



ANNALES

du 20^e CONGRÈS
de l'ASSOCIATION
INTERNATIONALE
pour l'HISTOIRE du VERRE

Fribourg / Romont 7-11 septembre 2015

This volume is sponsored by Vitrocentre and
Vitromusée Romont and by anonymous donators

**VITROCENTRE
ROMONT**

CENTRE SUISSE DE RECHERCHE
SUR LE VITRAIL ET LES ARTS DU VERRE
SCHWEIZERISCHES FORSCHUNGSZENTRUM
FÜR GLASMALEREI UND GLASKUNST
SWISS RESEARCH CENTRE
FOR STAINED GLASS AND GLASS ART

**VITROMUSÉE
ROMONT**

MUSÉE SUISSE DU VITRAIL
ET DES ARTS DU VERRE
SCHWEIZERISCHES MUSEUM
FÜR GLASMALEREI UND GLASKUNST
SWISS MUSEUM OF STAINED GLASS
AND GLASS ART

www.vitrocentre.ch

Cover illustration

Goblets with white filigree decoration, produced in Swiss glasshouses, late 17th to early 18th century. From different Swiss public and private collections. For a detailed discussion see: Erwin Baumgartner, *Reflets de Venise*, Bern 2015, p. 254–272, 322–328 and the contribution of Christophe Gerber in the present volume, page 564.

Editors

Sophie Wolf, Anne de Pury-Gysel

Editing Committee

Erwin Baumgartner, Sylvia Fünfschilling,
Marion Gartenmeister, Anne de Pury-Gysel,
Stefan Trümpler, Sophie Wolf

Scientific Committee

Anastassios Antonaras, Françoise Barbe, Erwin Baumgartner,
Uta Bergmann, Isabelle Biron, Brigitte Borell, Sally Cottam,
Patrick Degryse, Maria Grazia Diani, Anna-Barbara
Follmann-Schulz, Danièle Foy, Ian Freestone,
Sylvia Fünfschilling, Bernard Gratuze, Susanne Greiff,
Yael Gorin-Rosen, Despina Ignatiadou, Caroline Jackson,
Yves Jolidon, Dedo von Kerssenbrock-Krosigk,
Stephen Koob, Ingeborg Krueger, James Lankton,
Irena Lazar, Isabelle Lecocq, Reino Liefkes, Dave Lüthi,
Teresa Medici, Marie-Dominique Nenna, Sarah Paynter,
Jennifer Price, Anne de Pury-Gysel, Thilo Rehren,
Helmut Rieke, Beat Rütli, Lucia Saguì, Flora Silvano,
E. Marianne Stern, Stefan Trümpler, Marco Verità,
Sophie Wolf

Layout

Andrea Engl and fischbacher & vock

Cover and book design

fischbacher & vock

AIHV

Association Internationale pour l'Histoire du Verre
International Association for the History of Glass
Internationale Vereinigung für die Geschichte des Glases
www.aihv.org

© AIHV and authors

Romont 2017

Gesamtherstellung



Verlag Marie Leidorf GmbH,
Geschäftsführer: Dr. Bert Wiegel,
Stellerloh 65 · D-32369 Rahden/Westf.
Tel.: +49/(0)5771/9510-74 · Fax: +49/(0)5771/9510-75
E-Mail: info@vml.de
Homepage: www.vml.de
Gedruckt auf alterungsbeständigem Papier
Druck: druckhaus köthen GmbH&Co. KG, Köthen

ISBN 978-3-86757-024-4

CONTENTS

XI	PRÉFACE
XIII	PREFACE
XV	VORWORT
	<i>Sylvia Fünfschilling</i>

ANTIQUE AND ISLAMIC GLASS (KEYNOTES)

2	L'étude du verre antique. Etat de la question <i>Marie-Dominique Nenna</i>
10	Entre Orient et Occident, le verre islamique (VIII ^e –XIII ^e siècle) : apports récents et réflexions sur les échanges et les influences <i>Danièle Foy</i>

ARCHAIC, CLASSICAL AND HELLENISTIC GLASS

36	Glass fragments from Qal'eh Kali, an Achaemenid site in south-western Iran <i>Bernadette McCall, Amanda J. Dusting</i>
43	Capacity measurement to demonstrate standardised productions of the core-formed vessels from the late Archaic to the late Hellenistic period. An interim report <i>Peter Cosyns, Bieke Verhelst, Karin Nys</i>
48	The provenance of Hellenistic core-formed vessels from Satricum, Italy <i>Artemios Oikonomou, Marijke Gnade, Julian Henderson, Simon Chenery, Nikos Zacharias</i>
54	Glass vessels from the Persian and Hellenistic administrative building at Tel Kedesh, Israel <i>Katherine A. Larson, Andrea M. Berlin, Sharon Herbert</i>
61	Gold in glass <i>Despina Ignatiadou</i>
68	A study of the cut gold leaf decoration techniques on ancient gold sandwich glass, with emphasis on the Hellenistic 'Kirikane' technique <i>Hidetoshi Namiki, Yasuko Fuji</i>
73	Hellenistic mosaic glass and La Tène glass-working <i>Natalie Venclová, Šárka Jonášová, Tomáš Vaculovič</i>

ROMAN GLASS

82	Gold-band glass fragments in the Römisch-Germanisches Museum of Cologne: considerations about the techniques <i>Giulia Cesarin</i>
87	La vaisselle en verre de deux sépultures aristocratiques augusto-tibériennes à Ath/Ghislenghien (Province de Hainaut, Belgique) <i>Frédéric Hanut, Véronique Danese</i>
92	Le verre romain de Montignac-sur-Vézère (Dordogne) <i>Laure Simon</i>
98	The Roman necropolis of Budva (Montenegro) and its mould-blown glass assemblage <i>Irena Lazar</i>
103	Mold-blown glass from the Roman province of Dalmatia <i>Berislav Štefanac</i>
109	Römische Tintenfässer Isings 77 <i>Michael Johannes Klein</i>
116	A comparative investigation of the glass vessels and objects from eastern Thrace and Lydian tumuli in the light of the Dügüncülü and Güre finds <i>Ömür Dünya Çakmaklı, Emre Taştemür</i>

- 124 Le sanctuaire d'Yvonand-Mordagne (Vaud, Suisse) : premier aperçu de la vaisselle cultuelle en verre
Chantal Martin Pruvot, Ellinor Stucki
- 132 Blown mosaic glass of the Roman period: technical observations and experiments
E. Marianne Stern
- 140 Two polychrome mosaic bowls and associated glass vessels from a rich 2nd century burial at Kelshall, Hertfordshire, England
Sally Cottam, Jennifer Price
- 145 Früh- und mittelkaiserzeitliche Glasgefäße im nördlichen Obergermanien
Martin Grünewald
- 152 L'exceptionnelle verrerie d'un bûcher funéraire du III^e siècle après J.-C. de Jaunay-Clan (Vienne, France)
Laudine Robin
- 160 Le verre archéologique du Canton du Tessin (Suisse) : une révision
Simonetta Biaggio-Simona
- 163 More glass from Aquileia (Italy)
Luciana Mandruzzato

LATE ROMAN AND EARLY MEDIEVAL

- 168 Mapping glass production in Italy. Looking through the first millenium AD
Barbara Lepri, Lucia Saguì
- 175 Chemical signature and scale of production of primary glass factories around the Mediterranean in the first millenium AD
Patrick Degryse
- 181 The cut-glass beaker from Biel-Mett/BE
Sylvia Fünfschilling
- 184 New evidence about engraved glass from Milan (Italy) (3rd–4th century AD)
Marina Uboldi
- 190 Besondere Glasfunde aus dem Gräberfeld Gönheim (Kreis Bad Dürkheim) – Germania prima – und ein neuer Ort möglicher Glasverarbeitung
Andrea Ideli
- 194 Glass vessels from Late Roman burials in Languedoc-Roussillon (France): key points, from glass production to the ritual of grave deposits
Stéphanie Raux
- 203 Late antique and early medieval glass vessels from northern-central Apulia: productions, typologies, functions and circulation
Francesca Giannetti, Roberta Giuliani, Maria Turchiano
- 209 A large glass dish from Cástulo (Linares – Jaén, Spain) with an engraved representation of Christ in Majesty
David Expósito Mangas, Marcelo Castro López, Francisco Arias de Haro, José Manuel Pedrosa Luque, Bautista Ceprián del Castillo
- 213 Late Roman glass from Mala Kopašnica (Serbia) – forms and chemical analysis
Sonja Stamenković, Susanne Greiff, Sonngard Hartmann
- 222 Glass vessels from Late Roman graves in the Hungarian part of the Roman province Pannonia
Kata Dévai
- 230 Recent glass finds from Elaiussa Sebaste in Cilicia
Çiğdem Gençler-Güray
- 235 Indices d'ateliers de verriers à Apamée de Syrie, à la fin de l'Antiquité
Danièle Foy, avec la collaboration de Bernard Gratuze
- 240 Une mosaïque de verre à thème chrétien (V^e s.), du site monastique copte des Kellia (Basse-Égypte)
Denis Weidmann
- 243 New finds of mosaic glass inlays from Antinoupolis, Egypt
Flora Silvano

