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Original article

Dating the mosaics of the Durres amphitheatre through interdisciplinary analysis

Elisabetta Neri*, Bernard Gratuze, Nadine Schibille*

IRAMAT-CEB, UMR5060, CNRS/université d'Orléans, 3D, rue de la Férollerie, 45071 Orléans cedex 2, France

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ABSTRACT

This article presents the results of an interdisciplinary investigation of the mosaics in the main chapel of the Durres amphitheatre, the interpretation and chronological attribution of which have been the subject of debate. Art historical considerations about the mosaic's cultural and artistic affiliations are combined with *in situ* assessments of the mosaic techniques and physico-chemical analyses of 111 glass tesserae by means of scanning electron microscopy with an energy-dispersive detector (SEM-EDS) and laser ablation inductively coupled mass spectrometry (LA-ICP-MS). Our results show that the raw glass used for the mosaic tesserae derives from two primary production centres but with evidence of substantial recycling: Foy-2, possibly of Egyptian origin, and Levantine I from the Syro-Palestinian coast. While lead stannate, copper and manganese are colorants found commonly in tesserae from different Mediterranean contexts, cobalt correlated with nickel and lead-tin associated with arsenic and antimony have been attested in mosaic tesserae here for the first time. The chronological range of the raw glasses and colorants provides strong evidence for a sixth- to eight-century CE date for the tesserae. The stylistic and iconographic parallels of contemporary mosaic decorations and the mosaic techniques reflected in the plaster layers, preparatory paint and particular setting of tesserae corroborate this timeframe. In terms of the material provenance and artistic features, the mosaics of the Durres amphitheatre clearly reflect the merging of eastern and western elements, typical of the early medieval Adriatic, while visual references to Byzantine imperial iconography may have served to reassert a link with Constantinople and the Byzantine court. Taken together, the material, technical and artistic data reveal the cultural and economic connectivity that shaped the art of mosaic making in the late antique and early medieval period.

1. Introduction

A small chapel built inside the amphitheatre at Durres contains the only medieval mosaic that survives in Albania and the only medieval one in a Roman amphitheatre. The date and interpretation of the three figurative panels are highly controversial. The panel on the west wall presents a large central figure flanked by two angels and two haloed female figures against a white and green background that are identified by inscription as E(IRH)NH (Peace) on the left and COΦIA (Wisdom) on the right (Fig. 1a). The possible remains of the AΓIOC (Holy) epithet to the left of Sophia suggests that the two female figures represent divine attributes. The central figure is almost destroyed and its identification has thus proved ambiguous. By now it is widely believed to depict the Virgin Mary [1,2]. A small female donor is visible to the right of the central figure.

Two panels decorate the southern wall of the chapel (Fig. 1b). A smaller rectangular panel represents the martyr saint Stephen, clearly labelled O A(ΓIO)C CTEΦANOC. He is dressed in a white tunic with a red *clavus* and a white pallium with a *gammadion*, his golden hands are raised in prayer. The larger adjacent panel takes the form of a trapezoid, filling the wall segment prescribed by the architectural framework. It is dominated by a central figure between two angels, clad in imperial dress with jewelled *loros* and red shoes, a crown with *pendilia*, holding a staff in the right hand and a crowned globe in the left. Two donors about a third in size are inserted between the angels and the central figure. An inscription in the left-hand corner of the panel above the head of the angel reads +K(YPI)E BOHΘHCON TOY ΔOYΛOY COY AΛEΞANΔPOY ('Lord preserve your servant Alexander'), presumably evoking the prayer of the donor shown below.

The iconography of the panels remains elusive. The main problem is the interpretation of the central figure in what has often

* Corresponding author. Tel.: +33 2 38 25 76 18.
Adresses e-mail : eneri@cnrs-orleans.fr (E. Neri), nadine.schibille@cnrs-orleans.fr (N. Schibille).

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Fig. 1. Mosaics in the main chapel of the Durres amphitheatre: a: panel on the west wall, showing a central figure flanked by angels and Hagia Eirene (left) and Hagia Sophia (right); b: mosaics on the south wall with the Hagios Stephanos panel on the left and a trapezoidal panel with a figure in imperial dress in the centre, flanked by angels and two donors in reduced size in-between.

been called the Virgin panel on the south wall. The figure in imperial dress (*chlamys*, *loros*, red shoes, crown) has been variously identified as different emperors [1–6], as Christ *Basileus* [7], as an unnamed empress [8,9] or more commonly as Maria Regina, the Queen of Heaven [10–12]. According to the different readings, the mosaic has been dated to either the sixth to seventh century or to as late as the tenth century. The imperial dress of the main figure [1] and stylistic and iconographic comparison favour a sixth- to seventh-century attribution [7]. In contrast, the mention of Alexander in the inscription, identified by some as the emperor Alexander (912–913 CE) [3,5,13], contextual evidence such as the frescoes underneath the mosaics and some archaeological finds outside the chapel suggest a post-ninth-century date [2].

