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Vitreous Beads Found at the Bronze Age Cemetery from Câmpina (Prahova)

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Abstract: ***Vitreous Beads Found at the Bronze Age Cemetery from Câmpina (Prahova).*** The present study focuses on the analysis of a number of beads made of vitreous material found at the Late Bronze Age cemetery from Câmpina (Prahova County). We shall describe the primary and chronological context and broadly discuss the more or less close/contemporary analogies. Several physical analyses on four pieces produced in a specialised laboratory from Valahia University of Târgovişte bring up for discussion the chemical composition of the raw matter used. The results of these analyses have allowed a short introduction to the physicochemical analyses on vitreous materials found in archaeological contexts in advanced phases in Western Europe, but strangely unknown in Romania.

Key words: Bronze Age, graves, glass, faience, beads, Câmpina

Introduction

The funerary complex of Câmpina is located in the Southern Subcarpathian area, disposed on the high terrace on the left side of the Prahova river, north of the confluence with the Doftana river, at an altitude of 500 m. The landscape is dominated by high hills and terraces situated on both sides of the Doftana and Prahova rivers (Fig. 1). Archaeological researches were carried out in successive campaigns during 2008-2012. 60 tombs belonging to a biritual cemetery were uncovered and both inhumation and incineration graves were studied. As for the burial rite, inhumation is prevalent, covering nearly 80% of the total number of identified individuals. The grave inventory is typical of the Noua and Monteoru cultures, while several vessels decorated in a specific Tei culture manner were found in three of the inhumation graves. Seven instances of ^{14}C dating place the evolution of this cemetery somewhere between 1450-1150 BC.

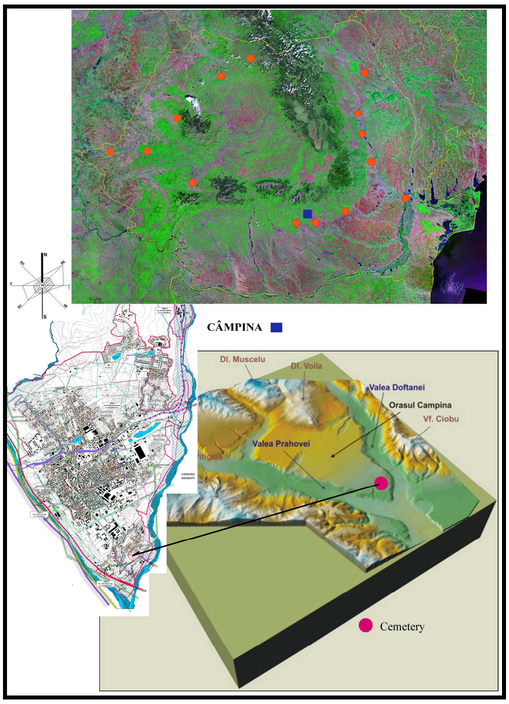


Fig. 1 – Romania: distribution of prehistoric vitreous beads; location of Câmpina cemetery.

Radiocarbon dating and relative chronology elements point to an evolution of this cemetery in the late phase of the Bronze Age (A. Frînculeasa *et al.*, 2011; A. Frînculeasa, 2012).

The archaeological background

Seven pieces made of vitreous material, consisting of small ring-shaped or spheroidal greenish, yellowish or turquoise blue beads, were found at Câmpina cemetery. All of them are less than 1 cm in diameter and were discovered in two inhumation graves, namely Grave 20 and Grave 58. The beads were parts of several bead strings put around the deceased's necks, associated with other amber, clay or limestone items.

✓ Grave 20 (pl. 1) – inhumed, found in 2010, in Sector 1, grid cell 7, DE7 squares, at -0.29 m, and -0.91 m at the base of the grave, approximately west-east oriented, in crouched position laterally, on the left side. The grave was 1.35x0.62 m and had a mound of stones above it. It had an inventory composed of two vessels (pl. 1/4, 7), two bronze earrings (pl. 1/1, 2), two clay beads (pl. 1/3, 6), four beads made of vitreous paste (pl. 1/5, 9). Anthropological determinations: female, 30-40 of age, 154.86 cm high; she presented pathologies such as osteoarthrosis, healed skull blows, an abscess. ^{14}C dating: 3159± 23BP, during the interval 1495-1402 BC, sigma 2 domain with 95.4% probability (Fig. 2).