- 248 Glass bead trade in northeast Africa in the Roman period.
A view according to the Museum of Archaeology University of Stavanger assemblage
Joanna Then-Obluska, Barbara Wagner
- 257 A Late Roman glass workshop at Komarov (Middle Dniester) and
the problem of the origin of 'Barbarian' facet cut beakers
Olga Rumyantseva, Constantin Belikov
- 265 The glass collections in the 'Museum Aan de Stroom' (MAS), Antwerp (Belgium)
Eugène Warmenbol, Annemie De Vos, Peter Cosyns
- 271 Le verre de la nécropole mérovingienne de La Mézière (Bretagne, France)
Françoise Labaune-Jean

BYZANTINE AND ISLAMIC GLASS, NEAR EAST

- 280 Opaque red glass tesserae from Roman and early-Byzantine sites of north-eastern Italy:
new light on production technologies
Sarah Maltoni, Alberta Silvestri, Gianmario Molin
- 288 The Early Islamic green lead glass from the excavations at Caesarea Maritima, Israel
Rachel Pollak
- 293 Study on the Early Islamic glass excavated in Paykend in the Bukhara Oasis, Uzbekistan
Yoko Shindo
- 300 Reexamination of a Mamluk glass collection from Jerusalem
Naama Brosh
- 307 Mamluk glass from Quseir al-Qadim: chemical analysis of some glass fragments
Laure Dussubieux
- 313 An outstanding glass assemblage from the medieval and Ottoman castle at Safed (Zefat)
Natalya Katsnelson, with a contribution by Matt Phelps
- 319 Byzantine glass bracelets in Western Rus. Archaeological finds from Belarus
Kristina A. Lavysheva

EUROPEAN GLASS FROM 700 TO 1500

- 326 Red and orange high-alumina glass beads in 7th and 8th century Scandinavia:
evidence for long distance trade and local fabrication
Torben Sode, Bernard Gratuze, James W. Lankton
- 334 Evolution of glass recipes during the Early Middle Ages in France:
analytical evidence of multiple solutions adapted to local contexts
Inès Pactat, Magalie Guérit, Laure Simon, Bernard Gratuze, Stéphanie Raux, Céline Aunay
- 341 'The Emerald of Charlemagne': new observations on the production techniques and
provenance of an enigmatic glass artefact
Cordula M. Kessler, Sophie Wolf, Jürg Goll
- 346 Les verres du Haut Moyen Âge issus des fouilles du *monasterium Habendum* (Saint-Amé, Vosges)
Hubert Cabart (†), Inès Pactat, Bernard Gratuze, avec la collaboration de Charles Kraemer et Thomas Chenal
- 354 Technological transition in early medieval northern Italy: preliminary data for Comacchio glass
Camilla Bertini, Julian Henderson, Sauro Gelichi, Elena Basso, Maria Pia Riccardi, Margherita Ferri
- 360 Where does the medieval glass from San Genesio (Pisa, Italy) come from?
Marja Mendera, Federico Cantini, Alessandra Marcante, Alberta Silvestri, Filomena Gallo, Gianmario Molin, Marco Pescarin Volpato
- 366 Natron and plant ash glass in the Middle Danube region during the Early Middle Ages
Danica Staššíková-Štukovská
- 374 Glass in fashion and trade in Bohemia in the 9th-11th century (archaeology and archaeometry)
Kateřina Tomková, Šárka Jonášová, Zuzana Zlámalová Cílová

- 379 13th–14th century glass in northwest Bohemia: typology, archaeometry and provenance
Eva Černá
- 385 Glass production in medieval Spain: a long-term perspective on knowledge transfer
Chloë N. Duckworth
- 391 Die Glaserzeugnisse Bolgars und ihr Verhältnis zu anderen mittelalterlichen Glasproduktionen
Svetlana Valiulina
- 399 Glass from Enez (ancient Ainos)
Üzlifat Canav-Özgümüş, Serra Kanyak
- 403 Indices de travail du verre rouge dans l’atelier médiéval d’Anlier, seconde moitié du XIV^e siècle (Luxembourg belge)
Chantal Fontaine-Hodiamont, Denis Henrotay

EUROPEAN GLASS FROM 1500 TO 2000

- 412 Looking through late medieval and early modern glass in Portugal
Teresa Medici, Inês Coutinho, Luís C. Alves, Bernard Gratuze, Márcia Vilarigues
- 421 La consommation du verre à Paris entre le XIV^e et le XIX^e siècle : des données récentes
Amélie A. Berthon, Isabelle Caillot, Kateline Ducat
- 429 Zur Frage der Provenienz von historischen Gläsern – Die Sammlung des Herzog Anton Ulrich-Museums in Braunschweig und des Rijksmuseums Amsterdam
Nicole Brüderle-Krug
- 435 Les verres émaillés vénitiens de la Renaissance : le projet Cristallo
Françoise Barbe, Fernando Filipponi
- 444 Renaissance Venetian enamelled glass. Genuine, façon de Venise and fake or copy artefacts
Marco Verità, Isabelle Biron
- 453 All-glass hybrids: Why they were made and the importance of identifying them
Suzanne Higgott
- 460 All-glass hybrids: What they are, manufacturing techniques and detection
Juanita Navarro
- 467 Venedig oder Tirol? Zur Lokalisierung einiger Hohlgläser des 16. Jahrhunderts mit Kaltbemalung im Bayerischen Nationalmuseum
Annette Schommers
- 474 Glashütte Hall in Tirol. Die archäologischen Grabungen 2008 und 2009
Anna Awad
- 482 Goblets of the late- to post-medieval period from archaeological excavations in Dubrovnik
Nikolina Topić
- 490 16th-century glass vessels from the burials of the Ascension Convent in the Moscow Kremlin
Ekaterina Stolyarova
- 495 The problem of forgeries in 19th century Murano
Aldo Bova
- 498 Deutsche Formgläser des 16. und 17. Jahrhunderts? Beobachtungen und Überlegungen zu einer Neudatierung
Dieter Schaich
- 506 Die älteren Glashütten der Schweiz (ca. 1200–1800)
Walter Schaffner
- 512 „À la façon de Venise“: Zur Geschichte des Begriffs und zur Verbreitung von Gläsern in venezianischer Art in Westfalen
Sveva Gai
- 522 Haushalt, Apotheke oder Gasthaus? Zusammensetzungen frühneuzeitlicher Glasfundkomplexe im Kontext ihrer Fundsituation
Birgit Kulessa

