STUDY OF MOSAIC GLASSES FROM THE ALPHA BASILICA (SIXTH CENTURY) OF NIKOPOLIS IN EPIRUS, GREECE

Cesare Fiori•
Department of Cultural Heritage, University of Bologna, Italy

Sabrina Gualtieri
CNR-ISTEC, Faenza, Italy

Dimitrios Chrysopoulos
Directorate of Conservation of Ancient and Modern Monuments, Ministry of Culture, Athens, Greece

Corrado Palmiero
Degree in Preservation of Cultural Heritage, University of Bologna, Italy

Keywords: Nikopolis in Epirus, ancient glass, mosaic glass, Byzantine basilica, Ravenna

1. Introduction

The main objective of the present work was the characterization of the composition, and the reconstruction of the production technology, of glass tesserae from the samples kept in the Archaeological Museum of Nikopolis in Epirus, Greece. The analysed tesserae belonged to lost parts of mosaic floors in the Alpha Basilica (or Doumetios Basilica), dated to the 6th century. In addition, the composition of these tesserae was compared with that of mosaic glasses of the same century recovered in Ravenna, in particular with the thoroughly studied mosaic glasses from the St Vitale basilica, in order to verify a possible common technological basis and a possible common production source for the two localities.

1.1 Historical notes

Nikopolis was founded by Caesar Augustus Octavian to celebrate the victory against Mark Antony at Actium (31 B.C.), a locality near the site where the new town stood. At that time, the area was in decline and almost abandoned, so the founding of a new town contributed to its repopulation [1-2]. Nikopolis subsequently drew the attention of successive emperors and obtained the statute of civitas foederata, that

• Corresponding author: cesare.fiori@unibo.it

established particular tax concessions. The town was embellished under the Emperor Hadrian and later included in the province of Epirus by the Emperor Antoninus Pius. Subsequently, due to reforms by Diocletian and Constantine, the town experienced a relatively long period of peace and prosperity that was suddenly interrupted by the first great barbarian migration. In 363 A.D., Claudius Mamertinus, the prefect of Illyricum, described the dramatic condition of Nikopolis after the first barbarian incursions that damaged the population (inhabitants either killed or captured, reduced to slavery, and ransomed for exorbitant sums of money), buildings and structures (roads, bridges, dams, aqueducts), and the general economy and management of public offices (since the high levels of taxation could no longer be sustained) [3]. Thus, between the 4th and 5th centuries the town experienced a sharp decline that put its existence at risk, due to the downfall of the Roman Empire [4].

The first Visigoth invasion in Epirus can be dated to 380 A.D. In 396 the Goths of Alaric invaded Epirus, then returned in 406, and stayed in Nikopolis for a year. In 429 the Vandals took over in North Africa, where they founded a powerful nation, and shortly after succeeded in dominating the central Mediterranean Sea through acts of piracy and incursions in coastal provinces. In 474 the Vandals, led by Genseric, subjected Nikopolis to a particularly heavy sack. Following this event, new walls were built that, however, surrounded only a sixth of the area occupied by the town in its full splendour; an indication of the strong decline at that time.

The earliest information about the birth of the Christian Church in Epirus refers to the first century A.D., following the passing of the apostle Paul; but the new religion experienced difficulties. It was only after the death of the Emperor Julian, the apostate, that there was a mass conversion. There was an attempt to limit the excessive number of ordinations of the Christian Clergy for fiscal reasons, but religious ferment led to the construction of many churches. In Nikopolis five basilicas were built in a period of one hundred years. The cultural level of the bishops was high, as they attended ecumenical councils, and as is evidenced by surviving inscriptions in the high quality of the floor mosaics.

The construction of new basilicas, during the fifth and sixth centuries, also indicates a certain economic recovery of the town. The Emperor Justinian reinforced the walls of the fifth century and this saved the internal part of the town from being sacked by the Ostrogoths in 551, as reported by Procopius of Caesarea [5]. Among the four basilicas inside the new walls, was the Alpha Basilica dedicated to St Demetrius and known as Basilica Doumetios, dated to the sixth century.

However, the barbarian incursions, together with the insufficient economic resources and political instability, were the cause of a new, definitive decline of the area and the town of Nikopolis [2].

1.2 Archaeological studies

The first archaeologist to mention Nikopolis was Ciriaco Pizzecolli, whose scripts were published in the eighteenth century; there are also notes by three diplomats from the beginning of the nineteenth century: two Frenchmen, Louis Duprè and Françoise Pouqueville, and the Englishman, Martin Leake [2, 6]. Archaeological exploration was started in 1913 by Alexander Philadelphus [7] who unearthed the Alpha Basilica during the excavations of 1915-1918 and began to explore the Basilica B (or Alkison Basilica) in 1921. The first local museum was built in Preveza. Other archaeologists took part in the excavations: George A. Soteriou and Anastassios Orlandos who completed the unearthing of the two basilicas in 1930. They began the excavation of the Basilica C in 1937-1938 [8-11]. The Second World War interrupted the excavations and damaged the archaeological site, including the Preveza Museum, which was also subjected to the sacking of its collections.

