination of knowledge and industrial espionage

There are many elements to the glassmaking story yet to be told, which sadly do not fit into this dissertation. However, this paper may act as a starting point and a spark of inspiration for someone else to formulate and answer new questions, as in the words of Pablo Neruda: "What we know is so little and what we presume is so much and we learn so slowly that we ask and then we die".[18]

18 *Through a Closed Mouth the Flies Enter* by Pablo Neruda.

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THE HISTORY OF GLASS IN THE CZECH LANDS AND CONTEMPORARY DYNAMICS IN THE MANAGEMENT OF CULTURAL HERITAGE

Culture is recognized as the comparative advantage of cities and can lead to creation and the enhancement of a sense of identity.[1] Place and culture are persistently intertwined with one another, for any given place is always a locus of dense human interrelationships while culture is a phenomenon that tends to have intensely local characteristics, thereby differentiating places from one another.[2] Cities have always played a privileged role as centers of cultural and economic activity. From their earliest origins, cities have exhibited a conspicuous capacity to generate culture in the form of art, ideas, styles and ways of life, as well as to induce high levels of economic innovation and growth.[3]

It is acknowledged that culture is "a powerful tool". It encompasses a mixture of images and memories, thus acquiring symbolic significance by enhancing the economy of cities and their ability to produce space, reflecting Zukin's interpretation that: "*rightly or wrongly, cultural strategies have become keys to cities survival.*"[4] Two major elements have propelled this relationship between culture and cities: the first is urban competition, as cities have recognized that distinctiveness is a unique asset that can be offered to the external world. The second is culture, which in a world of globalization and of increasing homogeneity, is a key element - alongside history and geography - that defines identity, makes a place unique, and consistently can be used as a significant tool for city marketing.[5]

Most European cities are facing, once again, a complex array of economic, social, physical and environmental problems, therefore requiring them to compete with one another for investment and economic growth. In this discourse, the contribution of culture is central in many ways. Culture, as an important aspect of

1 Zukin 1995, 268-271.

2 Scott 2000, 3-5.

3 Scott 1997, 323-324.

4 Gibson and Stevenson 2004, 1-4; Lash and Urry 1994; Philo and Kearns 1993, 1-31; Zukin 1995, 259-294.

5 Arthurs 2002; Landry 2003, 5-18; Landry 2000; Tsenkova 1999.

urban policy, is often used to enhance the image of the city as well as a tool to strengthen social and cultural integration and sustainable development. Culture creates a climate of optimism - the essential "can do" attitude - and provides a means for developing creative cities.[6] As Adorno observed "culture suffers damage when it is planned and administered, but when left to itself… threatens to not only lose its possibility of effect but its very existence as well".[7]

Within this framework, this paper explores the dynamics in the management of cultural heritage as well as the relationship developed between cultural policies and sustainable development. The following case study of the long history of glassmaking in the Czech Lands, together with its profound connections with education, science, art and economy, has been selected from a series of world paradigms. The aim is to take glass into the future with interdisciplinary networks of world-wide cooperation towards a global Cultural Route of Glass.[8]

The Czech state was always an important crossroads of cultural currents and political interests and its geographic core has been connected with a range of lands or regions in the course of time. Bohemia with its 'classic position in the heart of Europe' has been linked during its history with Moravia, Silesia and Slovakia. The preconditions for advancement have been present for centuries. In his introduction to *The History of the Czech Nation in Bohemia and Moravia*, František Palacký, a preeminent Czech historian of the 19th century, emphasized that "*Nature itself, having completed and formed Bohemia as a particular unit, thus predetermined the main character of Czech history*"[9] within the European framework. The historical landscape in the contemporary cultural landscape is preserved to a certain degree and captures numerous political, economic, social and cultural events.