- 532 Mirrors, spectacles and looking glasses in Antwerp and the Duchy of Brabant: aspects of production and use of optical glass based on serial documentary and archaeological evidence
Danielle Caluwé
- 537 *Façon de Venise*, une étiquette problématique. Propositions pour une méthodologie raisonnée de l'étude de la verrerie à l'italienne en Europe, XV^e-XVIII^e siècle, à partir de l'exemple du marché parisien (1550-1665)
Benoît Painchart, Christiane Guyomar
- 542 Diagnostic differences between early filigree glass and the Rosenborg Castle-type filigree glass
Kitty Laméris
- 547 The golden age of Amsterdam glass. A chemical and typological approach to recognize Amsterdam 17th century glass production
Michel Hulst, Jerzy J. Kunicki-Goldfinger
- 554 What's the purpose: oil lamp, perfume sprinkler or trick-glass?
Reino Liefkes
- 561 Court, Pâturage de l'Envers : une verrerie forestière du début du XVIII^e siècle entre tradition et modernité (Jura bernois, Suisse)
Christophe Gerber
- 567 Der Kühlprozess der Glashütte von Court, Pâturage de l'Envers (1699-1714) im Berner Jura (Schweiz)
Jonathan Frey
- 575 Quelques révélations sur l'outillage de la verrerie du Pâturage de l'Envers à Court (1699-1714)
Lara Tremblay
- 578 Eighteenth century lead glass in the Netherlands
Anna Laméris
- 585 Imported beads in Russia in the 17th and first half of the 18th centuries (Moscow, Mangazeya, Smolensk region)
Julia Likhter
- 591 „Pressglas“ aus Benedict Vivats Glasfabriken
Valentina Bevc Varl
- 597 Glass fishing floats from Greek sites
Anastassios Antonaras
- 602 Crizzling glass – corrosion products and chemical composition of Bohemian glass
Zuzana Zlámálová Cílová, Helena Brožková, Michaela Kněžů Knížová, Irena Kučerová
- 606 The development of the chemical composition of Czech mosaic glass from the Middle Ages to the present day
Michaela Kněžů Knížová, Zuzana Zlámálová Cílová, Irena Kučerová, Martin Zlámál
- 612 The glass collection of Felice Barnabei at the Museo Nazionale Romano – Palazzo Massimo in Rome
Giulia Giovanetti, Silvia Bruni
- 617 Zwei vernachlässigte Glasvarietäten des 19. Jahrhunderts: Aventurin-Hohlglas und Uran-Selenglas
Sibylle Jargstorf
- 621 The Glass Room of the National Palace of Necessidades in Lisbon
Alexandra Rodrigues, Bruno Martinho, Frederik Berger, Anísio Franco, Márcia Vilarigues
- 625 Albert Dammouse (1848-1926) et la pâte de verre (1897-1913)
Véronique Ayroles
- 631 Le verre artistique de Saint-Prex (1928-1964)
Stanislas Anthonioz, Ana Quintero Pérez

ASIAN GLASS

- 640 A unique glass object from a Buddhist context in Sri Lanka
Brigitte Borell
- 647 Glass exchange and people in ancient East Asia
Chizuko Kotera

- 652 Glass from Mughal India. A study of four eighteenth century cobalt blue bottles
Tara Desjardins

WINDOW GLASS AND STAINED GLASS

- 660 The early medieval stained glass windows from St. John, Müstair: materials, provenance and production technology
Sophie Wolf, Cordula M. Kessler, Jürg Goll, Stefan Trümpler, Patrick Degryse
- 668 Painted window glasses from Akko/Acre from the Crusader period (1099–1291 CE).
Manufacturing processes and conservation
Adrienne Ganor
- 672 Medieval window glass in Scotland
Helen Spencer, Craig Kennedy
- 680 Untersuchungen zur Provenienz von Gläsern aus dem Kloster Maulbronn
Manfred Torge
- 684 Swiss *Kabinettscheiben* from a 19th century Portuguese collection. Study and chemical characterisation
Andreia Machado, Alexandra Rodrigues, Mathilda Coutinho, Luís C. Alves, Victoria Corregidor, Rui C. da Silva, Vincent Serneels, Ildiko Katona Serneels, Sophie Wolf, Stefan Trümpler, Márcia Vilarigues
- 689 Le vitrail dans les hôtels suisses de la Belle-Epoque : une importance sous-estimée ?
Dave Lüthi
- 697 „Magisches Licht“ – Glasfenster in der neo-islamischen Architektur
Sarah Keller
- 699 The window glass and stained glass windows of Belém: a cultural history of the Brazilian Amazon region
Amanda Corrêa Pinto, Márcia Vilarigues, Thais Sanjad
- 703 Autour d'un artiste-verrier de la première moitié du XX^e siècle.
Marcel Poncet (1894-1953) : à la jonction de la peinture et du vitrail
Camille Noverraz
- 706 L'activité créatrice de Paule Ingrand au sein d'« Art et Verre » (1946 à 1962)
Isabelle Lecocq, avec la collaboration de Catherine Thomas
- 713 Makellos transparent oder mit romantischen Schlieren? Überlegungen zu Sortenvielfalt und Ästhetik des
Fensterglases im frühen 20. Jahrhundert mit Fokus auf dem Spiegel- oder Kristallglas
Anne Krauter, Ueli Fritz

REVERSE PAINTING ON GLASS

- 722 Une œuvre du Vitromusée Romont passée à la loupe. Un cabinet de facture napolitaine décoré de plaquettes
de verre peintes
Elisa Ambrosio
- 725 La peinture sous verre « savante » en France au XVIII^e siècle : oubliée puis redécouverte
Jeannine Geyssant
- 732 La peinture sous verre chinoise au XVIII^e siècle. Une rencontre artistique Chine – Occident
Thierry Audric
- 735 La peinture sous verre monumentale de l'église paroissiale de Mézières (Fribourg, Suisse) :
« La délivrance de Saint Pierre », 1940, par Emilio Maria Beretta
Monika Neuner, Yves Jolidon, Pascal Moret

GENERAL THEMES

- 740 Le verre à l'école, un projet pour les jeunes
Maria Grazia Diani, Luciana Mandruzzato

LOOKING THROUGH LATE MEDIEVAL AND EARLY MODERN GLASS IN PORTUGAL

Teresa Medici, Inês Coutinho, Luís C. Alves, Bernard Gratuze, Márcia Vilarigues

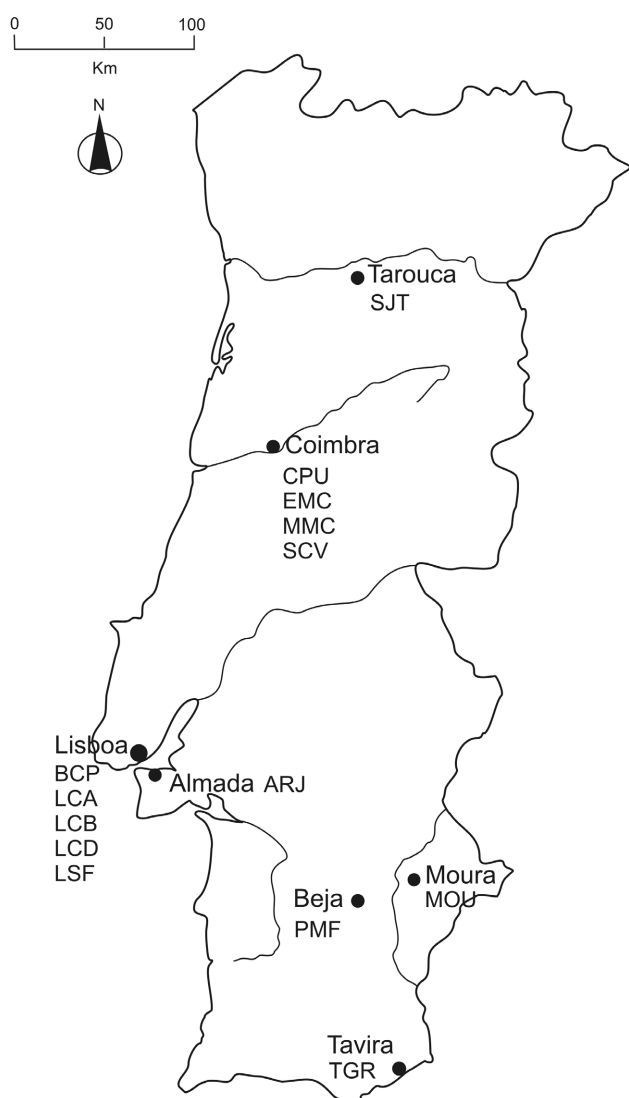


Fig. 1: Localisation of the archaeological sites included in the study.

Post-Roman glass in Portugal has recently become a subject of extensive investigations combining archaeological and archaeometric approaches. Within the research project 'Portuguese glass collections: study and preservation' carried out by VICARTE with C2TN/IST - University of Lisbon (Portugal), and IRAMAT - Centre Ernest-Babelon, CNRS Université d'Orléans (France), several glass collections and archaeological assemblages dating from the 14th through 19th century are being studied.

