



## The palaeo-Christian glass mosaic of St. Prosdocimus (Padova, Italy): archaeometric characterisation of 'gold' tesserae

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### ABSTRACT

A systematic and extensive archaeometric study was carried out on the loose polychrome tesserae of the palaeo-Christian glass mosaic which decorated the votive chapel of St. Prosdocimus in Padova until its replacement by the current frescoes of Renaissance age and which is one of the only two known in the Veneto region (Italy). In particular, the present paper focuses on the 'gold' tesserae, i.e., tesserae with a metal foil, usually composed of gold, and characterised by transparent glass not deliberately coloured or decolourised. The main research aims were the identification of the 'base composition' of the glass used for mosaics and the reconstruction of production techniques. In addition, comparisons with major compositional groups identified in the literature allowed us to contextualise Paduan 'gold' tesserae in the wider context of glass production in the 6th century AD. The compositional characterisation of Paduan 'gold' tesserae, carried out by means of EMPA and LA-ICP-MS analyses, showed that most of the glass samples were obtained with natron as flux, although the coexistence of various production technologies and the extent of recycling, which confirm the 6th century AD as a period of technological transition, are documented. Identification of some soda ash tesserae also allowed us to attest Medieval restoration operations. The good match between compositional groups identified in the literature for glass vessels and compositional groups identified in the 'gold' tesserae suggests technological links between these two production types. The chemical similarity between 'gold' tesserae from Ravenna and some from Padova also links production technologies in these two towns during the 6th century; coupled with the results of the historical-artistic study, these factors provide further evidence to the hypothesis that the Paduan production was mainly influenced by the nearby city of Ravenna, the capital of Byzantine mosaics in Italy.

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### 1. Introduction

The production of glass in ancient times has been the subject of many archaeometric contributions, focusing in particular on chemico-physical and mineralogical characterisation, production techniques, sources of raw materials and decay processes (e.g., Newton and Davison, 1999; Brill, 1999; Henderson, 2000; Freestone et al., 2000; Foy et al., 2003; Silvestri et al., 2005a, 2005b; Silvestri, 2008; Foster and Jackson, 2009 and references therein). Little is known concerning the manufacturing techniques and production sites of ancient glass used in mosaics, so that these artefacts are an active subject of study and experimentation. Until quite recently, mosaics were generally studied in terms of their style or iconology, although, with reference to conservation issues, special attention is now being devoted to materials characterisation and glass working

procedures (e.g., Freestone et al., 1990; Shugar, 2000; Azzoni et al., 2002; Fiori et al., 2004; James, 2006). In particular, due to their extraordinary variety of colours, the refined use of opacifying agents, the extensive use of metal coatings (gilding), and the complex technology of thermal redox treatments optimised in kilns, glass polychrome mosaics, such as those of the palaeo-Christian votive chapel of St. Prosdocimus in the Basilica of St. Justine (Padova) which are the subject of the present study, represent a stimulating yet challenging field of research in materials science. Some authors have addressed the problem of classifying mosaic glass (Ruffini et al., 1999a, 1999b; Verità, 2000; Brill, 2002; Fiori et al., 2004; Andreescu-Treadgold et al., 2006; Vandini et al., 2006) and identified some important differences on chronological and geographical bases, starting with the use of various raw materials, colourants and opacifiers. However, a systematic and extensive study on glass mosaics has not yet been undertaken; those carried out so far (e.g., Freestone et al., 1990; Brill, 1999; Verità, 2000; Verità et al., 2002; Verità and Vallotto, 2003; Henderson, 2004; Verità and Zecchin, 2007; Boschetti et al., 2008; Arletti et al., 2008a, 2008b; 2011; van der Werf et al., 2009) mainly

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focus on a few samples coming from the same site, probably due to the value and availability of the material, often still *in situ*, and cover various periods of time, often not contiguous with one another. The possibilities offered by the specific case under consideration here – of working on more than 3000 loose tesserae characterised by a full range of colours – is an unique occasion for careful and precise analytical study on palaeo-Christian glass mosaics. Our research is aimed at the characterisation of glass composition, with particular attention to the identification of colourants, decolourants and opacifiers, and their correlation with the chromatic and optic appearance of the glass tesserae; identification of raw materials and sources of supply; and reconstructing production techniques. These data, when integrated with historical and stylistic studies, will render the Paduan glass tesserae into ‘witnesses’ of well-defined historical, technological and economic contexts. The palaeo-Christian mosaics of the chapel of St. Prosdocimus are an exceptional testimony to the past, when the ecclesiastic and monumental complex of St. Justine played the role of a reference point for the city of Padova and for the history of Christianity in all of the Veneto and Adriatic area. In addition, the glass mosaics of St. Prosdocimus have considerable historic value, as they were made during the 6th century AD, known to be a transition period between Roman and Medieval glass production technology. Therefore, the study of this mosaic cycle is critical for an understanding of the processes which led to such profound changes in both glass production technology and types of raw materials.

The more than 3000 loose tesserae of the palaeo-Christian votive chapel of St. Prosdocimus in Padova were divided into eight colour types (blue, yellow, orange, red, brown, green, white and ‘gold’), and 200 representative samples were selected for archaeometric analysis.