Glass has been continuously present in the Czech Lands, which is known to have the most developed glass manufacturing in Europe; an unceasing tradition of more than a thousand years.[10] The first traces reach back to the early Bronze Age and are associated with imports from the Middle East to Central Europe. From the reign of the Holy Roman Emperor Charles IV to the reign of the Holy Roman Emperor Rudolph II, glassworks reached a supreme level of technical perfection and there are also cases of royal glassmakers raised to the rank of hereditary aristocracy.[11] The outstanding "procédé de Bohême,"[12] used until the 19th century in the case of stained glass windows, a variety of luxury products developed in the course of time (such as painted and double-walled glass), unique engraving and cutting techniques, the discovery of special colours (such as the characteristic ruby red and ruby filigree, but most of all the "Czech crystal"), conquered the world market.[13] The Bohemian example influenced glass production in neighbouring countries[14] and led to a cultural revival and commercial success, thereby threatening Venice. At the beginning of the 18th century there was a remarkable boom in foreign sales which propelled the manufacture of glass "à la façon de Bohême" in France, Switzerland, Portugal, Spain, Italy, Belgium and Russia.

Gradually, when the trends of Classicism and the style of Empire defined the look of European glass, Bohemian glass achieved worldwide popularity[15] under the auspices of the Association for the Promotion of the Bohemian Glass Indus-

6 Agnew *et al.* 1984; Council of Europe 1997; Evans 2001; Florida 2002; Landry 2000; Matarasso 2001.

7 Quoted in Evans 2001, 139.

8 http://www.culture-routes.lu.

9 Langhamer 2003, 9; Pánek, Tůma *et al.* 2009, 25.

10 Davis 1972, 73-86; Drahotová 1983; Drahotová 1981b, 46-55; Galuška *et al.* 2012, 61-92; Haggrén and Sedláčková 2007, 185-250; Hess and Husband 1997, 127-190, 191-252; Klesse and Mayr 1987, 65-89; Kraskovská 1981, 11-17; Lněničková 2002; Langhamer 2003; Petrová and Olivié 1990; Sedláčková 2007, 181-226; Sedláčková 2006, 191-224.

11 Drahotová 1981a, 34-45; Hejdová 1981, 19.

12 Langhamer 2003, 16-18; Petrová and Olivié 1990, 28.

13 Lukáš 1981, 56-63.

14 Langhamer 2003, 39-53.

15 Brožová 1981, 64-73; Leonard and Rakow 1983, 195-200.

try alongside its excellent performance at world expositions. In the late 19th century, Bohemian glassmakers were among the best Art Nouveau producers after France and the United States.[16] The Bohemians, influenced also by the trends of cubism and functionalism, undertook important projects in the fine arts, industrial crafts and architecture while many creators collaborated against mass production in a bid to connect the art of glass with daily life.[17] Medals of merit were awarded and glassmakers designated as worldwide royal suppliers. Their products were mostly imitated in Europe and spread rapidly to America as well. Business and cultural leaders believed in Bohemian glass and strongly supported it. Furthermore, the preeminent education system turned the Czech Lands into a center for modern European-oriented glass creation and manufacture, which was based on a tradition of academic and creative excellence.

The Czech Lands demonstrated the most developed industrial base of any part of Austria-Hungary and progressively became one of the world's most industrialized nations, representing 20% of the world glass trade. The tough economic periods after both World Wars had an impact on glass production, but thanks to their frequent contact with the public and new multidimensional collaborations, Czech glassmakers were able to achieve notable results and construct a unique regional character. According to Dr Edmund Schebek, the first historian of Bohemian glassmaking, "*Nothing made the Czechs more world known than their glass.*"[18]

Today, the Czech Republic has a well-established, modern glass industry[19] that meets high standards in terms of competitiveness and thus represents approximately 7.33% of glass production in the European Union. Therefore, there is huge economic and entrepreneurial potential. The glass industry belongs to the traditional industrial branches of the Czech Industry, with a strong export orientation; over 80% of production is exported. Thus, it is susceptible to economic and political developments around the world.