This study looks at fourteen glass assemblages dating to between the 14th and the 17th century, coming from different

Portuguese archaeological sites from the North to the South of the country (figure 1). The examination of almost 2800 objects made it possible to propose, for the first time, a chrono-typological classification for late medieval and Early Modern glass in Portugal.¹

The glass from the 14th to 15th century fits into the typical range of late medieval glassware in Europe; drinking glasses, bottles, and urinals in primarily yellowish or green glass make up the majority of the studied groups (figure 2a). The beakers are often decorated with mould-blown rib patterns and/or applied trails. A few colourless fragments have a blue trailing on the rim. One beaker with enamelled decoration ('Aldrevandin beaker') dates from the late 13th to the first half of the 14th century. Fragments of pruned beakers (*Krautstrunk*) were also identified. The goblets have hollow stems and mould-blown rib decoration and were probably made shaping one single parison of yellowish or green glass. Pedestal beakers are documented from the end of the 15th century.

The presence of bracelets is also worth noting. During the 14th and 15th century, bracelet diffusion in Western Europe seems to be restricted to the Iberian Peninsula, probably as a result of the Islamic presence. In Spain they appear frequently in burials worn by women, not only in Al-Andalus, but also in Mudejar, Christian, and Jewish cemeteries in the Meseta, Castella, and Aragon.² They were also worn by a young Christian woman found in the Portuguese town of Alcácer Ceguer, Morocco.³

During the 16th century, most medieval forms were gradually replaced by typical Renaissance footed glass types, such as goblets with stems made of one or more knops, pedestal beakers, and *tazzas* (figure 2b). So far, all of the footed specimens recorded were produced by blowing and shaping a single gather of glass. This is a different technique than Venetian stemmed glasses that were made by joining separate elements. Another common feature of this period are globular bottles with truncated-conical or long cylindrical necks, often decorated by a mould-blown ribbed pattern. Bracelets are still popular, made from black, blue, or yellow glass rods, either plain or decorated with a spiraling white trail.

¹ MEDICI 2014a. Preliminary results have been published in FERREIRA 2004; FERREIRA and MEDICI 2010; MEDICI 2005; MEDICI 2008; MEDICI 2011; MEDICI 2014b; MEDICI et al. 2009.

² BALADO PACHÓN and ESCRIBANO VELASCO 2001; MALALANA UREÑA and LORA HERNÁNDEZ 2014.

³ REDMAN 1986, 204.

During the 17th century, the functions of glass objects widened to include all the aspects of everyday life (figure 3). Table glass, jugs, utilitarian and decorative vases, lamps, urinals, devices for medical and hygienic care (like suction cups), inkwells, and so on seem to have large circulation. The variety of glass colours available broadened to include dark green, blue, and dark red.⁴ Venetian glass is identified, as the opaque white cups with speckled decoration or a moulded vase with human faces and festoons.⁵ Others types, belonging to the *façon de Venise* family, are also present. Some bowls and jars could have a Spanish origin. Rare items were also found, for example a globular bottle with gilded decoration: a fairly common Portuguese form from the 17th century glass, the decoration on this bottle makes this a very special piece.⁶ *Millefiori* and opaque red glass also appeared in several places.

THE ORIGIN OF THE GLASS FOUND IN PORTUGAL

The lack of suitable archaeological records concerning furnaces strongly hinders the comprehension of the glass types produced and circulating in Portugal before the 18th century.

Written sources show that glass production in Portugal began as early as the 15th century. The locations of workshops and names of several glass masters are known.⁷ The import of glass from Venice, Catalonia, and the Low Countries is mentioned and valuable objects identified as Venetian appear in inventories.⁸ Documents rarely describe the objects in detail, so it is impossible to know what kind of glass was being produced or imported. A verdict dated February 22nd 1625, which puts an end to a dispute between the glasshouse of Covo (Oliveira de Azeméis) and the counts da Feira, records that in order to liquidate the appropriate amount the guilty party should deliver 'seis peças de vidro bons como no prazo se dizia e ajuam de ser guarrafas púcaros guomis',⁹ that is 'six items of good glass ... and should be bottles, mugs and ewers', in addition to some money.

Both local production and imports from abroad reached some significance during the 16th century. A royal charter from King D. Sebastião, passed in 1563, prohibited the import of Venetian glass because the local production was of a comparable quality:

'Eu ElRey...sam informado que os vidros que trazem de Veneza a vender a estes Reinos não sam necessários nem proveituosos por aver em eles vidros da teRa que hos podem escusar ...'.¹⁰

A report addressed to Ferdinand I de' Medici, *Granduca di Toscana*, dating to 1592, discusses the Murano glass trade. The document mentions that during that year a variety of glass was sent to Lisbon, including vessels in the shape of lions and boats:

'Per Lisbona vetraria fina e cristalli assai per duc. 10.000. Cristalli bolliti, grandi, di lire 40 fino a 50 cento, foggie di li-one, nave, sporte, fontane, tal pezo lire 1,1 ½, lire 2, 2 ½, e lire 3 il pezo, e spechiere fornite'.¹¹

In the 1704 inventory of the goods of D. Luís de Lencastre,

Count of Vila Nova, the origin of the listed glass is not mentioned. However, a detailed description of some of the objects allows us to identify some items as Venetian or *façon de Venise*. The document lists, among other items, two crystal goblets with gilded stems, one in the shape of a serpent with two emerald eyes and the other in the shape of an owl, both recalling well known 17th century types.¹²

'Outra taça com seu pée forma de uma bicha tudo de cristal com sua cauda vazel em o pée e garganta de ouro tem duas esmeraldas em os olhos ... Hum mocho de christal com pées e vazel em o pescoço tudo de prata dourada ...'.¹³

Approaching the archaeological glass under study, a stylistic approach was the first analytical method to discern the difference between imported and locally produced glasses.

In some cases, well-known glass types such as some 17th century Venetian or *façon de Venise* glasses were easily identified. In other cases, the identification of features that are without parallels outside Portugal provided evidence to consider some objects as local products, at least as a working hypothesis, as for example the gourd-shaped bottles (figure 3: SCV0079-V022).

Chemical analysis was conducted on a selection of the glass vessels believed to be local products and on a selection of supposed Venetian and *façon de Venise* glasses with the aim of identifying some compositional features supporting our interpretation. All the late medieval and early modern fragments analysed so far were made of soda-lime-silica glass using coastal plant ashes as the flux, connecting the products with the Mediterranean glass-making tradition. Some samples have unusually high alumina contents, 3–6 wt. % Al₂O₃, which is rare for European glass from this period. Some pieces revealed an additional complexity such as the *millefiori* glasses. *Millefiori* is considered to be a typical Venetian decoration, but the analyses have highlighted that in some objects the body glass and the glass used for the decoration are different. The vessel bodies were produced with non-Venetian glass with a high alumina content while the decoration was made from multicoloured glass rods of genuine Venetian origin.¹⁴

4 FERREIRA 2004; MEDICI et al. 2009.

5 MEDICI 2014b.

6 COUTINHO et al. 2016b.

7 MENDES 2002, 39, fig. 28; VALENTE 1950.

8 MATOS SEQUEIRA [s.d.] III.

9 Cartório da Casa do Covo, Sentença da Casa da Relação do Porto, de 18 de Junho de 1626, *apud* COSTA 1955, 12.

10 I know that glasses arriving from Venice to be sold in these kingdoms are superfluous and not convenient, because glass from this country does exist that make them unnecessary': 'Alvará régio sobre a importação e venda de vidros de Veneza: 1563-VII-15', in: *Documentos* 1969, 70.

11 CORTI 1971, 653.

12 See for example a serpent stem with blue eyes at the Corning Museum of Glass (inv. n.º 51.3.118, available at: <http://www.cmog.org/> through the "Search collection" tool (27th January 2016) and an owl stem at the British Museum (inv. n.º S.461: TAIT 1991[2012], 144, fig. 86).

13 DE ANDRADE E SOUSA 1956, 33–34.

14 For preliminary results concerning late medieval glass objects from Beja and 17th century glass from Coimbra, Sta. Clara-a-Velha, see: LIMA et al. 2012; COUTINHO et al. 2016a; COUTINHO et al. 2016b; and COUTINHO et al. 2016c.