Archaeological exploration was resumed in 1956 by Orlandos [9-10] who worked at Basilica D and from 1956 began collaborating with D.Pallas [12]. In 1969 Sotiriou Dakaris, archaeologist and director of Byzantine studies on Epirus, headed the construction of a new museum built in the archaeological area. Afterwards, the main activity was dedicated to the restoration and conservation of the archaeological remains. Between 1991 and 1995, Dakaris and the Boston University archaeologist James Wiseman collaborated to create the Nikopolis Project. It was a multidisciplinary project, experimented in the southern part of Epirus, involving a number of prospecting techniques which dealt with the question of ancient settlement patterns in the region and management of the cultural heritage. A present day view of the Basilica Alpha remains is shown in Figure 1; a plan of the Basilica [8] is reported in Figure 2.

Figure 1. Remains of the Alpha Basilica of Nikopolis, with the built shelters of the mosaics of the transept south and north wings) and the nartex (south wing). (Photo by C.Palmiero)

Philadelphus [7] described the Byzantine structure of the Alpha Basilica oriented west-east (entrance-apse). The plan with the correct measurements was mapped out by Soteriou [8]. The Basilica was constructed in two distinct phases: (1) at the beginning of the sixth century and (2) around the middle of the same century, according to the dates proposed by Kitzinger [13]. The total length is 56 m; the main entrance has a propylaeum, which opens onto an atrium that precedes a narthex; the main body of the church has a nave and two aisles, with the nave separated from the aisles by colonnades; the apse is raised 1.5 m above the nave level. R. Krautheimer [14], in his study on paleochristian and Byzantine architecture, identified Greek churches as having a distinct architectural style, with influences from the Eastern Church, as regards the liturgy, and the Western Church, related to the masonry. In this period the basilicas, of remarkable dimensions, on the outside appeared simple and bare, while all the richness was concentrated in the interior, with gilded ceilings, furnishings with gold and silver, columns made of precious marbles, and fine mosaic decorations.

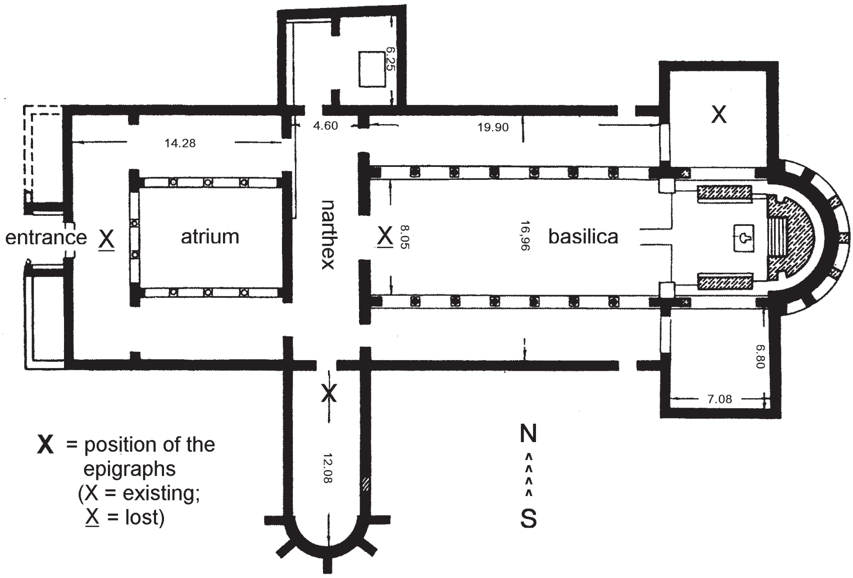


Figure 2. Plan of the Alpha Basilica of Nikopolis [8]

1.3. The mosaics

Kitzinger [13] based his dating of the two construction phases of the basilica on the stylistic, iconographic and epigraphic characteristics of the mosaics. Following the chronological order proposed by Kitzinger and reports of the excavation campaign by Philadelphus [7], who saw that most of the floor was still intact, M. Spiro [15] has described the mosaics in detail, analysing drawings, colours and materials. The floors of the second decorative phase are of a remarkably inferior quality in comparison to those of the first phase.