Detailed technical observation of the mosaics *in situ* together with physico-chemical analyses of the glass tesserae can help to reconstruct the technical and historical processes involved in the making of the mosaic and in so doing shed light on the possible date of the decoration. The chronological and geographical resolution and chemical characterisation of glass production groups as well as the use of colorants and opacifiers during the time in question have been significantly refined over the last decade due to analytical techniques with high sensitivity and accuracy [14–16]. This paper thus presents major, minor and trace element data as well as the microstructures of crystalline inclusions of over one hundred glass mosaic tesserae from the main chapel at Durres alongside archaeological and art historical evidence to re-assess the dating and provenance of the materials. By situating the analytical and archaeological data within the historical context of Byzantine Albania, this study explores the cultural connections and artistic affiliations underlying the unusual decorative scheme of the Durres mosaics.

2. Materials and methods

2.1. Archaeological context and samples

The mosaics are found in the main chapel that was built into the very fabric of the Roman amphitheatre under the *vomitorium* of the second elliptical gallery, situated in the western part of the Byzantine wall (Fig. 2). The chapel must have been constructed sometime after the amphitheatre lost its original purpose. The date of this Christian conversion is unknown and it has been assumed that the amphitheatre was used for spectacles as late as the fifth or sixth century CE [2]. The earliest evidence of a Christian intervention in the form of Christian burials dates to the seventh century [2]. The construction of the main chapel is thus traditionally dated to the seventh century also [3–5]. Recent excavations have documented an abandonment phase of the amphitheatre in the early years of the seventh century, providing a *terminus post quem* for the construction of the chapel [17,18]. A tenth-century date has been argued for based on the discovery of two ninth- to eleventh-century ceramic shards built into the exterior wall of the chapel and some tenth-century coins found in the main tomb in the apse [17]. Judging from the ceramics found in the demolition layers, the chapel must have been in use until the Ottoman period, even though it is last mentioned in a letter of Charles I from 1280 [3,4,18]. The chapel, together with the amphitheatre, was abandoned and faded into oblivion until its re-discovery in 1966, when it was first excavated by Toçi [3,4] and subsequently by Miraj in 1983 [19]. The function

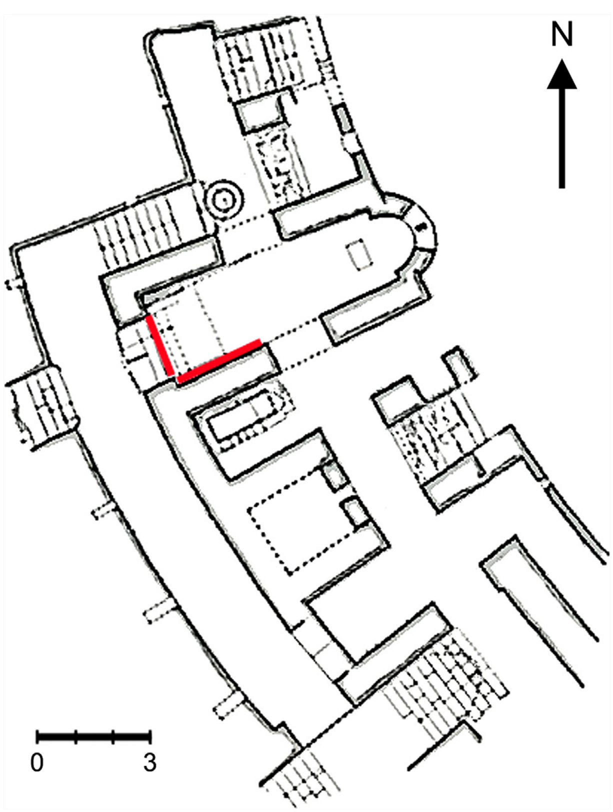

Fig. 2. Ground-plan of the chapel within the Roman amphitheatre in Durres. Location of the mosaic panels is indicated by red bars (adapted from [2]).

of the chapel is similarly unclear. It might have served as a martyrium of St. Asteios, a local martyr [20], or a monumental burial chamber for one of the elite families of the city [1].

The mosaic panels have been repeatedly restored, plainly visible thanks to gaps filled in with a modern mortar and revealed in the drawings from 1982 deposited in the Archaeological Institute (IMK) archives at Tirana. For example, the irregular distribution of tesserae in the lower corners of the west panel, as well as between the feet of the personification of Sophia and the angel, and below the feet of the central figure, clearly show previous restorations (Fig. 1a). During the restoration of 2014 and 2016, the conservators collected 111 glass tesserae from within the main chapel for optical and chemical analyses. The colours include black, different shades of blue, green, yellow, purple and turquoise as well as grey and gold-leaf tesserae. All the glass tesserae are of an unusually poor quality compared to contemporary mosaics from other sites, showing heterogeneous structures and bubbles as well as heavily weathered surfaces. Due to the severe deterioration (most of the tesserae are covered with a yellowish-white crust), the tesserae were ground and polished on one side, before they were examined under the optical microscope to determine their colour.