15 GRIME and DAWSON 1995.

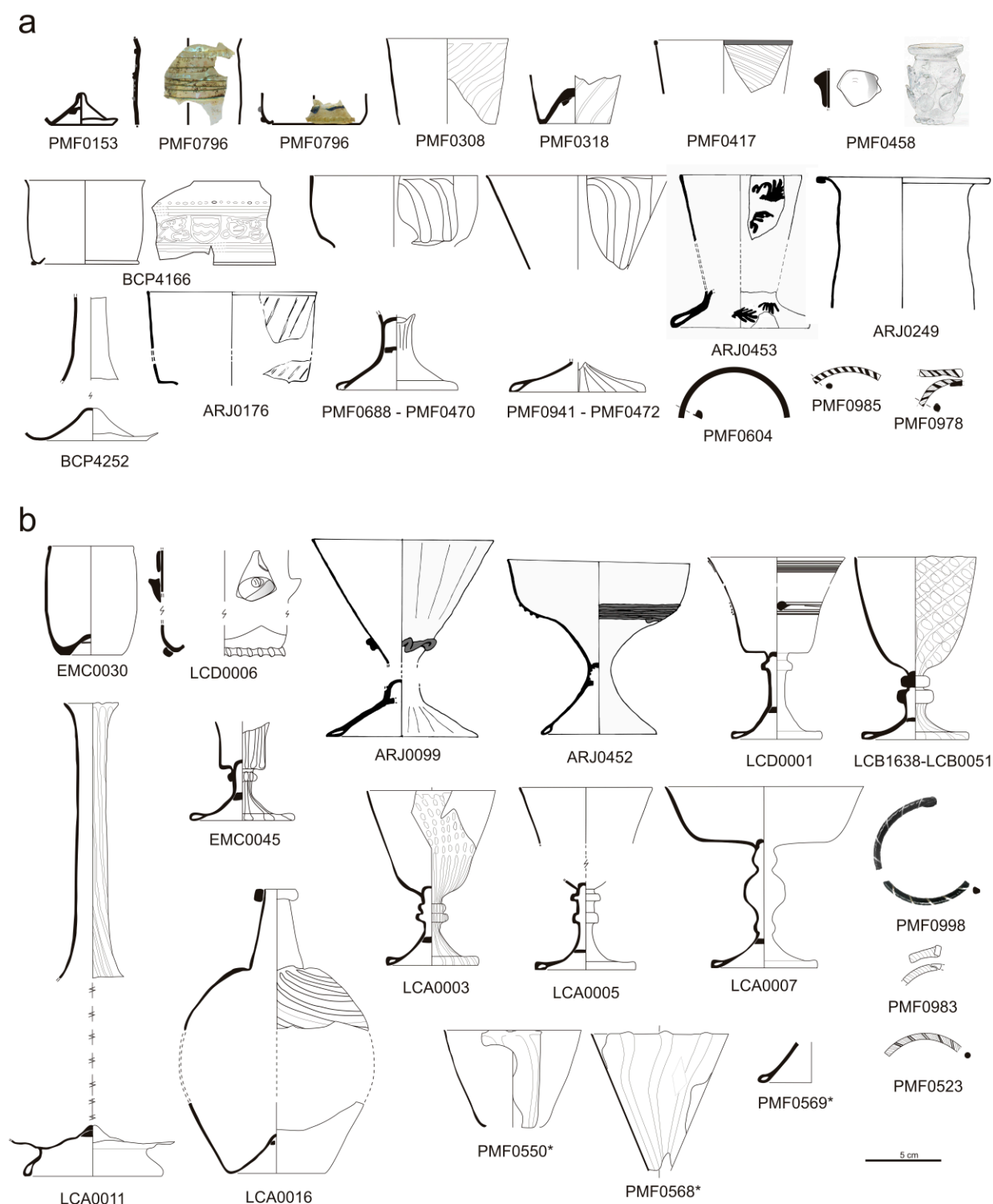


Fig. 2: a) 14th–15th century glass; b) 16th century glass. The asterisk (*) indicates the analysed objects (drawings: T.Medici; scale 1:4).

VENETIAN OR *FAÇON DE VENISE*?

A deeper investigation was done on a selection of 31 Venetian and/or *façon de Venise* objects belonging to the archaeological contexts of Santa Clara-a-Velha Monastery in Coimbra (SCV), São João de Tarouca Monastery (SJT), Miguel Fernandes square in Beja (PMF), and to the Coimbra University courtyard (CPU). The mostly colourless goblets and bottles, sometimes with a greyish or bluish hue, are decorated with filigree, diamond point engraving, or mould blown ribs (figures 2 and 3).

Experimental

The chemical composition was determined by particle induced X-ray emission (μ -PIXE) down to tens of $\mu\text{g/g}$ level. The results allowed selecting some objects to further extend the trace elements analysis down to the ng/g level through the use of laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). Glass colours and natural hues were studied by means of UV/VIS reflectance spectroscopy.



Fig. 3: 17th century glass. The asterisk (*) indicates the analysed objects (drawings: T. Medici, M. Ferreira, and N. Santos, scale 1:4; photographs by T. Medici and I. Coutinho, unless SCV0030-V034, SCV0002-V002, and SCV-V108 by Miguel Munhóz © DRCC / Mosteiro de Santa Clara-a-Velha).

The chosen methodology implied sampling of all selected objects in order to avoid erroneous results by analysing and quantifying corrosion layers instead of the uncorroded bulk glass. Small samples of 2–4 mm² were dry-cut from the fragments using a diamond wire. Samples were embedded in an epoxy resin and polished with SiC sandpapers down to 4000 mesh. This sampling procedure was performed only on broken objects and on individual fragments without possible connections.

Produced by the 2.5 MV Van de Graaff accelerator installed at Polo de Loures, Portugal, from IST, MeV proton beams were used to perform μ -PIXE sample analysis using an Oxford Microbeams OM150 type nuclear microprobe. The proton beam was focused down to 3 × 4 μ m² and the pro-

duced X-rays detected by a 145 eV resolution Si(Li) or SDD detector. In order to avoid or detect possible local glass heterogeneities, imaging (2D elemental distribution) and X-ray spectra were obtained from an irradiated sample area of 750 × 750 μ m². Operation and basic data manipulation were achieved through the OMDAQ software code¹⁵ and quantitative analysis done with GUPIX program.¹⁶ The results in oxides weight percentage (wt. %) form were normalized to 100 %. In order to validate the results, two glass reference standards were also analysed, Corning B and Corning C.

¹⁶ CAMPBELL et al. 2010.

¹⁷ GRATUZE 2013; GRATUZE 2014.

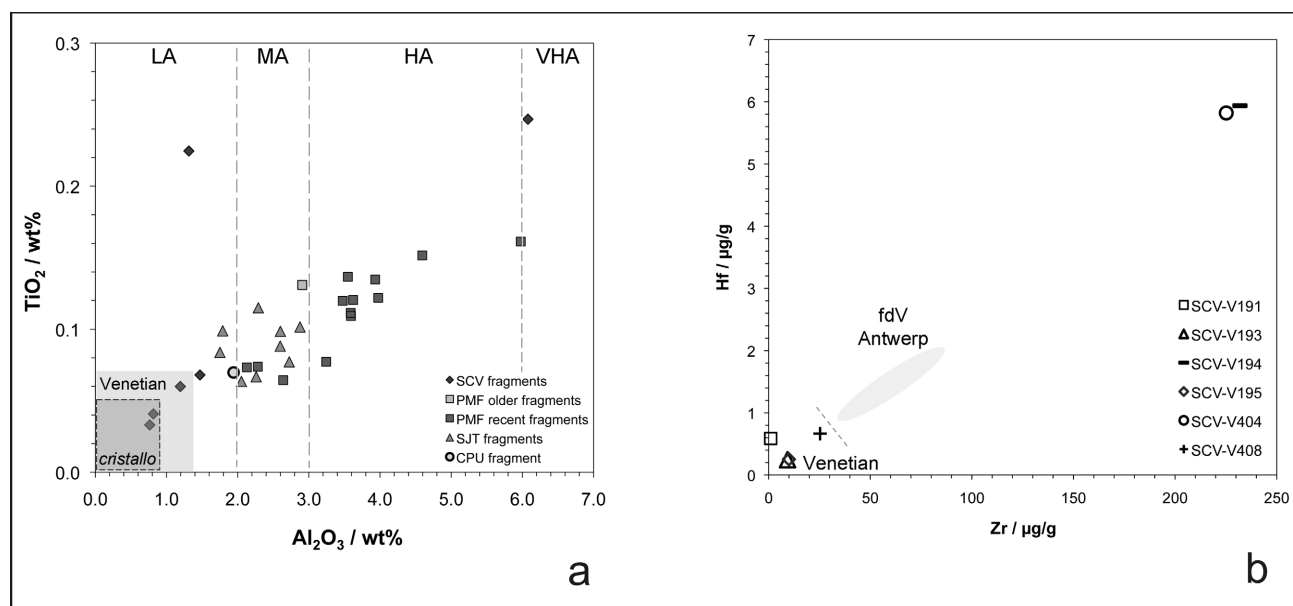


Fig. 4: Binary plots of a) Al_2O_3 vs. TiO_2 , in weight percent of oxides and measured by μ -PIXE; and b) of Zr vs. Hf concentrations in $\mu\text{g/g}$ determined by means of LA-ICP-MS for the SCV *façon-de-Venise* objects. The dashed lines are general Antwerp *façon-de-Venise* and general Venetian regions taken from the literature (DE RAEDT et al. 2001).