The central part of the floor of the atrium, referable to the second construction phase, was decorated with a mosaic epigraph which cited the dedication of the church to St Demetrius and the name of the episcopal sponsors of the first and second phases: Doumetios I and his successor Doumetios II. At the western entrance was another epigraph reporting the information that Doumetios I was the promoter of the building, from its foundations to the decorative scheme [16]. The preserved epigraphs confirm the dedication of the church to St Demetrius. Part of the floor mosaic was lost after the excavations; only those of the transept and the southern wing of the narthex are preserved as they were laid on new supports and protected by the construction of shelters (Figure 1). In the mosaic carpets a clipeus decoration with figures of hunters, animals, plants, and fruits predominates. Details of the mosaics are shown in Figures 3 and 4.

The mosaic carpets of the north (prothesis) and south (diakonikon) wings of the transept are referable to the first phase of construction of the basilica. In the northern wing, there is a mosaic panel (Figure 3) that, besides the epigraph, shows fruit trees alternated with cypresses, two guinea-fowls and birds in the sky; the tones of the colours are very strong, particularly the very dark green of the trees that contrasts with the yellow and red of the fruits. Outside the panel, there is a frame with waves in turn surrounded by a band in which water fowl, fish and aquatic plants are represented. In this pattern a strong Hellenistic style persists and the central panel is probably a schematic representation of the whole world, corresponding to a popular cosmological tradition. In the southern wing of the transept there is a mosaic panel composed of a badly damaged central emblema surrounded by 16 clipeus, decorated with acanthus and racemes, containing representations of hunters and animals (Figure 4); on the outer band fish and aquatic plants are represented. A large section of the hunting scene in the centre is lost, thus its interpretation is difficult; assuming a correspondence with the northern wing, it can be supposed that it deals with the Garden of Eden. Thus, the two panels of the transept should represent a complex cosmological and geographical scheme of the Earth, through a precise and schematic symbolism [13, 17].

In the southern wing of the narthex, the mosaic floor shows a more common style and subjects, such as in the outer band with polychromatic interlaced patterns and the inner part with small squares containing pictures of animals and geometrical and botanical motifs. The most important part is the epigraph.

Figure 3. Particular of the mosaic in the southern wing of the transept. (Photo by C.Palmiero)

Figure 4 – Particular of the mosaic in the southern wing of the transept. (Photo by C.Palmiero)

2. Archaeometric study of the glass mosaic tesserae

Glass tesserae were amply used for the floor mosaics of the Alpha Basilica. This is rather unusual for that epoch, when the use of more resistant stone tesserae prevailed. However, the mosaics decorating the floors of the Basilica were reserved exclusively for the clergy and authorities and therefore less subject to deterioration from foot traffic. The glass tesserae are mainly in shades of blue and green, but tones of yellow, ochre, red and black are also present.

The twelve analysed tesserae were selected from among those lost and damaged parts of the floor mosaics of the basilica. Knowing the period of construction of the church was the sixth century A.D., and that the twentieth century excavations and studies did not evidence either past restoration such as integrations or that any kind of intervention was promoted, except for the consolidation and protection of original parts, the examined glass tesserae are certainly original. Thus, their characterization is useful to trace the production technology of glass referable to a well-defined period, which may at most be extended to the second part of the previous century. Furthermore, the perfect correspondence with the construction period of the Byzantine basilicas in Ravenna (fifth/sixth centuries) makes an interesting comparison with the characteristics of the well studied mosaic glass of Ravenna and, in particular, those of St Vitale, which represent one of the most important productions and applications of mosaic glass of that period [18].

2.1 Analytical techniques

Determination of the composition of the glass samples was performed through chemical and mineralogical analyses. The quantitative chemical compositions were obtained using a scanning electron microscope equipped with energy dispersion microanalysis (SEM-EDS). The Cambridge-INCAX, Sight Oxford Instrument, mod.7060, with STEREOSCAN 360 electronic gun and a thermo-ionic emission tungsten wire, was used. Operating conditions were as follows: a fragment of cobalt as a benchmark for energy intensity was used; the distance of the sample surface from the objective lens (WD) was of 25 mm, and the beam acceleration (ETH) was of 15 KV. Before the analysis procedure, small fragments of the samples were fixed on aluminium supports with adhesive cement Leitc-C and then coated with a very fine graphite film using the instrument Assing Automatic HR Sputter Coater. With the aim of obtaining representative results, a minimum of ten analyses was carried out for each sample, on areas of 1 mm^2. The X-ray diffractometric (XRD) analysis was carried out using the Rigaku instrument, mod. Miniflex, with CuKα_1 radiation, nickel filter, angular velocity $\vartheta/2\vartheta$ of 0.25/0.5°/min, 2ϑ range from 4° to 64°. A small fragment (about 0.3 g in weight) of each tessera was pulverized for the analysis.