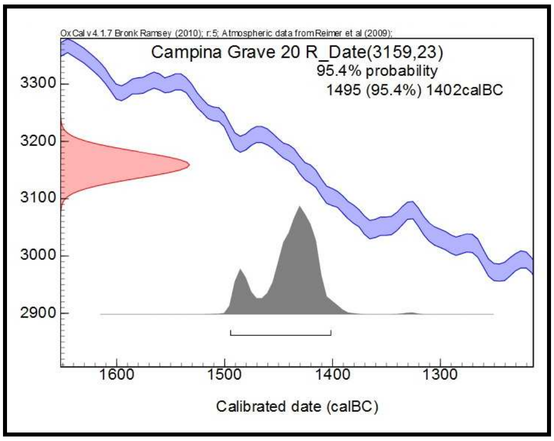


Fig. 2 – M20, ^{14}C dating diagram.

✓ Grave 58 (pl. 2) – inhumed, found in 2012 in the excavated surface between S.I and S.II, in the B4-5 squares, at a depth of -0.49 m, with the bottom of the grave at-0.65 m. The relatively well-preserved skeleton was WNW oriented, crouched on the left side; the grave was rectangular with round corners, 1.60x0.85 m in size. Some stones were preserved in situ and seem to have belonged to the mound built above the grave/deceased. Grave inventory: a fragmented vessel in secondary position, lying both in the upper area and towards the dead person's hip (pl. 2/4); a string arranged at the base of the mandible, made of 13 amber beads 7-15 mm in diameter and 2-3.5 mm thick (pl. 2/2, 9), 3 beads of vitreous paste (greenish or turquoise-blue (pl. 2/3, 5, 7), a white lime bead? (pl. 2/6), another fragmentary one made of a blackish-brown material not yet determined (2/8). Anthropological determinations: adult, female.

piece no.	context	thickness	external diameter	internal diameter	colour
1	Grave 20	5 mm	6 mm	4	green
2	Grave 20	3 mm	7 mm	4	green
3	Grave 20	3 mm	7 mm	4	yellow
4	Grave 20	4 mm	-	-	green
5	Grave 58	2 mm	6 mm	4 mm	green
6	Grave 58	2 mm	6 mm	4 mm	green
7	Grave 58	7 mm	7 mm	1 mm	turquoise-blue

Table 1 – Morphometry of beads made of vitreous paste.

Elemental (X-ray Fluorescence) analyses on the four pieces were performed at Valahia University laboratories.

X-ray Fluorescence (XRF) method

Among the various analytical techniques available today for the chemical characterisation of materials, X-ray fluorescence (XRF) (R. Jenikins, 1998) stands out as one of the most advantageous and reliable methods. In comparison with most other analytical methods, XRF offers a rapid, non-destructive, multi-elemental, accurate and highly reproducible analysis with little or no sample preparation in a wide dynamic range (few ppm to 100%). The X-