The SCV fragments were also analysed by LA-ICP-MS since the study of this assemblage is part of a larger research project. The LA-ICP-MS analysis was carried out on the resin embedded glass cross-sections. The ablation system used here is located at the National Centre of Scientific Research (CNRS) in Orleans, France. It consists of a Nd:YAG laser working at 266 nm (quadrupled frequency) operating at a maximum energy of 2 mJ and at a maximum pulse frequency of 15 Hz. The laser beam diameter can be adjusted from 20 μm to 100 μm . The glass analysis was performed at 8 Hz with a beam diameter of 80 μm . A pre-ablation time of 20 s was set in order to eliminate the transient part of the signal which was then acquired for 55 s corresponding to 20 mass scans from lithium to uranium (the signal in counts/second is measured in low resolution mode for 58 different isotopes). Calibration for glass was undertaken by employing NIST610 and Corning B, C, and D glass reference material.¹⁷ The detection limits range from 0.1 % to 0.01 % for major elements and from 20 ng/g to 500 ng/g for others. The composition is calculated from the average of two ablations carried out in different areas of the sample. In order to validate the obtained concentration results, the glass reference standard Corning A was also analysed as an unknown sample.

Results and Discussion

Analysing the relation between aluminium and titanium oxides makes it possible to formulate some considerations on the employed silica sources. Regarding the division of alumina contents as defined by Lima et al.,¹⁸ the objects can be divided in four groups with low, medium, high and very high alumina contents (figure 4 a).

Venetian and *façon de Venise* glass are characterised by their choice of pure raw materials with low contents of impurities.¹⁹ The results (figure 4 a) show that some of these

objects have a chemical composition that is unusual for *façon de Venise* glass. Many of these fragments have high alumina contents that do not match with any European *façon de Venise* production centres that are known.²⁰

The alumina content is attributable to the siliceous materials chosen for the glass production, notably sand.²¹ It is known that the choice of raw materials was a primary phase of glass manufacture, since these influenced the quality of the final result, particularly in terms of transparency and of the possibility of obtaining colourless glass. The most pure material was quartz and was used by the Venetian glass-makers who imported it from other Italian regions.²² However, typically the most exploited raw material was sand and it came from places near the glass production locations.²³ For this reason we cannot exclude that the high alumina levels derive from the use of local sands rich in feldspar.

According to values published in literature, Venetian glass (both *cristallo* and *vitrum blanchum*) is characterised by low contents of TiO_2 [around 0.05 wt. %], as represented in figure 4a by the two marked regions.²⁴ Three SCV objects, with alumina contents below 2.0 wt. % and titanium dioxide content below 0.1 wt. %, are compatible with Venetian compositions; from these, two are within the *cristallo* boundaries.

¹⁸ LIMA et al. 2012.

¹⁹ VERITÀ and ZECCHIN 2009.

²⁰ For typical Venetians compositions see VERITÀ 2013; for values of glass in several *façon de Venise* production centres see LIMA et al. 2012, p.1244, Table 4.

²¹ MORETTI and HREGlich 2013.

²² VERITÀ and ZECCHIN 2009.

²³ NAVARRO 2003, 130.

²⁴ VERITÀ 2013.

²⁵ VERITÀ and ZECCHIN 2009.

Comparing the obtained results with coeval and genuine Venetian and *façon de Venise* glass²⁵ confirms that few fragments from SCV are probably genuine Venetian objects. To validate the Venetian provenance of selected SCV fragments, these were analysed by LA-ICP-MS. This allowed quantifying the trace and the rare earth elements that are considered the fingerprint of the employed raw materials. Looking at the contents of zirconium and hafnium (figure 4 b), both elements deriving from the silica source, four of the SCV fragments are within the Venetian boundaries;²⁶ this confirms that these objects are genuine imports from Venice.

The fragments from the remaining assemblages do not fall within the Venetian boundaries and are considered to originate from different production centres. The PMF fragments form one group and a majority of samples from SJT form another one.

Regarding the flux properties, studying the distinct fractions of sodium and potassium oxides will allow one to distinguish between the different fluxes used. In the chart presented in figure 5, the fractions of both oxides were normalised to the content of all alkaline and alkaline-earth oxides.²⁷

A large group of fragments is arranged along the inverse correlation line of glass made by using purified ashes and is close to the *cristallo* boundaries. The objects from this group were probably manufactured using pure ash similar to the ones brought to Venice from the Levantine region. The lower normalised potassium oxide values imply higher contents of soda, which is compatible with the identification of Levantine ashes used in genuine Venetian glass production.²⁸ The three SCV objects (figure 3: SCV-V191, SCV-V193 and SCV-V195) previously identified as Venetian are within this region (the points appear overlapped) and for this reason they are considered imported Venetian *cristallo* glass.

The majority of PMF fragments fall between the purified and unpurified ashes tendency lines. The fluxes employed in their manufacture were chosen to approach and imitate *cristallo* glass. Recalling the alumina contents of these objects, this reinforces the idea that these objects were made in a *façon-de-Venise* production centre where glass was melted using sands rich in feldspar, a circumstance that so far seems to have never been recorded for European glass of the 17th century.

Some SJT and CPU fragments are also within or close to the *cristallo* boundaries. The CPU fragments always appear related to SJT and some PMF fragments, especially when analysing the flux but also the silica sources. This indicates that these objects were manufactured in the same production centre or using the same raw materials.

When looking closer at the SJT fragments, three objects (figure 3: SJT0014, SJT0112, and SJT0135) present lower amounts of Na₂O and higher amounts of K₂O and CaO when compared to the remaining SJT fragments. Two of these samples are close to the *vitrum blanchum II* area and sample SJT0135 is close to the European *Barilla* area.

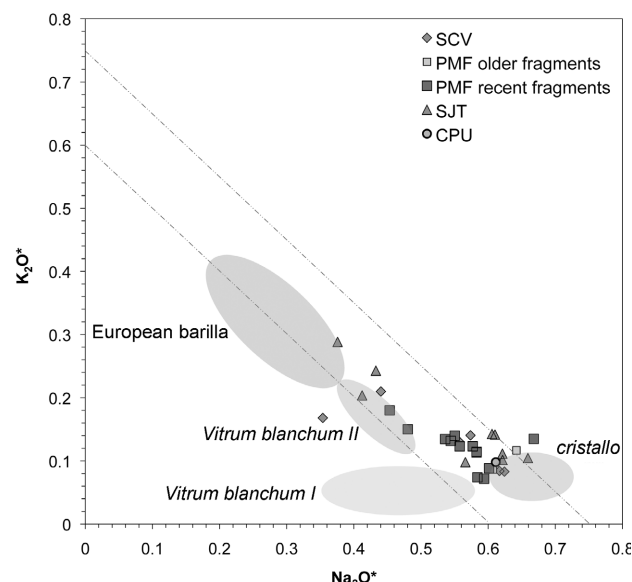


Fig. 5: Binary plot of Na₂O* vs. K₂O*. Na₂O* and K₂O* values are obtained through the division of the respective oxide by every components introduced by the ash (Na₂O, MgO, P₂O₅, K₂O and CaO). The two correlation lines represent the purified ash (Na₂O* + K₂O* = 0.75) and the unpurified ash (Na₂O* + K₂O* = 0.6). It is also possible to observe the Venetian *cristallo* boundaries, as well as the two *vitrum blanchum* known areas and the European Barilla area (CAGNO et al. 2012; ŠMIT et al. 2009).