2.2. Analytical methods

The mosaic panels were investigated *in situ* with the help of a portable microscope (Dino-lite Premier). For the chemical and microstructural analyses, small fragments of the individual tesserae were mounted in epoxy resin and polished. These polished cross-sections were analysed by LA-ICP-MS at the Centre Ernest-Babelon (CEB) of IRAMAT (Orléans), using a Thermofisher Element XR combined with a Resonetic UV laser microprobe (ArF 193 nm), which was operated at 5 mJ, with a laser pulse repetition rate of 10 Hz [15,21]. The standard spot size of 100 μm was reduced when saturation occurred. The spot mode results in bulk analyses and requires the live spectra to be closely monitored to identify and potentially discard inclusions or anomalies. Fifty-eight elements were simultaneously measured, following the standard protocol of 20 seconds pre-ablation and 40 seconds collection time. Blanks were run after every ten samples to determine the offset. The response coefficient (k) for each element was calculated using a set of five glass standards (NIST SRM610, Corning B, C and D, APL1) to allow the signals to be converted into quantitative data [22]. Reference materials Corning A and NIST 612 were repeatedly measured throughout the analytical run to determine accuracy and precision. The analytical precision reflected in the relative standard deviation (σ) was generally better than 5% for most elements and accuracy was better than 10% (Table S1).

To characterise the crystalline phases, the mounted samples were carbon-coated and examined using a scanning electron microscope with an energy-dispersive spectrometer (SEM-EDS) at IRAMAT-CEB [16]. Back-scattered images (BSE) were obtained and qualitative analyses were performed with an acceleration voltage of 20 kV, a beam diameter of 1 μm and a working distance of 10 mm for 300 seconds.

3. Results

3.1. Mosaic techniques: observations in situ

The plaster of the mosaics consists of three layers of lime mortar with pounded brick varying from 3 cm to 5 cm in total thickness (Fig. 3a). The lime-rich mortar is typical of ancient and Byzantine mosaics. The lack of organic materials in any of the three layers of plaster has also been frequently attested, particularly in wet environments [23,24].

Fig. 3. Details of preparatory plaster layers underneath the mosaics: a: layers in the east part of the south panel (1 cm scale); b: junction between the Hagios Stephanos panel (left) and the trapezoidal panel (right), displaying a connection error at the joint border.

The plasters of the three different panels appear to be identically composed, even though they are physically separated. The panel of Hagios Stephanos is smaller than the adjacent trapezoidal Virgin panel and a vertical separation line is clearly visible in the plaster where the tesserae are missing and the red border shows clear signs of a connection error (Fig. 3b). The joint between the two panels does not correspond to the limits of the section of plaster laid with mosaics in a single day ("pontata"), because the plaster of the Hagios Stephanos panel occasionally overlaps with that of the Virgin panel. The two panels on the south wall must thus have been sequentially executed [25]. The western panel does not have a common border with its southern neighbour and extends much lower on the wall (Fig. 1b). Its execution is less accurate, but it nonetheless shares the same technical features and material as the southern panels, implying a contemporaneous origin for all three mosaics [2,9,26]. The remnants of nails found in the southern panels are similar in dimension and typology to nails used in the preparatory layers of other mosaics from the sixth to the fourteenth century [27]. Given that they do not protrude from the surface, these nails probably served a structural function to strengthen and stabilise the mosaic panels, and not, as has been previously proposed, to hold lamps [2,9,26].

Some parts of the setting bed preserve traces of preparatory paint of three colours typical of Byzantine mosaics. Black paint is found underneath the black tesserae used for outlining the figures; yellow ochre underlies the yellow tesserae used to render the angels' hair and military garments; red is used as background for flesh tones and gold tesserae. The green mosaic background is likewise underlain by a yellow ochre paint. No preparatory paint was used beneath the white marble background. Gold tesserae were employed exclusively in the halo of the central figure and in the halo and hands of Hagios Stephanos (Fig. 1b). Limestone was used for white, pink, beige, orange and occasionally red (white stone tesserae with red paint). All the flesh tones, for instance, are constructed of small pink stone tesserae. The glass tesserae tend to be irregular in shape and size (0.2–1.5 cm side length). Large round tesserae were used for eyes and drop-shaped tesserae for *pendilia* and gems.

3.2. *The glass matrix*

All the analysed tesserae are made of soda-lime-silica glass with potassium and magnesium oxide concentrations below 1.5% (Table S2), corresponding to natron-type glass typical of the Roman and early medieval period prior to the ninth century [28,29]. Two different compositional groups were identified based on the TiO_2/Al_2O_3 versus Al_2O_3/SiO_2 ratios, representing the relative abundance of heavy minerals and feldspars in the silica source (Fig. 4a). The different ratios of both TiO_2/Al_2O_3 as well as Al_2O_3/SiO_2 strongly support distinct origins for the two main compositional groups.