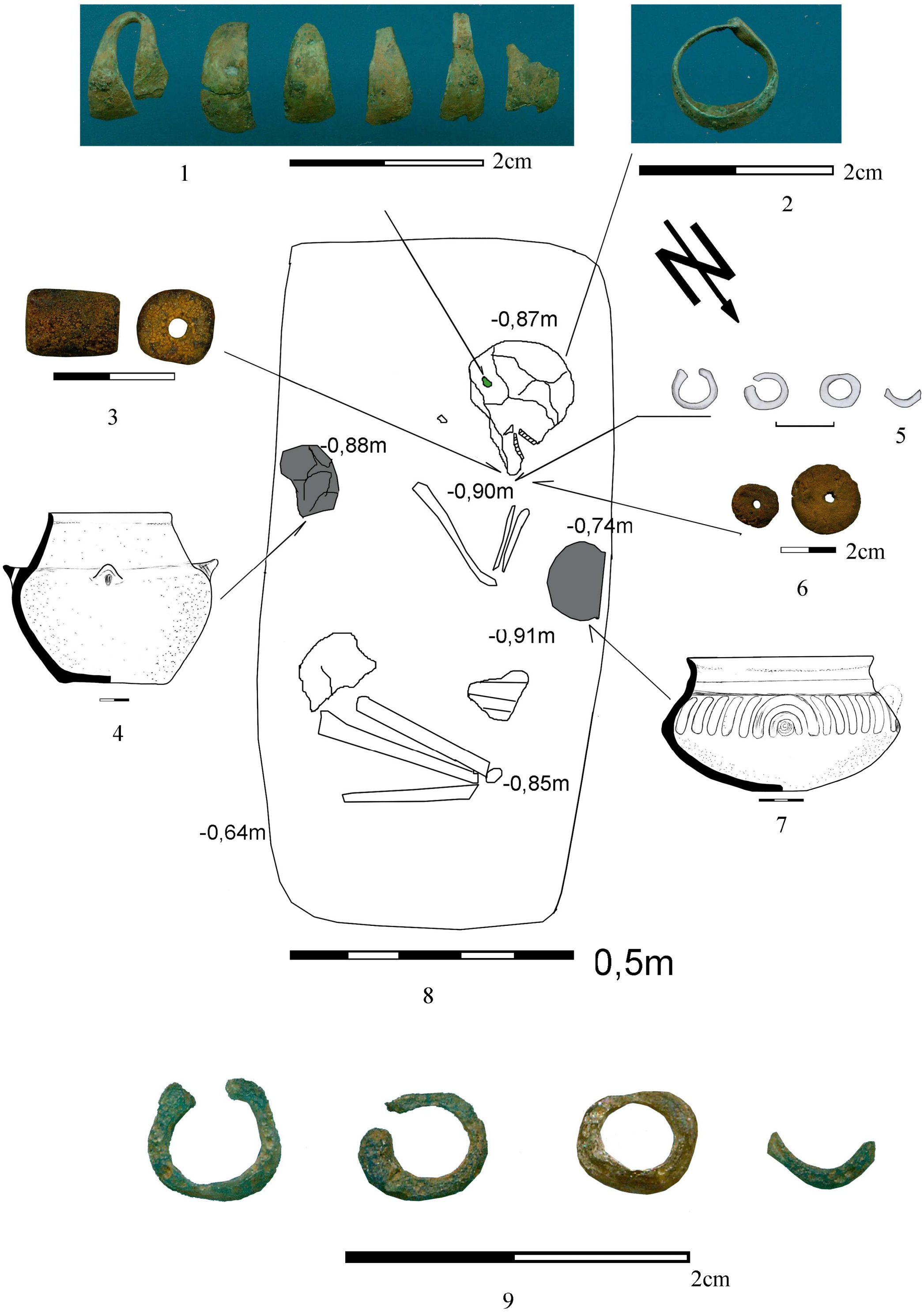


Plate 1 – grave 20: bronze rings (1, 2); clay beads (3, 6); grave (8); glass beads (5, 9); pots from grave (4, 7)

Plate 2 – grave 58: glass beads (2, 5, 7); other beads from grave (6, 8); amber beads (2, 9); pot from grave (4)

ray spectrum acquired during the XRF process reveals a number of characteristic peaks. The energy of the peaks leads to the identification of the elements present in a sample, on the base of the Moseley law (qualitative analysis) and the peaks intensity provide the relevant or absolute elemental concentration – (quantitative analysis).

Energy dispersive X-ray Fluorescence (EDXRF) measurements of glass samples from archaeological sites

The concentrations of elements (Ag, As, Ca, Co, Cr, Cu, Fe, Ni, Si, Sr, Ti) in glass samples were determined by Energy Dispersive X-Ray Fluorescence (EDXRF) technique, using the ELVAX spectrometer from Valahia University of Targoviste, having an X-ray tube with Rh anode, operated at 50 kV and 100 µA. Samples were excited for 300 s and the characteristic X-rays were detected by a multichannel spectrometer based on a solid state Si-pin-diode X-ray detector with a 140 µm Be window and a energy resolution of 200eV at 6.4 KeV. The characteristics X-ray spectra acquired are presented in figures (annexe 1-4). Quantitative calculations were made by the regression coefficient method (J. D. Winefordner, 1999).