2.2 Results and Discussion

In Table 1 the results of the chemical investigation are reported. The high percentage of sodium (15% Na_2O approx.), as well as silica, and the relatively high quantity of calcium (6% CaO approx.) are clearly evident. Seven samples (1,2,3,4,5,10 and 11) are also characterised by amounts of lead oxide comprised in the range 5-12% PbO. The remaining five samples have very low or even no lead contents. Aluminium oxide (around 2% Al_2O_3), and magnesium and potassium oxides (less than 1%), as well as chlorine, can be considered as impurities in the raw materials used to produce the glass. In particular, the alumina content is to be ascribed to the presence of feldspars and micas in the sand used as silicate raw material. The fairly variable amounts of elements such as iron, copper, manganese, cobalt, antimony, and tin are connected with obtaining the various colours, as discussed below.

Table 1. Chemical composition

Sample	1 *Light green*	2 *Light green*	3 *Light green*	4 *Emerald green*	5 *Emerald green*	6 *Light blue*	7 *Light blue*	8 *Blue*	9 *Dark blue*	10 *Ochre*	11 *Red*	12 *Black*
SiO_2	64.17	62.44	62.88	62.47	63.55	68.34	70.81	69.89	71.53	65.03	60.11	68.93
TiO_2	0.14	n.r.	0.10	0.17	n.r.	n.r.	0.12	0.07	n.r.	n.r.	n.r.	n.r.
Al_2O_3	1.95	1.88	1.87	1.89	1.97	2.19	2.41	2.18	2.22	1.89	2.05	2.01
CaO	6.40	5.22	6.15	6.23	6.30	6.37	6.78	6.07	6.37	5.57	5.74	6.42
MgO	1.05	1.00	0.82	0.92	1.09	0.65	0.64	0.69	0.55	0.95	0.79	0.65
Na_2O	14.12	15.16	11.17	14.94	15.34	17.29	15.08	16.07	16.23	13.69	14.90	14.52
K_2O	1.01	0.92	1.07	0.83	0.93	0.60	0.81	0.79	0.68	1.01	1.21	0.74
Fe_2O_3	1.24	0.72	0.85	1.11	0.69	0.69	0.86	0.73	0.70	1.09	4.13	5.52
MnO	n.r.	n.r.	n.r.	n.r.	n.r.	0.32	0.72	0.57	0.58	n.r.	0.60	0.57
CuO	0.97	1.34	1.31	2.25	2.54	n.r.	n.r.	n.r.	n.r.	n.r.	1.41	n.r.
CoO	n.r.	n.r.	n.r.	n.r.	n.r.	0.03	.003	0.05	0.09	n.r.	n.r.	n.r.
Sb_2O_3	0.45	n.r.	0.35	0.35	n.r.	2.38	0.65	0.55	n.r.	0.55	0.50	n.r.
SnO_2	n.r.	0.50	0.60	0.25	n.r.	n.r.	n.r.	n.r.	n.r.	0.35	n.r.	n.r.
PbO	7.81	10.22	12.18	7.98	6.96	n.r.	n.r.	0.43	0.47	9.04	4.93	n.r.
Cl	0.69	0.60	0.65	0.61	0.63	0.57	0.59	0.61	0.58	0.93	0.63	0.64
SO_3	n.r.	n.r.	n.r.	n.r.	n.r.	0.67	0.50	0.70	n.r.	n.r.	n.r.	n.r.

n.r. = not revealed

On the basis of the chemical composition, the glass of the tesserae is classifiable as soda-lime silicate glass, obtained mixing natron as the sodic flux (a natural deposit of salts in Egypt consisting mainly of a sodium carbonate) and a quartziferous sand. This glass typology corresponds to that of Roman glasses of the first centuries A.D. [19-20]. The low percentages of potassium and magnesium oxides, as also illustrated in the correlation diagram of Figure 5, are indicative of the use of natron instead of plant ashes, that are a possible alternative flux for ancient glasses.

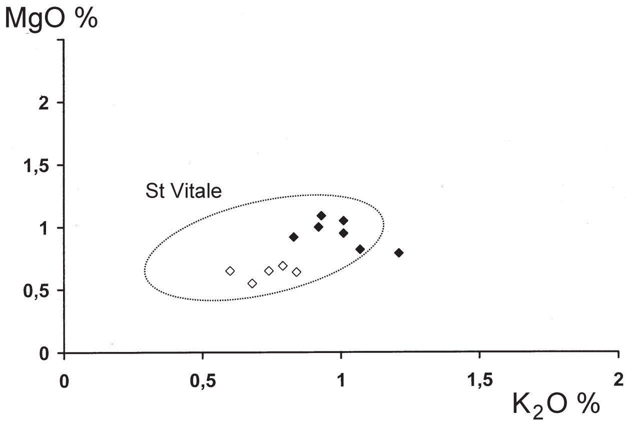


Figure 5. MgO vs. K_2O diagram, also showing the compositional field of the tesserae from S.Vitale (Ravenna)