Most tesserae (96 samples) fall into a group that is characterised by higher levels of boron, lithium, magnesium, titanium and zirconium and on average lower potassium, calcium and aluminium (Table S2, Fig. 4). This group bears similarities to the so-called Foy-2 family of glasses found among late antique assemblages from France, Carthage as well as Byzantine glass weights [15,30,31], and the HLIMT group identified in Cyprus [32]. However, the tesserae from Durres tend to have on average lower iron, magnesium, titanium and zirconium compared to 'série 2.1' as defined by Foy and colleagues [30] and the sixth-century glass from the Lower Danube [33]. A slight decline in these elements together with a decrease in manganese and an increase in trace elements typically associated with colourants from série 2.1 to série 2.2 has been interpreted as sign of recycling [30]. Given the general variability of Foy-2 glasses and a certain degree of recycling evident also in many of the série 2.1 samples it is difficult to relate the Durres tesserae unambiguously to either of the two sub-groups. Rather, the compositional features of the Durres tesserae are intermediate between the 2.1 type of raw glass and the later specimens of série 2.2 that exhibit substantial signs of recycling. While the glasses of série 2.1 have been firmly attributed to the sixth and seventh century (e.g. [15] and references therein), the recycled série 2.2 dates to the seventh to the late eight centuries [30].

Fifteen samples show a very different chemical composition. Compared to the first group, these have typically higher alumina to silica (> 0.04) and lower titanium oxide to alumina ratios (< 0.04), higher lime and potash concentrations and significantly lower levels of sodium, magnesium and heavy elements (Fe, Ti, Zr, V, Hf; Table S2, Fig. 4 [34]). Concomitantly, this second group has lower lithium, boron and uranium contents relative to the soda levels that suggest that these tesserae have been produced not only from a different silica source, but also from a different mineral soda than the Foy-2 samples (Fig. 4b). The base glass composition of these 15 tesserae corresponds to Levantine I glass produced in Syro-Palestine (Fig. 5b). More specifically, the tesserae appear to be more closely related to the sixth- to seventh-century glass from Apollonia [14,35,36] rather than to the fourth-century glass from Jalame [37]. A chronological development in the relative alumina and lime as well as soda to silica concentrations has been previously observed [14,31,38], but it needs to be stressed that there is some

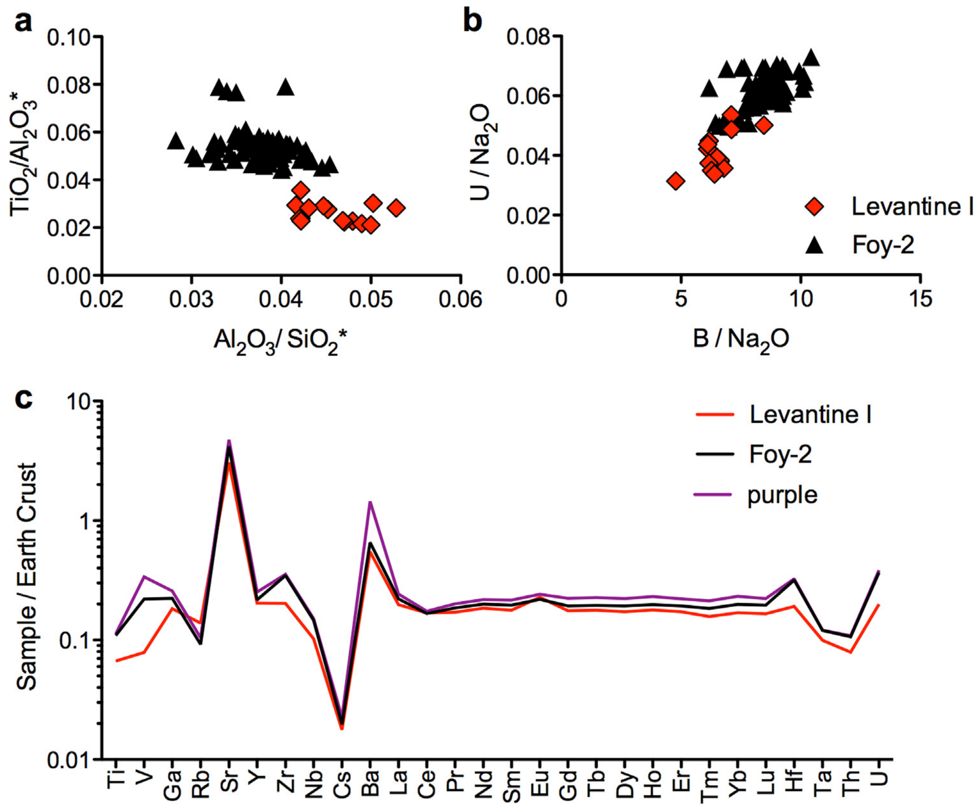

Fig. 4. Base glass composition of the Durres tesserae: a: TiO_2/Al_2O_3 versus Al_2O_3/SiO_2 ratios illustrate the geochemical characteristics of two distinct silica sources; b: U/Na_2O and B/Na_2O ratios distinguish two sources of mineral soda; c: average trace element concentrations normalised to the MUQ [34] confirm the two different glass groups. The profile of the purple samples identifies the elements associated with the manganese source. Asterisks (*) indicate that the data were reduced to the major and minor elements (Na_2O, MgO, Al_2O_3, SiO_2, P_2O_5, Cl, K_2O, CaO, TiO_2, MnO, Fe_2O_3) and normalised to 100%.

overlap between the glass from the primary production centres of Jalame and Apollonia, obscuring a clear separation. In any case, the Durres tesserae coincide more comfortably with the Apollonia group.