Analogies and discussions on chronology

We should mention that the pieces (beads) made of vitreous materials were defined in the autochthonous bibliography in a broad sense as "glass/faience" or "paste" with no clear distinction between them. The earliest findings could originate from a Usatovo grave from Brăiliţa where there is a mention of a greenish bead string (I. T. Dragomir, 1959), but here there are several inconsistencies regarding the raw matter used. Though highlighted in a study on the appearance of glass in Central Europe (A. Harding, 1971), taking over an earlier piece of information (M. Gimbutas, 1965), the authors of the finding identified, as raw matter source, a "slightly arenaceous" dark-green micaceous clay (I. T. Dragomir 1959, p. 685; N. Harţuche, 2002).

As regards the necklace found in a grave dating from the same period, researched at Brad, there is a fairly accurate description, namely "a string of beads made of a red paste and bone, composed of 90 pieces" (V. Ursachi, 1995, p. 21). At Gorgota, a string of "kaolin beads painted green" were found in an Early Bronze Age inhumation grave (T. Muscă, 1996, p. 52); they seem to be rather made of glassy paste (A. Frînculeasa, 2007).

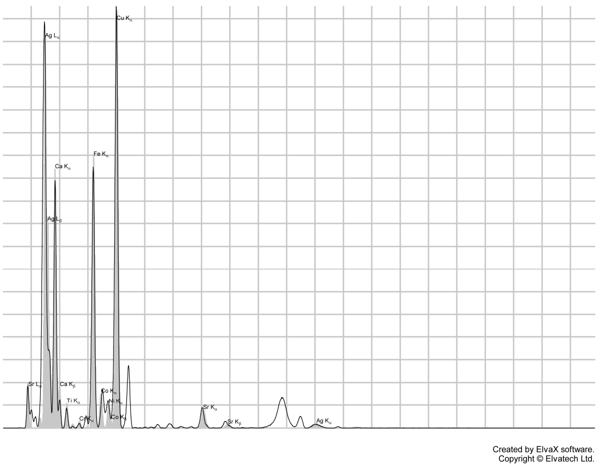
In the same chronological context attributed to the same chronological stage, a green pierced bead made of glassy paste has been recently found at Păulești (Prahova) in a grave which is part of a tumulus assigned to the Jamnaja burial horizon.

Beads of glassy paste or "faience" were also identified in Monteoru graves at Poiana, Cândeşti, Sărata Monteoru (E. Dunăreanu-Vulpe, 1938; M. Florescu, 1978; L. Bârzu, 1989; M. Petrescu-Dâmboviţa, 1998). We should mention *cemetery 4* of Sărata Monteoru where, in Grave 142, 417 faience and glass beads (I. Nestor, E. Zaharia, 1961), turquoise-blue or bright white in colour (L. Bârzu, 1989) were found. In Grave 35 eight glass pieces were found, while in Grave 122 ten were discovered, several others being in Grave 21, Grave 32, Grave 72, Grave 88, Grave 103 (L. Bârzu, 1989).

A faience bead was found at Almaș (E. Dunăreanu-Vulpe, 1938), two appeared in a vessel discovered at Răcătău, in a Monteoru settlement, associated with amber beads that formed a string (V. Căpitanu, Ursachi, 1979), 19 other made of "glassy matter" in a Noua hoard at Ulmi-Liteni (M. Florescu, 1961), and also in those belonging to the Late Bronze Age period - Hallstatt A1 at Cioclovina (E. Comşa, 1966; I. Emödi, 1978), Dobrocina (M. Rusu, 1963; Petrescu-Dâmboviţa, 1974). The items found at Lăpuș, Igrița (two blue glass beads) also belong to the same chronological horizon (I. Emödi, 1978; 1980). Other glass beads were found at Pecica II (I. Emödi, 1980). The largest number of pieces, approximately 2,800 glass and faience beads, were found in the Cioclovina hoard (E. Comșa, 1966; I. Emödi, 1978).