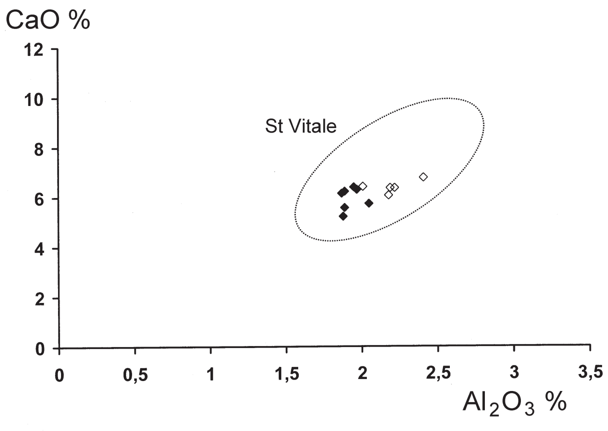


Figure 6. CaO vs. Al_2O_3 diagram, also showing the compositional field of the tessearae from S.Vitale (Ravenna)

The presence of lead in the above mentioned samples is linked to technological requirements because certain colours (bright shades of green, yellow, orange, and red) could only be obtained with a lead-based glass. The lead component of the fusible mix could be derived from the recovery of metallic alloy scraps or from metallurgy slag [19, 21]. These seven samples are also characterised by slightly higher concentrations of potassium and magnesium oxides than unleaded samples (Figure 5); this may be due, for the distinct production of leaded glasses, to the use of raw materials (sand and flux) with higher amounts of impurities containing potassium and magnesium. The “red” sample also has a potassium content over the average of natron glasses, but not so high as to denote the use of plant ash as flux. This content is not an anomaly for red glasses produced in that epoch; in fact, these glasses were produced under reducing conditions, probably obtained with the introduction of fuel (wood) ash, relatively rich in potassium, into the fusible mix [22-24]. In the MgO vs. K_2O diagram, the compositional field of the mosaic glasses of St Vitale is also reported [19], into which the samples from Nikopolis fall (with the exception of the above mentioned red glass).

As regards the type of quartziferous sand used, the relationship between alumina and calcium oxide contents in Nikopolis glasses (Figure 6), in accordance with that of Byzantine mosaic glasses from St. Vitale, seems to confirm that a type of sand such as that found at the mouth of the River Belus in ancient Palestine (today Haifa Bay, Israel) was used. This sand also contained fragments of shells, and thus calcium carbonate, in an optimal dose for providing calcium as a stabilizing element of the glass; therefore, it was used for the primary production of glasses of the Roman epoch and glasses of the early Byzantine period (Levantine I type), in the Egyptian-Palestinian area [20]. In the CaO vs. Al_2O_3 diagram, it can be noted that the leaded glasses are slightly shifted towards the left and downwards, maybe due to the relative decrease in the sand content as a consequence of the introduction of the lead component into the fusible mix.

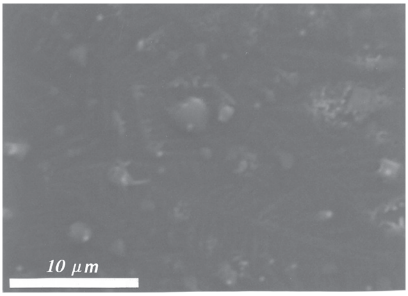
In some tesserae, with the highest lead oxide content, small amounts of tin oxide were measured. As ascertained in previous studies on mosaic glasses of the sixth century [19, 25], the presence of tin is linked to that of lead, and not due to the intentional addition of tin as an opacifier, as antimony was used for this function. The use of tin instead of antimony as an opacifier for mosaic glasses became widespread after the sixth century.

As regards the colouring elements, copper was used for obtaining the leaded green glasses. The variability in the concentration of copper oxide is due to the intensity of the final hue. These glasses also present a moderate quantity of iron contents and, in some, traces of antimony. In the light blue and blue glasses, with PbO<0.5%, the colour is due to very low percentages (less than 0.09% CoO) of cobalt oxide, that however has extremely high colouring capacity; in this case too, the intensity of the colour increases with the concentration of the colouring element. The iron content influences the colours of the ochre, red and black glasses, naturally together with other parameters, such as the concomitant presence of other elements and melting atmosphere conditions. More in detail, the ochre glass owes its colour to the presence of iron, lead (9% PbO approx.), and antimony traces, while in the black glass it is the high amount of iron oxide (5% Fe_2O_3 approx.) and the absence of lead that are responsible. As mentioned before, the red colour was obtained by melting in reducing conditions a glass with a moderate content of lead oxide (around 5%) in which very fine metallic copper particles were segregated; it is these that are actually responsible for the colour. The relatively high content of iron, together with the probable addition of fuel (wood) ash during the fusion, contributed to the attainment of the reducing conditions [25].