3.3. Colouration and opacification

The manganese content in the Durres tesserae varies widely (0.02 to 2.66%). The glasses assigned to the Levantine I group have manganese concentrations either at the natural contamination levels of silica sources (Mn < 250 ppm) or at the level of unintentional contamination through recycling (Mn < 0.3%). In contrast, the Foy-2 type tesserae have manganese generally at concentrations that indicate its deliberate addition as colorant or decolourant (Mn > 0.5%) apart from seven turquoise samples (Table S2). All gold-leaf tesserae have similar amounts of manganese as decolourant (MnO 1.2–1.7%), but express slightly different shades from perfectly decolourised (Durres 008) to a slightly yellowish tinge (Durres 001). At levels more than 2%, manganese serves as a colorant for purple and black. In terms of their trace element patterns, the purple tesserae have somewhat higher strontium and barium contents, reflecting the manganese-bearing mineral that was used, as well as higher vanadium, related to the elevated iron contents of these glasses (Fig. 4c). In addition, the SEM investigation revealed numerous undissolved particles of iron, manganese and silica (Fig. 6a). Similar particles have been detected in a purple tessera from the seventh-century mosaics of SS. Cosmas and Damian in Rome [39].

The blue tesserae are all coloured with cobalt ranging from 240 ppm to 900 ppm. Excluding two outliers (Durres 009, Durres 021), the cobalt is strongly correlated with nickel (Fig. 7a). A similar association of cobalt and nickel has been found in sixth- to seventh-century Byzantine glass weights [15], sixth- to seventh-century

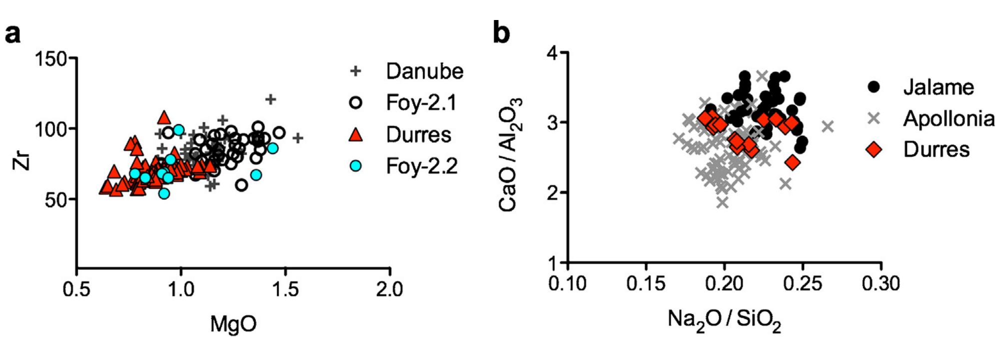

Fig. 5. Affiliation of the two glass groups from Durres: a: the Durres tesserae of the Foy-2 family compared to published data [30,33]; b: the Levantine I type tesserae from Durres in comparison with glasses from Apollonia and related assemblages [14,35,36] and Jalame [37].