The accession of the Czech Republic to the EU gave confidence to the industry. Contact with developed economies facilitated access to European markets, new materials and technologies as well as enhanced cooperation. However, the financial crisis in 2009 had a tremendous impact on the industry, freezing all activities; within one year revenue for products and services in all glass groups decreased by a total of 23.6%. The crisis acquired broad dimensions and threw into question the position of the Czech glass industry within world production and the association of the domestic industry with the global economy. In 2011, foreign trade became the only growth impulse and according to the Ministry of Finance "the productivity of the Czech economy increased by 1.7 %."[20] A calm period in the Euro zone as a result of the restructuring of the Greek debt and the positive impact of European Central Bank policies reduced risk as far as the future development of the Czech economy was concerned. Nevertheless, as problems in the Euro zone still persist, new negative external shocks to the Czech economy are to be expected.

Creative growth and the competitiveness of the glass industry are threatened mostly by the following: the strong development of the glass industry in emerging economies; the regional shortage of young professionals; the dissolution of a part of the technical production that could not overcome competition; the limited support of glass technology research; and a lack of interconnection among domestic manufacturers. On the other hand, the industry's assets include its world reputation; the high quality of raw materials and products; the renowned glass education system; the high potential of glass technicians and artists; as well as the successful development of small and medium-sized glassmaking businesses.

16 Adlerová 1981, 82-90; Urbancová 1981, 74-81.

17 Petrová and Olivié 1990, 99.

18 Langhamer 2003, 10, 123, 150-151.

19 Filgas and Dráždil 2005, 4-5; Lorenc 2005, 11; Purkrábková 2005, 9-10; Smerček 2005, 3; Tlapa 2005, 9; Vlasáková 2005, 8; Association of the Glass and Ceramic Industry of the Czech Republic (AGCICZR) at http://www.askpcr.cz.

20 AGCICZR 2011, Annual Report, at http://www.askpcr.cz/admin/files/vz/VZ2011-angl-final.pdf.

A focus on further development would encompass measures and investment incentives against increasing production costs and growing workforce losses, as well as shifts in legislation regarding sustainable development and the use of renewable sources. Furthermore, it would intensify investment on research for breakthrough changes in glass technology and high value added products.[21] The future of the industry depends on qualified people with vision who will promote imaginative enterprise and partnerships, encourage specialized education and professional orientation as well as safeguard the history and tradition of glass in the Czech Lands through the sustenance of cultural tourism.

At this critical crossroads of postmodern history, a broad understanding of the function of culture as a source of creativity, empowerment and "human capital"[22] seems crucial more than ever. Cultural policies have the potential to protect cultural values and shared memories while at the same time they can contribute to sustainable development, offering significant and long-lasting benefits; a wide spectrum broadening the concept of culture to the limit.[23] One of these cultural policies is the *Cultural Routes* Programme of the Council of Europe., launched in 1987. It is a pan-European programme and the idea was to make Europeans aware of their shared cultural heritage by means of a journey through space and time, through a trajectory covering one or more countries or regions, organized around topics whose historical, artistic or social interest proved to be European, either due to the geographical layout of the route, or its contents and significance. The Council of Europe awards "Cultural Route of the Council of Europe" or "Major Cultural Route of the Council of Europe" certification depending on the project's scale.[24]

Such joint efforts, managed by one or more independent and organized networks, led to new resources and approaches: cultural and educational exchanges; interdisciplinary and intercultural dialogue; mutual respect; support for innovation in the field of cultural tourism; and long-term multilateral cooperation projects, thereby offering new perspectives in the mobility of people and collections.[25]

Within this framework and taking into consideration the significance of the *Cultural Routes*, a proposal has been put forward for the International Association for the History of Glass to lead the initiative for the foundation of a prospective *Cultural Route of Glass*. The long history and tradition of the Association provide all the essential documentation and the dynamics for the advancement of such a route that would merge the history of glass with innovative creative potential.

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21 Hotar 2012a, 14-20; Hotar 2012b, 19-26; Prokop 2005, 10; Rydvalova and Hotař 2012; Turnovský 2005, 11.
22 Council of Europe 1997.
23 Evans and Shaw 2004.
24 http://www.culture-routes.lu
25 Consejo de Europa 2007; Council of Europe 1997; Etienne-Nugue 1990; Faucher 1994; Pettersson *et al* 2010; Unesco 2004.

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