While opaque glasses, characterised by antimony-based and non-antimony-based opacifiers, are discussed separately, the present paper focuses on the ‘gold’ tesserae, i.e., tesserae with a metal foil, usually composed of gold, and characterised by transparent glass not deliberately coloured or decolourised, with the aim of identifying the ‘base composition’ of the glass used for these mosaics and of contextualising it in the wider context of glass production in the 6th century AD, by means of comparisons with major compositional groups identified in the literature. Analysis of these assemblages provides valuable insights into the complexities of the mosaic glass industry in the 6th century AD, perceived to be a period of technological transition within a clearly defined context.

## 2. The palaeo-Christian votive chapel of St Prosdocimus and glass mosaics: historical background

The present-day monumental complex of the Basilica of St. Justine, inside which the chapel of St. Prosdocimus is located, is the result of a long process, still not well-known, spanning the entire history of Christianity in Padova. The Basilica of St. Justine is an extra-urban edifice, built on the spot where St. Justine was buried after her martyrdom in 303–304 AD. *Cellae memoriae* were initially built around her tomb, and subsequently expanded to become a cemeterial church which grew even larger over time. The most important contribution to the monumentality of the palaeo-Christian basilica was made by Opilion, prefect of the Praetorian Guard. He built a votive chapel in the 6th century *in honore(s)(an)c(t) ae Iustinae mar/tyris*, as attested by the inscription on the triangular tympanum placed over the door leading into the chapel, which is dedicated to St. Prosdocimus, Padova’s first bishop, who was buried there. It is still unclear whether the basilica itself had already been built when the votive chapel was created, or whether the basilica itself was also rebuilt by Opilion. Few traces of the palaeo-Christian basilica now remain. Only the votive chapel of St. Prosdocimus, notwithstanding many changes, has survived over the centuries.

The chapel is in the form of a cross with equal wings inscribed in a square, the arches are covered by a barrel vault, and the eastern wing finishes with an apse, circular inside and pentagonal outside, following the tradition of Ravenna. The hemispheric cupola, in a quadrangular *tiburio*, rests on an octagon created by the walls which continue over the arches and the quadrangular *cuffie* (Bresciani Alvarez, 1970; Lusuardi Siena, 1989). Similarities in architectural structure with well-known buildings such as the Mausoleum of Galla Placidia (Ravenna), the Chapel of Saints Teuteria and Tosca (Verona), St. Maria Formosa (Pula), Hosios David (Thessaloniki), and St. *Maria Mater Domini* (Vicenza) have been identified (Nicoletti, 2005).

In 1958, during restoration work on the votive chapel of St. Prosdocimus, many glass mosaic fragments, composed of tesserae bound in mortar and loose polychrome tesserae, were found under the paved floor. The mosaic fragments, covering a presumed surface area of about 18 m<sup>2</sup>, and the tesserae (about 3000) are the only remains of the mosaic decoration of the chapel. They had been removed in 1564, to be replaced by the current frescoes of Renaissance age. The decoration was one of only two examples of palaeo-Christian mosaics with glass tesserae known in the Veneto region. The beauty and importance of these decorations are documented in historical sources, which describe “*pars vero superior quae testudineo clauditur arcu longe deaurata relucet et opere musoleo depicta quasi celeste palatium ac viridania paradisi prata demonstrat*”.<sup>1</sup> Very few traces of the mosaics are still visible in the intrados of two small monophores under the cupola; other remains are conserved in the Basilica of St. Justine in 110 wooden boxes. The sources, architecture of the chapel, and possible reconstructions of the mosaic iconography are described in the historical-artistic bibliography (Bettini, 1936–37; Zovatto, 1970; Lusuardi Siena, 1989; Nicoletti, 2000, 2005; Cortella, 2006). As regards the Paduan mosaic decorations, it must be noted that the most reliable iconographic reconstruction suggests correlations with similar subjects in the Ravenna mosaics, especially those in the Chapel of St. Prosdocimus in the Baptistry of the Orthodoxes in Ravenna (Cortella, 2006).

## 3. Materials

The loose tesserae were stored in one of the 110 wooden boxes containing the remains of glass mosaics in the Basilica of St. Justine. They may be considered as randomly chosen and are therefore statistically representative of all the tesserae of the Paduan mosaics, due to their sporadic nature and the non-selective manner in which they were first detached from the cupola and then collected in boxes.

The approximately 3000 tesserae were first counted and preliminarily separated by colour according to the NCS (Natural Colour System)<sup>®</sup> brilliant index (Scandinavian Colour Institute AB). This subdivision was further confirmed by colorimetric analyses on opaque coloured glass, carried out in order to obtain CIELAB coordinates. Twenty-four chromatic groups were identified and further grouped into eight colour types (Table 1): white, yellow, orange, red, brown, green, blue and ‘gold’ (i.e., tesserae with a metal foil, usually composed of gold, and sometimes also of silver<sup>2</sup>). All the tesserae are roughly square in shape, with 1 cm as a maximum side length, and weigh about 1 g. Taking into account the total number of tesserae in each chromatic group and their weight, the highest number of tesserae fall in the ‘gold’, blue and green colour types,

<sup>1</sup> Latin text from the “Leggenda di S. Daniele”, written by an anonymous author between 1075 and 1117 and reported in *Dondi dall’Orologio* (1816). English translation of the text by Gabriel Walton: “a whole cupola, resplendent thanks to the gold background and figures representing the heavenly palace and the green meadows of Paradise”.

<sup>2</sup> Twenty fragments of gold foil without glass, with mean dimensions of 1.0 × 1.0 × 0.005 cm, were also identified.

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