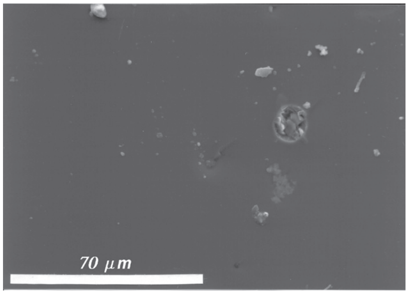
Apart from a clearly opaque light blue glass, the tesserae are either translucent or the colour is so intense that the glass is not transparent. The X-ray diffraction study allowed us to determine the presence of opacifying crystalline phases in a part of the samples, which developed in a remarkable way or only as traces, depending on the variable content of antimony oxide. In some unleaded glasses (6,7, and 8) the crystalline phase of calcium antimonate, $CaSb_2O_6$, is present; this is particularly evident in the opaque light blue sample (6), as ascertained through SEM observations (Figure 7a) and XRD analysis (Figure 8). In green (1, 3, and 5) and ochre (10) samples containing small amounts of antimony oxide, traces of the crystalline phase of lead antimonate, $Pb_2Sb_2O_7$, known to be yellow in colour, were detected (Figure 9). However, while in the green samples these traces did not significantly influence the colour due to the colouring element copper, in the ochre tessera, lead antimonate most likely contributed to that particular shade of colour. For the red tessera, the XRD spectrum showed some peaks attributable to Cu (Figure 10) confirming the interpretation at SEM observations (Figure 7b).

The tesserae without crystalline phases (or with their presence below the detectable level) are some of the green (2 and 5), the dark blue (9) and black (12) ones.

The results of all investigative analyses seem to indicate that the technology for the production of the coloured mosaic glasses fully corresponds to that of the mosaic glasses of Ravenna [19].



a



b

Figure 7. a) SEM photo of the red tessera showing the presence of the crystalline phase metallic Cu; b) SEM photo of a light blue tessera showing the presence of the crystalline phase $CaSb_2O_6$

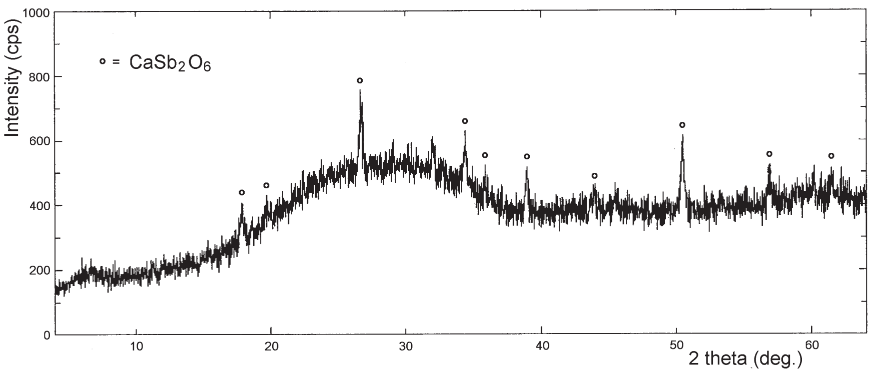


Figure 8 – X-ray diffractogram of a light-blue tessera showing the presence of the crystalline phase $CaSb_2O_6$

3. Conclusions

An examination of the literature and an inspection of the site, with a visit to the local archaeological museum, have allowed us to obtain the essential historical-artistic information relating to the mosaic floors of the Alpha Basilica of Nikopolis in Epirus built in the sixth century A.D.

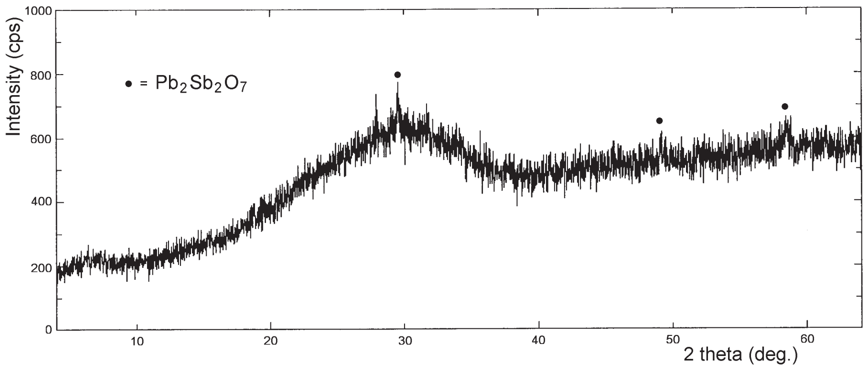


Figure 9 – X-ray diffractogram of a green tessera showing the presence of the crystalline phase $Pb_2Sb_2O_7$