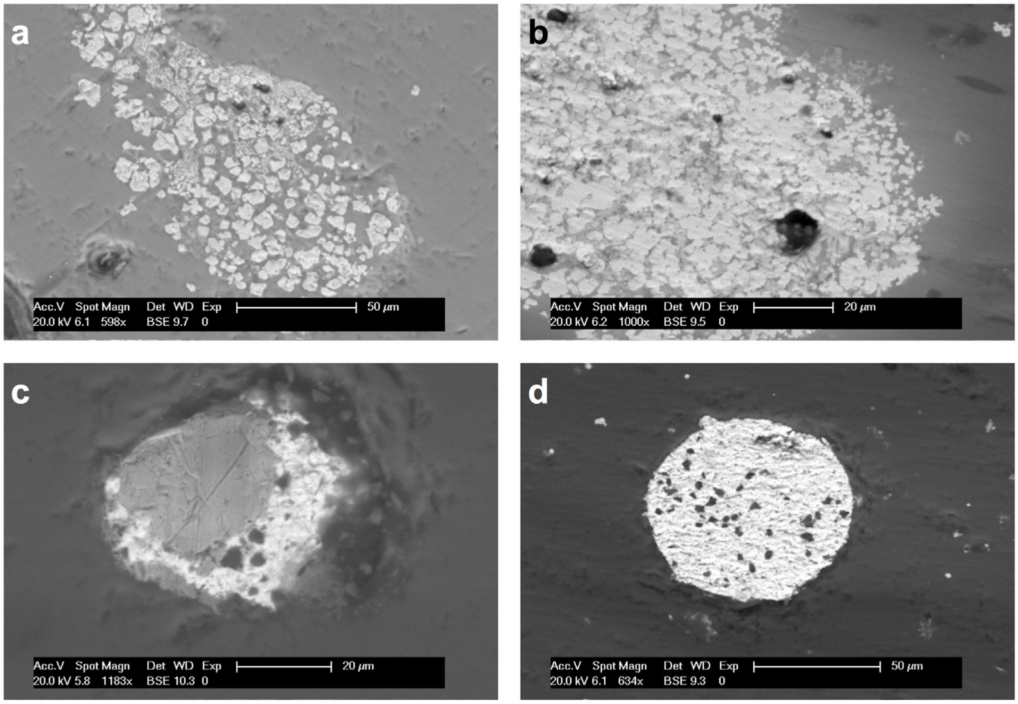

Fig. 6. Back-scattered electron images (BSE): a: particles of manganese and iron in black sample Durres 041; b: aggregates of sub-circular lead stannate particles in greenish yellow tessera Durres 053; c: large copper inclusion in green sample Durres 091; d: round droplet of lead in yellowish green sample Durres 062.

glasses from Xanthos [40], the remains of a seventh-century secondary glass workshop in Beirut [41], as well as in Merovingian glass from Larina [42]. No opacifiers other than air bubbles were detected. The majority of the turquoise tesserae also appear to be opacified mostly by air bubbles, while the light blue or turquoise colour is obtained by the addition of copper oxide (Table S2).

The strong correlation between lead and tin in the yellow and green tesserae and the detection of crystalline phases reveal the use of lead stannate as yellow colorant (Fig. 6b). Variations in the trace elements associated with lead stannate point to different types of the yellow pigment. For example, in a set of thirteen greenish yellow tesserae, tin shows a strong positive correlation with arsenic and antimony (Fig. 7b). This is a very distinct colorant that has hitherto been identified only in a set of Merovingian beads (unpublished data). The yellow pigment in the other yellow and green tesserae from Durres is similar to the lead stannate used for the tesserae and opus sectile in multiple fourth- to seven-century sites (Fig. 6b) [43–49]. What is somewhat unusual at Durres is the variability of minor components (Zn, Fe) in the crystalline phases of the lead stannate. Such a diversity in the same archaeological context is known only from modern Venetian recipes [49]. In our assemblage, the relative presence of minor elements in the opacifying crystals does not appear to be related to the colour of the tesserae.

The green tesserae obtain their colour through a combination of lead stannate and copper. Particles of a leaded copper alloy with tin (Cu-Pb-Sn) or silver (Cu-Pb-Ag) demonstrate the use of metallic residues for the coloration of mosaic tesserae. Only two tesserae (Durres 091, Durres 102) contain particles (ca 30 μm) of copper sulphide (Cu_2S) and lead galena (PbCuS), indicating the use of minerals instead of metallic compounds (Fig. 6c). Cassiterite aggregates (SnO_2) are sometimes present as well, which might be a residual of the lead-tin yellow pigment. Bright droplets of tin-free lead in some samples provide evidence of the intentional addition of lead (Fig. 6d). Similar practices have been observed in relation to one green tessera from Amorium [50], but the reason for the additional lead remains unknown. Low densities of quartz crystals were

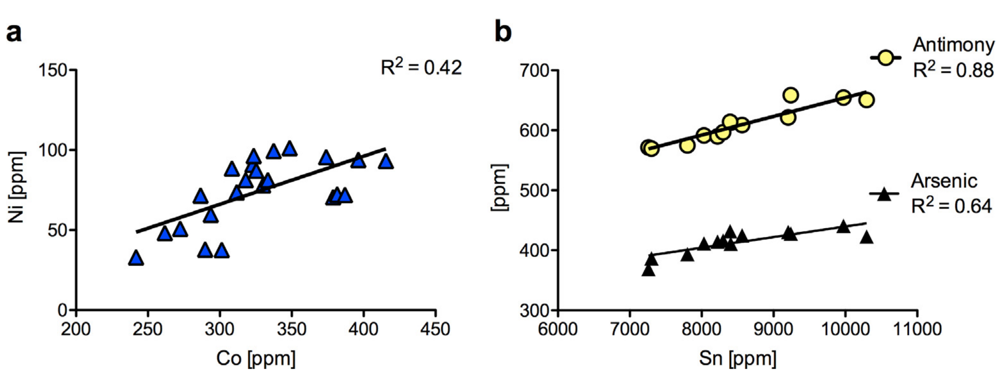

Fig. 7. Colouring agents of blue and greenish yellow tesserae: a: correlation of cobalt and nickel in the blue tesserae of the Foy-2.2 type; b: correlation of tin versus antimony and tin versus arsenic in thirteen greenish yellow tesserae.

detected in some of the green tesserae, but without opacifying capacity as is the case in other middle Byzantine mosaics [51–54].