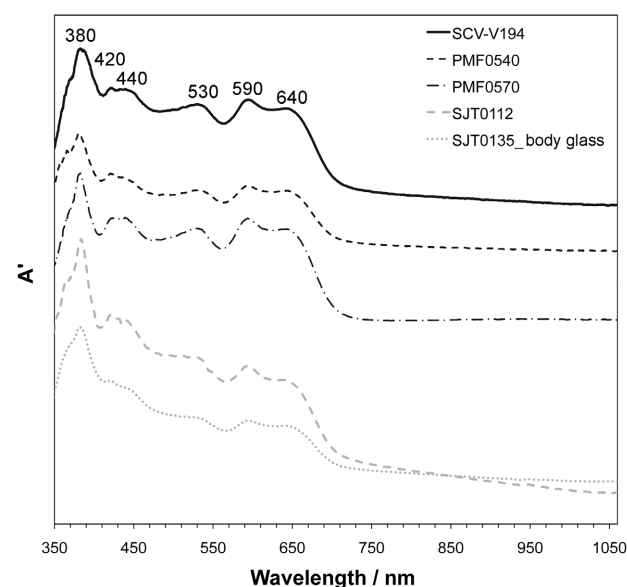


Fig. 6: UV-Vis reflectance spectrum of several *façon-de-Venise* objects from SCV, PMF and SJT assemblages.

Another particularity of the group was the natural hue of the glass featuring shades of grey and blue. Only the SCV fragments imported from Venice do not present such visible hues.

²⁶ DE RAEDT et al. 2001.

²⁷ CAGNO et al. 2012, ŠMIT et al. 2009.

²⁸ CAGNO et al. 2012

²⁹ JACKSON 2006.

UV-Vis reflectance spectroscopy allows one to determine that this grey/blue hue is caused by the simultaneous presence of iron and cobalt oxides (Fe(III) – 380 nm, 420 nm and 440 nm; Co(II) – 530 nm, 590 nm and 640 nm) as shown in figure 6. As far as it is known, the presence of cobalt in colourless *façon-de-Venise* glass is not usual and has rarely been reported in the literature.²⁹

In conclusion, a Venetian provenance is confirmed for some specimens from SCV. The objects made of *cristallo* glass are: a stem with a ribbed knop and an engraved pattern on the foot (SCV – V195), a lid with *vetro a fili* decoration (SCV – V191), and a wall fragment with an applied raspberry prunt and engraved decoration, possibly belonging to a cup (SCV – V193) (figure 3).

Among the remaining objects whose provenance could not be determined, some were made using ashes from carefully chosen plants capable of originating pure glass as raw material for the flux. This was done to imitate *cristallo* glass, but their composition is not compatible with glass originated in Venice or in any other *façon de Venise* production centre analysed so far because of the alumina content.

This is the case for most samples from Beja (PMF) that present high alumina levels. These objects are mainly bowls or bases of goblets in greyish glass either plain or decorated with mould blown ribs (see figure 2b: PMF0550, PMF0568, and PMF0569).³⁰ The glass used to blow this assemblage seems to be made with silica from the same sources, very rich in alumina and different from the silica used to produce the other sets. Closely related to the PMF samples is a previously analysed *millefiori* fragment from Coimbra (figure 3: SCV-V108).³¹ This indicates that this glass was possibly made using raw materials coming from the same sources or having the same provenance.

A second sort of *façon-de-Venise* glass from the São João de Tarouca Monastery has been identified, which presents medium alumina levels. These samples are all closely related in terms of the silica source. The majority were also made using purified ashes. Two samples are close to the *vitrum blanchum II* area and one sample (figure 3, SJT0135, body glass) falls close to the border of the European Barilla area. This last object presents a decoration of white trails freely applied around the rim. The available fragments seem to be consistent with the shape of a *tazza* but the entire form cannot be reconstructed because the foot or stem is missing. It is worth noting that some of the specimens are decorated with a sort of 'rough' version of *vetro a fili* (SJT0012, SJT0123, SJT0135), while others are decorated with typical *façon de Venise* patterns and techniques such as SJT0121, with *filigrana a retortoli*; SJT0122, with broken threading; SJT0105, with gilding and engraving; and SJT0112, with ice glass effect (figure 3).

It is proposed that the analysed PMF and SJT fragments were produced in two unknown *façon de Venise* production centres whose location is yet to be discovered.

FINAL REMARKS

The results obtained during these first years of investigation are encouraging. Important goals were achieved, including the creation of a first typological classification of late medieval and early modern archaeological glass in Portugal and the first hypotheses on the production, diffusion, and use of glass in the country during the pre-industrial era. The main source of this information derives from the archaeological data.

The identification of the origin of the glass assumed to be imported confirms that trade imported glass from Venice and from other *façon de Venise* manufactures to Portugal. However, the influx of imported goods did not inhibit the development of a local glass production that took advantage of local raw materials and created vessels with recognizable shapes.

The identification of two kinds of *façon de Venise* glass, whose compositions demonstrate the attempt to employ pure raw materials, but present unique features, as the medium and high alumina levels, allows us to assume the existence of two yet unknown *façon de Venise* production centres.

The lack of comparable data concerning Portuguese glass furnaces earlier than the 18th century represents a limitation to our research and so far no final proof has been obtained concerning glasses of unquestionable Portuguese origin. The field archaeology will eventually provide these answers, and this is a necessary condition for the identification of shapes and types that we can surely consider as genuine Portuguese.

ACKNOWLEDGEMENTS

The authors would like to thank the support of the Portuguese Science and Technology Foundation (FCT/MCTES) through grants SFRH/BD/72552/2010 and UID/EAT/00729/2013. L.C. Alves gratefully acknowledges the FCT support through the UID/Multi/04349/2013 project. T. Medici thanks Amy McHugh for helping with the English text.

REFERENCES

- BALADO PACHÓN, Arturo and ESCRIBANO VELASCO, Consuelo, 2001. 'Brazaletes de vidrio de influencia andalusí procedentes del castillo de Portillo (Valladolid)'. In: *Actas del V Congreso de Arqueología Medieval Española (Valladolid 1999)*. Valladolid, 923–930.
- CAGNO, Simone, FAVARETTO, L., MENDERA, Marja, IZMER, Andrei, VANHAECKE, Frank and JANSSENS, Koen, 2012. 'Evidence of Early Medieval Soda Ash Glass in the Archaeological Site of San Genesio (Tuscany)', *Journal of Archaeological Science* 39.5, 1540–1552.
- CAMPBELL, John L., BOYD, Nick I., GRASSI, Novella, BONNICK, Patrick and MAXWELL, John A., 2010. 'The Guelph PIXE software package IV', *Nuclear Instruments and Methods B* 268, 3356–3363.

³⁰ More similar analysed fragments are: PMF0540, PMF0556, PMF0570, PMF0996, and PMF0527.

³¹ LIMA et al. 2012.