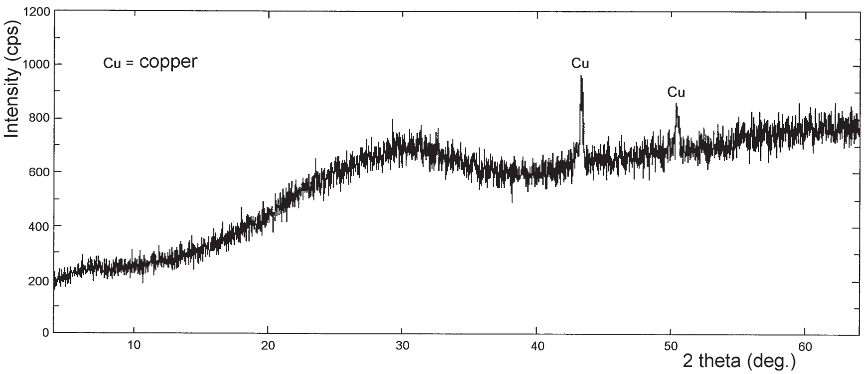


Figure 10. X-ray diffractogram of the red tessera showing the presence of the crystalline phase metallic Cu

Glass tesserae belonging to lost and degraded parts of the mosaic floors of the Basilica were analysed determining their chemical composition and the possible presence of crystalline phases.

As in all glasses produced in the Mediterranean area in that epoch, they are soda-lime silicate glasses, in part with lead, obtained using natron (a natural Egyptian deposit of salts, mainly made up of sodium carbonate) as a flux (and not plant ashes, an alternative flux used in other areas or epochs); this is evident from the high sodium oxide content and low concentrations of potassium and magnesium oxides. The raw silicate material was of the kind present at the mouth of the River Belus (ancient Palestine). The typology corresponds to that of the primary production in the Egyptian-Palestinian area, of Roman glasses employed in the same period for the basilicas of Ravenna; in particular, the comparison was made with the widely studied glass tesserae of the St Vitale Basilica.

As concerns the colours, the green tesserae were obtained with leaded glass and copper as the main colouring element; in some green glasses traces of the crystalline phase lead antimonate, with a yellow colour, are present, but they do not affect the colouring that is, instead, affected by the relatively high presence of copper. The light blue and blue colours have an unleaded base (or only traces of lead) and the colouring was obtained using small quantities of cobalt, the concentration of which increases accordingly with the intensity of the colour. The light blue colour is opaque due to the presence of the crystalline phase calcium antimonate. The ochre colour is due to iron as the main colouring element together with traces of lead antimonate which, in this case (the copper being absent), have contributed to the colour. The red leaded glass was obtained under reducing conditions that allowed the formation of metallic copper particles. The black colour of the glass, unleaded, is in relation to the particularly high concentration of iron oxide.

The technology behind the production of coloured glasses is quite analogous to that of the mosaic glasses of Ravenna. It can therefore be assumed there is a common source for the production of the mosaic glasses used in Nikopolis and Ravenna in the sixth century and that this source was in the Near East, perhaps in Constantinople itself.

References

[1] KARATZENI V., 2001, *Epirus in the Roman Period - Foundation and destruction*, Nikopolis and northwestern Greece: The archeological evidence for the city destructions, the foundation of Nikopolis and the synoecism, Athens, Aarhus University Press, pag.163

[2] BOWDEN W., 2003, *Epirus Vetus: The Archaelogy of a late Antique Province*, London, Duckworth Publishing, pag.14

[3] http://www.documentacatholicaomnia.eu/02m/0362-362,_Mamertinus_Claudius,_Gratiarum_Actio_Juliano_Augusto,_MLT.pdf

[4] SAKELLARIOU M.B., 1997, *Epirus, 4000 years of Greek history and civilization*, Athens, Historikoi Hellēnikoichōroi, pag. 58

[5] PROCOPIO DI CESAREA, *De aedificiis* IV, 1, 37; De Bello Gothico, VIII, 22, 31

[6] LEAKE W.M., 1835, *Travels in Northern Greece*, vol. 1, London, pag.185

[7] PHILADELPHEUS A., 1916, Ἀνασκαφαῖ Νικοπόλεως Αρχαιότατη Χριστιανική Βασιλική, ArchEph, pp.34-54, 65-72

[8] SOTERIOU G.A., 1929, Βασιλική Α. Νικοπόλεως της Ηπείρου, ArchEph, pp.206-207

[9] ORLANDOS A.K., 1937, *Praktika tís AkadímiasAthinón*, Akadímia Athínón, Athens, pp.15, 78-81, 461-462

[10] ORLANDOS A.K., 1968, *To Ergon tes Archaiologikes Hetaireias*, Archaiologike Hetarieia, Athens, p.27