4. Discussion

4.1. Chronological re-attribution of the mosaics

The compositional data point to a sixth- to eighth-century date for both the raw glass as well as the colorants and opacifiers used for the manufacture of the mosaic tesserae from Durres. The exclusive use of natron-type glass in what is a statistically significant sample size (> 100) makes a date for their manufacture after the eighth century highly unlikely. The two primary glass families employed (Foy-2, Levantine I) were produced and used between the sixth and late seventh centuries. The fact that a substantial proportion of the tesserae appears to contain recycled material (e.g. série 2.2 [30]) allows possibly for a date as late as the late eighth century. Moreover, the use of colorants that have been evidently exploited during the sixth and seventh centuries, such as cobalt correlated with nickel and lead stannate associated with arsenic and antimony, confirms a sixth- to eighth-century attribution.

The stylistic and iconographic features of the mosaic favour a similar date. The seventh-century mosaics of Saint Demetrios in Thessaloniki, for example, offer close artistic parallels [12,55]. Just like the depictions of Saint Demetrios in Thessaloniki, so too is Hagios Stephanos in Durres portrayed as a youthful saint with his raised hands represented in gold. The tesserae of Demetrios' golden halo are arranged in neatly placed horizontal rows in the same fashion as in the central figure of the large south panel at Durres. This contrasts with the more traditional technique, whereby the gold tesserae are laid concentrically, following the curvature of the nimbus. The rendering of diminutive donor figures is a recurring theme in the mosaics of Saint Demetrios [55], as are the stylised pink shadows of the halos in the panel of Saint Demetrios and the builders [56]. Interestingly, an early attestation of the abbreviation ɣ to indicate the OY in the inscriptions of Saint Demetrios is another feature shared with Durres [56].

Another decidedly late antique feature is the representation of the Maria Regina with gem-studded *loros*, which is a quintessential Byzantine imperial insignia. The earliest surviving example of the Maria Regina iconography is the mid-sixth-century fresco in Santa Maria Antiqua in the Forum Romanum in Rome [57]. Mary here also wears a lavishly decorated *loros* that is absent from later representation of this type, as seen, for instance, in the encaustic icon of the Madonna della Clemenza in Santa Maria in Trastevere in Rome, dating to the sixth to eighth century [58]. An early date might thus be assumed for the Durres mosaics. The conspicuous presence of the jewelled *loros* in the Durres panels may have served as much as an imperial reference as it establishes a visual link with the Byzantine capital, the seat of the Byzantine court. No imperial intervention is known on the Balkans between 572 and 591, and the sources particularly emphasise the Byzantine absence from 602 to 843, when *Dyrrachium* becomes capital of a *theme* [59,60]. The mosaics are thus an important document that reflect how the local elite and church may have tried to fill the power vacuum caused by the withdrawal of the Byzantine sovereignty by visually proclaiming a link with Constantinople and thereby expressing legitimacy [5,59,61].

The iconographic, stylistic and analytical evidence indicate a sixth- to eighth-century date for the mosaics at Durres. The complete absence of raw materials post-dating the eighth century from our set of samples substantiates this interpretation further. If the mosaics were later, at least some post-eighth century material would be expected. Only two gold tesserae with a soda ash flux have been reported in an earlier study, but these probably belonged to later restorations [62]. This practice was very common as, for instance, in the mosaics of St. Ambrose in Milan [27], St. Justine in Padua [63] or St. Vitale in Ravenna [64].

4.2. Provenance of the materials

The different types of raw glass and varying colouring and opacifying recipes in comparison with tesserae from other Albanian sites reveal complex supply networks and chronological developments. The Roman and late antique tesserae from Butrint in southern Albania, for example, are made from a Levantine raw glass, opacified with calcium and lead antimonate [65]. In contrast, the Durres tesserae have been made mostly from recycled glass of a presumably Egyptian origin. Changes in the supply networks have already been proposed in context of the overall glass assemblage from Butrint [65], but appear to have been a wider phenomenon, judging from an increased influx of Egyptian glasses in Albanian mosaics more generally [66]. This development might be related to Justinian's re-conquest of North Africa and the western Mediterranean that re-opened trade routes and boosted the influx of African and Egyptian products throughout the Byzantine realm from the latter part of the sixth to the middle of seventh century [67].

In terms of colouring and opacifying techniques, the picture is not clear cut. The use of a cobalt colorant related to nickel and lead-tin pigments characterized by traces of arsenic and antimony are recognised here for the first time in the manufacture of mosaic tesserae. These colorants have previously been documented in Byzantine glass weights [15] and in Merovingian glass beads (unpublished data), respectively, but the sources of their supply are unknown. While the cobalt mines of Qamsar in central Iran may be a possible source for cobalt even though no exact chemical match has thus far been found [42,68], the tense political relationship between the Byzantine and the Persian Empires during the late sixth and seventh centuries introduces some degree of uncertainty about the viability of this option.

The other coloration and opacification recipes evident in the Durres assemblage cannot be related to any specific geographic or chronological origin because they reflect relatively conventional techniques. Lead stannate, for example, was used throughout the Mediterranean from the fourth century onwards [16,43–48]. Metallurgical remains as the source of copper have likewise been detected in the mosaic tesserae from numerous places from Italy to Asia Minor [16,27,43, 65,69]. Manganese associated with iron and silica was found at various contexts from Rome [39] to Constantinople [70]. The similarity in secondary glass working techniques bears witness to common technological traditions for mosaic tesserae, while variations in associated trace elements imply disparate production events and by extension secondary production centres.