- CORTI, Gino, 1971. 'L'industria del vetro di Murano alla fine del sec. XVI in una relazione al granduca di Toscana', *Studi Veneziani* 13, 649–654.
- COSTA, M. Pereira Da, 1955. 'Subsídios para a História da Indústria Vidreira no Conselho de Oliveira de Azeméis (Casa e Fábrica do Côvo, e continuadores desta no Conselho de Oliveira de Azeméis)', *Separata do Arquivo do Distrito de Aveiro* XX and XXI.
- COUTINHO, Inês, MEDICI, Teresa, ALVES, Luís C., GRATUZE, Bernard and VILARIGUES, Márcia, 2016a. 'Provenance studies on 17th century *façon-de-Venise* glass excavated in Portugal', *Journal of Archaeological Science: Reports* 7, 437–448.
- COUTINHO, Inês, MEDICI, Teresa, SILVA, Rui J. C., GRATUZE, Bernard, CATARINO, Helena and LIMA, Augusta, 2016b. 'Gilding on glass: new evidence from a 17th century flask found in Portugal', *Journal of Archaeological Science: Reports* 6, 293–301.
- COUTINHO, Inês, MEDICI, Teresa, COENTRO, Susana, ALVES, Luís and VILARIGUES, Márcia, 2016c. 'First archaeometric study on medieval glass found in Southern Portugal (Beja)', *Journal of Medieval Iberian Studies* 8, 148–175.
- DE ANDRADE E SOUSA, Maria Teresa, 1956. *Inventário dos bens do Conde de Vila Nova D. Luís de Lencastre: 1704*. Lisboa.
- DE RAEDT, Ine, JANSSENS, Koen H. A., VEECKMAN, Johan, VINCZE, Laszlo, VEKEMANS, Bart and JEFFRIES, T. E., 2001. 'Trace analysis for distinguishing between Venetian and *façon-de-Venise* glass vessels of the 16th and 17th century', *Journal of Analytical Atomic Spectrometry* 16, 1012–1017.
- Documentos para a história da arte em Portugal, vol. 2. Arquivo histórico da Câmara Municipal de Lisboa. Posturas diversas dos séculos XIV a XVIII* (tomo organizado por Maria Teresa Campos Rodrigues). 1969. Lisboa.
- FERREIRA, Manuela and MEDICI, Teresa, 2010. 'Mould-blown decorative patterns on medieval and post-medieval glass beakers found in Portugal (14th–18th century)'. In: FONTAINE-HODIAMONT, Chantal (ed.), *D'Ennion au Val Saint-Lambert. Le verre soufflé-moulé. Actes des 23^e Rencontres de l'Association française pour l'Archéologie du Verre*. Bruxelles, 401–409.
- FERREIRA, Manuela Almeida, 2004. 'Espólio vítreo proveniente da estação arqueológica do Mosteiro de Sta. Clara-a-Velha de Coimbra: resultados preliminares', *Revista Portuguesa de Arqueologia*, 7.2, 541–583.
- GRATUZE, Bernard, 2013. 'Glass characterization using Laser Ablation Inductively Coupled Plasma Mass Spectrometry Methods'. In: JANSSENS, Koen H. A. (ed.), *Modern Methods for Analysing Archaeological and Historical Glass*. Chichester, 201–234.
- GRATUZE, Bernard, 2014. 'Application de la spectrométrie de masse à plasma avec prélèvement par ablation laser (LA-ICP-MS) à l'étude des recettes de fabrication et de la circulation des verres anciens'. In: DILLMANN, Philippe and BELLOT-GURLET, Ludovic (eds.), *Circulation des matériaux et des objets dans les sociétés anciennes*. Paris, 259–291.
- GRIME, Geoffrey W. and DAWSON, Mike, 1995. 'Recent developments in data acquisition and processing on the Oxford scanning proton microprobe', *Nuclear Instruments and Methods B* 104, 107–113.
- JACKSON, Caroline M., 2006. 'Compositional analysis of the Gnalič glass'. In: LAZAR, Irena and WILLMOTT, Hugh (eds.), *The Glass from the Gnalič Wreck*. Koper, 87–95.
- LIMA, Augusta, MEDICI, Teresa, PIRES DE MATOS, António and VERITÀ, Marco, 2012. 'Chemical analysis of 17th century *millefiori* glasses excavated in the Monastery of Sta. Clara-a-Velha, Portugal: comparison with Venetian and *façon-de-Venise* production', *Journal of Archaeological Science* 5, 1238–1248.
- MALALANA UREÑA, Antonio and LORA HERNÁNDEZ, Olga, 2014. 'Catálogo de un ajuar de brazaletes de vidrio de época nazarí (siglo XIII) perteneciente a los conjuntos funerarios de la Calle Mendivil (Málaga)', *Revista Portuguesa de Arqueologia* 17, 245–261.
- MATOS SEQUEIRA, Gustavo de, [s.d.]. *A indústria vidreira em Portugal. Introdução ao catalogo da Companhia Industrial Portuguesa*. Lisboa.
- MEDICI, Teresa, 2005. 'The Glass finds from Rua da Judiaria, Almada, Portugal (12th–19th century)', *Revista Portuguesa de Arqueologia* 8.2, 535–569.
- MEDICI, Teresa, 2008. 'A Medieval Enameled Beaker from Lisbon', *Journal of Glass Studies* 50, 316–318.
- MEDICI, Teresa, 2011. 'O espólio vítreo do Núcleo Arqueológico da Rua dos Correios, Lisboa', *Revista Portuguesa de Arqueologia* 14, 313–353.
- MEDICI, Teresa, 2014a. *Vidros da terra. O vidro tardomedieval e moderno em Portugal (séc. XIV–XVII). O contributo da arqueologia*. PhD Thesis. Universidade de Coimbra.
- MEDICI, Teresa, 2014b. 'Not only in museums. Archaeological evidence of 17th century luxury glass in Portugal' [online], *Reviews on Glass* 3, 25–30. Available at: http://issuu.com/icom-glass_reviewsonglass01/docs/reviews_on_glass_iii (21st of January 2016).
- MEDICI, Teresa, LOPES, Filipa M., LIMA, Augusta, LARSSON, M. A. and PIRES DE MATOS, António, 2009. 'Glass bottles and jugs from the Monastery of Sta. Clara-a-Velha, Coimbra, Portugal'. In: JANSSENS, Koen, DEGRYSE, Patrick, COSYNS, Peter, CAEN, Joost and VAN'T DACK, Luc (eds.), *Annales du 17^e Congrès de l'AIHV. Annales of the 17th Congress of the AIHV*. Anvers 2006. Brussels, 391–400.
- MENDES, José Amado, 2002. *História do vidro e do cristal em Portugal*. Lisboa.
- MORETTI, Cesare and HREGLICH, Sandro, 2013. 'Raw materials, recipes and procedures used for glass making'. In: JANSSENS, Koen H. A. (ed.), *Modern Methods for Analysing Archaeological and Historical Glass*. Chichester, 23–47.
- NAVARRO, Jose Maria Fernandez, 2003. *El Vidrio*. Madrid.
- REDMAN, Charles L., 1986. *Qsar es-Seghir: an archaeological view of medieval life*. Orlando.
- ŠMIT, Žiga, STAMATI, F., CIVICI, N., VEVECKA-PRIFTAJ, A., KOS,

Mateja and JEZERŠEK, D., 2009. 'Analysis of Venetian-type glass fragments from the ancient city of Lezha (Albania)', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 267, 2538–2544.

TAIT, Hugh, 1991, 2012. *Five Thousand Years of Glass*. London.

VALENTE, Vasco, 1950. *O Vidro em Portugal*. Porto.

VERITÀ, Marco, 2013. 'Venetian soda glass'. In: JANSSENS, Koen H. A. (ed.), *Modern Methods for Analysing Archaeological and Historical Glass*. Chichester, 515–536.

VERITÀ, Marco and ZECCHIN, Sandro, 2009. 'Thousand years of Venetian glass: the evolution of chemical composition from the origins to the 18th century'. In: JANSSENS, Koen, DEGRYSE, Patrick, COSYNS, Peter, CAEN, Joost and VAN'T DACK, Luc (eds.), *Annales du 17^e Congrès de l'AIHV. Annales of the 17th Congress of the AIHV*. Anvers 2006. Brussels, 602–613.

Teresa Medici

VICARTE

Faculdade de Ciências e Tecnologia, Universidade NOVA de Lisboa

Campus de Caparica, 2829-516 Caparica, Portugal.

teresa.medici@gmail.com

Inês Coutinho

VICARTE

and

Department of Conservation and Restauration

Faculdade de Ciências e Tecnologia, Universidade NOVA de Lisboa

Campus de Caparica, 2829-516 Caparica, Portugal.

iac17191@campus.fct.unl.pt

Luís C. Alves

C2TN, Instituto Superior Técnico, Universidade de Lisboa

E.N.10, 2695-066, Bobadela LRS, Portugal.

lcalves@ctn.ist.utl.pt

Bernard Gratuze

IRAMAT - Centre Ernest-Babelon, CNRS Université

d'Orléans

3D Rue de la Ferrollerie, 45071 Orléans, Cedex 2, France.

gratuze@cnrs-orleans.fr

Márcia Vilarigues

VICARTE

and

Department of Conservation and Restoration

Faculdade de Ciências e Tecnologia, Universidade NOVA de Lisboa

Campus de Caparica, 2829-516 Caparica, Portugal.

mgv@fct.unl.pt