[11] LEMERLE P., 1937, *Chronique des fouilles et découvertes archéologiques en Grèce*, BCH, 6l
[12] PALLAS D., 1977, *Monuments paléochrétiens de Grèce découverts de 1959 à 1973*, Città del Vaticano, pp.134-137
[13] KITZINGER E., 1951, *Studies on late antique and early Byzantine floor mosaic: Mosaics at Nikopolis*, DOP 6, pp.83-122
[14] KRAUTHEIMER R., 1986, *Architettura paleocristiana e bizantina*, Torino, Einaudi; Citazioni Nikopolis d'Epiro: pp.145-152,160, 195, 208, 325
[15] SPIRO M., 1978, *Critical Corpus of the Mosaic Pavements on the Greek Mainland*, Fourth/Sixth Centuries, with Architectural Surveys, vol.2, New York, pp. 425- 464
[16] FARIOLI R., 2009, *Mosaici con iscrizioni vescovili in Grecia: il ruolo dell'autorità ecclesiastica alla luce di nuovi scavi e ricerche*, Ideologia e cultura artistica tra Adriatico e Mediterraneo Orientale (IV - X secolo), edited by, A.Augenti. R.Farioli, C.Rizzardi, P.Porta, I.Baldini Lippolis, Bologna- Ravenna, Ante Quem, pp.35-36
[17] PELEKANIDIS J.-S., 1940, *Die Symbolik der frühbyzantinischen Fußbodenmosaiken Griechenlands,* Zeitschrift für Kirchengeschicht, Berlin, pp.114-124
[18] FIORI C., VANDINI M., MAZZOTTI V., 2004, *I colori del vetro antico. Il vetro musivo bizantino*, Saonara (Pd), Il Prato, pp.105-166
[19] FIORI C., VANDINI M., 2004, *Chemical composition of glass and its raw materials: chronological and geographical development in the first millennium A.D.*, When Glass Matters. Studies in the History of Science of Art from Greco-Roman Antiquity to Early Modern Era, ed. by M.Beretta, Firenze,Leo S.Olschki, pp.151-194
[20] FREESTONE I.C., GREENWOOD R., GORIN-ROSEN Y., 2002, *Byzantine and early Islamic glassmaking in the eastern Mediterranean: production and distribution of primary glass*, 1st International Conference Hyalos-Vitrum-Gass. History, technology and conservation of glass in the Hellenic world, ed. by G.Kordas, Athens, pp.167-174
[21] REHREN Th., KRAUS K., 1999, *Cupel and crucible: the refining of debased silver in the Colonia Ulpia Traiana, Xanten*, Journal of Roman Archaeology, 12, pp.263-272
[22] FREESTONE I.C., STAPLETON C.P., RIGBY V., 2003, *The production of red glass and enamel in the Late Iron Age, Roman and Bizantine periods*, C.Entwistle (ed.) Through a glass brightly – studies in Byzantine and Medieval Art and Archaeology presented to David Buckton, Oxbow, pp.142-154
[23] BARBER D.J., FREESTONE I.C., MOULDING K.M., 2009, *Ancient copper red glasses: investigation and analysis by microbeam techniques*, A.J.Shortland, I. C.Freestone, T.Rehren (eds.) From Mine to Microscope. Advanced Study in Ancient Technology, Oxbow Books, pp. 115-127
[24] STAPLETON C.P., FREESTONE I.C., BOWMAN G.E., 1999, *Composition and origin of early mediaeval opaque red enamel from Britain and Ireland*, Journal of Archaeological Science, 26, pp.913-922
[25] FIORI C., 2011, *"Vetro musivo del VI secolo dagli scavi della basilica di S.Severo a Classe (Ravenna)"*, Riv. Staz. Sperim. Vetro, XVI (1) pp. 22-34

Biographical notes

Cesare Fiori, Associate Professor of the scientific division “Chemistry of the environment and cultural heritage” at the Department of Cultural Heritage, University of Bologna, branch of Ravenna (Italy).He currently teaches “Conservation and treatment of materials” and “Restoration Chemistry” in the first level degree of Conservation of Cultural Heritage, and “Techniques for the conservation of mosaics”, in the Master of Science Degree of Conservation and Valorization of the Archaeological Heritage.

Sabrina Gualtieri, Researcher at the Institute of Science and Technology of Ceramic Materials, National Research Council (CNR), Faenza (RA), Italy. Research Group: New technologies for the environment, construction industry and cultural heritage; sector: Archaeometry, diagnostics and technology for cultural heritage conservation.

Dimitrios Chrysopoulos, Conservator of mosaics. Head of the Department of Conservation of Byzantine Antiquities, Directorate for the Conservation of Ancient and Modern Monuments, Ministry of Culture, Athens, Greece. Currently retired.

Corrado Palmiero, Degree in Conservation of Cultural Heritage, University of Bologna, Ravenna (Italy).