4.3. The mosaic of Durres and its affiliation

The material, technical and iconographic affiliations of the mosaics in the amphitheatre of Durres reveal the cultural diversity and multilateral networks that shaped the late antique and early medieval world of the Adriatic. Technically, the mosaic panels are closely related to eastern traditions. The three layers of plaster and the three-colour palette of the preparatory paint on the setting bed (red, yellow/ochre, black) are common features of mosaics elsewhere (e.g. Mar Gabriel, Nea Moni at Chios, the Koimesis Church in Nicea, the church of Dereagzi [27], St. Apollinare in Classe at Ravenna [71]). A combination of glass tesserae and natural stones is again typical of late antique mosaics in Thessaloniki, Ravenna and Poreč [28,56,72]. The technique of setting the gold-leaf tesserae in horizontal rows in haloes and medallions is attested in numerous sixth- and seventh-century mosaics from Constantinople to Thessaloniki [73]. The practice of using round instead of square tesserae to render eyes can be found throughout the Byzantine period [28,56,72].

Stylistic similarities exist with the seventh-century mosaics of Saint Demetrios in Thessaloniki, whereas contemporaneous mosaics in Rome tend to be different as regards the representation of faces or the hieratic position of the figures (e.g. SS. Primo and Feliciano, SS. Cosmas and Damian, St. Zeno, St. Venantius and St. Agnese) [11]. For example, the superposition of different planes and the interaction of smaller and bigger figures are not found in contemporary Roman mosaics. The schematised shadows, line-renderings of noses and lips, as well as the proportionally bigger eyes are also peculiar to the mosaics in the amphitheatre of Durres and not typical of the mosaics of Rome. However, the mosaics in the oratory of Pope John VII in Saint Peter's (705–707 CE) have been shown to bear some stylistic and technical resemblance to the mosaics of Durres [74]. The narrative aspects of the mosaic as well as the seemingly random distribution of tesserae of various dimensions and no modelling of the drapery that are merely outlined by a single black line offer an artistic parallel.

Finally, in terms of subject matter, assuming the central figure on the southern panel is indeed a representation of the crowned Virgin in imperial *regalia*, the iconography of the Maria Regina seems to have been especially popular and widespread in the west during the sixth to eighth centuries [57,58]. Whether or not this type of Marian imagery developed also in the Byzantine east is at this point impossible to tell due to the lack of any visual evidence in Byzantium [58]. Irrespective of the precise geographic origin of the Maria Regina iconography, the depiction of the Virgin in Byzantine imperial dress is an unmistakable cultural and artistic reference that is intimately linked to the Byzantine court. This link might well be indirect through the mediation of the visual tradition in the west, particularly Rome. However, as we argue in this paper, the mosaics were created at a time (sixth to eighth century) when Durres was firmly embedded in the Byzantine ecclesiastical hierarchy [1]. The lack of secular Byzantine institutions might have inspired the depiction of the Virgin in Byzantine imperial *regalia* to visually proclaim and reassert Byzantine control in the city.

5. Conclusions

The interdisciplinary analysis of the mosaics of the Durres amphitheatre enabled us to reassess the technical and cultural affiliations of the decoration. The value of the mosaic lies particularly in its merging of eastern and western elements, mostly due to the strategic position of Durres on the northern Adriatic shipping routes and the western terminus of the *Via Egnatia*. The analytical data in particular allow a great degree of precision about the chronological and geographical attribution of the materials and, by extension, the mosaics *in situ*, which adds substantially to the interpretation attainable by archaeological and art historical data alone. It has been shown that the mosaic tesserae were made from base glasses that date to between the sixth and eighth century CE, and the colorants and opacifiers used were common during the same period. This strongly suggests a similar date range for the mosaics at Durres, especially since no later material was among the tesserae analysed. Such a date is consistent with the stylistic and iconographic interpretation of the mosaics that have parallels in seventh- and early eighth-century mosaic decorations. These findings are in contrast to a recent archaeological assessment of the chapel that proposed a post-ninth-century date [2]. The authors of that study conceded that the evidence is ambivalent. Our data provide a missing piece to the puzzle, underlining the need for multidisciplinary approaches.

The mosaics cannot be unambiguously associated with an eastern or western tradition. As we have just discussed, the materials of the tesserae are decidedly eastern in origin. Raw glass during the early medieval period continued to be produced (almost) exclusively on the Levantine coast and in Egypt and, judging from their distribution patterns, some of the colouring and opacifying techniques seem to likewise originate in the eastern Mediterranean. Technically, the panels *in situ* also appear to have been closely related to practices in the Byzantine east. In contrast, many of the artistic features are a conglomeration of Byzantine and Roman elements. This means that trade networks and cultural or artistic affinities do not necessarily converge and potentially follow different principles. It also highlights the complex geopolitical and economic mechanisms underlying the creation of a mosaic programme, especially when considering a site exposed to multiple influences [18].

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.culher.2017.05.003.

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