Such pieces are commonly encountered in Central Europe in Nitra, Aunjetitz, Mierzanowice, Lausitz, Lusatian etc. cultures (M. Gimbutas, 1965; A. Harding, 1971; 2010; A. Harding, S. Warren, 1973; J. Vladar, 1973; J. Batora, 1995; A. D. Popescu, 1999-2001; N. Venclova *et al.*, 2011; I. Motzoi-Chicideanu, 2011) or the Periam-Pecica culture, Otomani-Füzesabony (L. Olexa, 1987; I. Motzoi-Chicideanu, 2011). Faience or glass beads are also to be found in western Europe, in Spain, France, Switzerland, Germany (J. Henderson, 1993; G. Hartmann *et al*,. 1997; N. Rafael *et al.*, 2008; B. Gratuze, K. Janssens, 2004) as far as the British Isles, including Ireland (A. Aspinal *et al.*, 1972; J. Henderson, 1988). We should also mention the

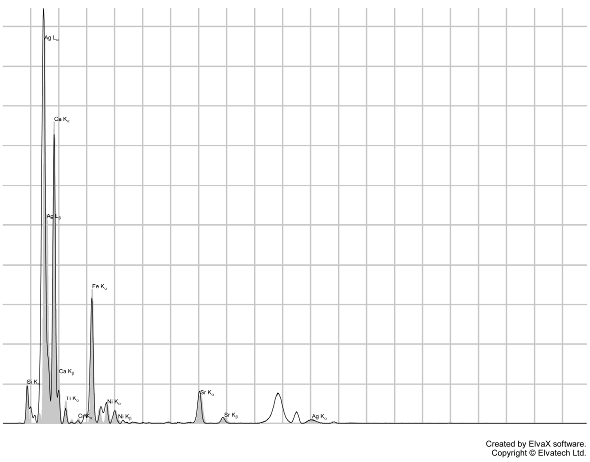
Report of Elemental Analysis
Date of analysis: 4/26/2012, 11:24 AM
Sample: sticla_inel_1.evt
Acquisition time: 1200 seconds
Performed by: C. Stihi / L. Toma



At. numb.	Element	Series	Intensity	Concentration
47	Ag	K	32606	0.211%
20	Ca	K	655671	62.871%
27	Co	K	48886	1.535%
24	Cr	K	13017	1.488%
29	Cu	K	47585	0.983%
26	Fe	K	435514	17.779%
28	Ni	K	65603	1.657%
14	Si	K	64856	0.149%
38	Sr	K	156380	0.756%
22	Ti	K	59083	12.572%

Annex 1

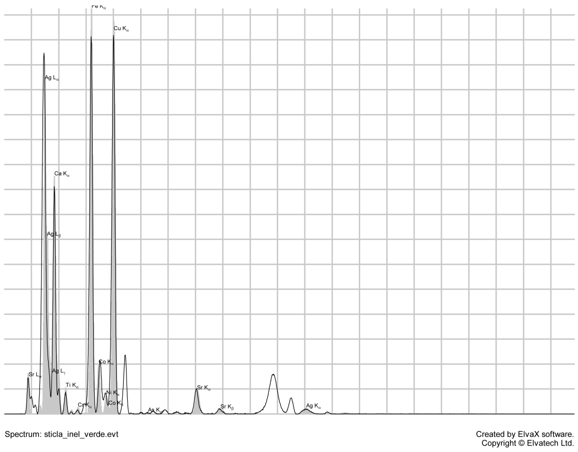
Report of Elemental Analysis
Date of analysis: 4/26/2012, 10:25 AM
Sample: yelow bead
Acquisition time: 1200 seconds
Performed by: C. Stihi / L. Toma



At. numb.	Element	Series	Intensity	Concentration
47	Ag	K	29987	0.212%
33	As	K	2970	0.033%
20	Ca	K	510395	44.368%
27	Co	K	101544	2.027%
24	Cr	K	16548	1.021%
29	Cu	K	1340307	22.393%
26	Fe	K	766044	19.726%
28	Ni	K	71716	1.415%
14	Si	K	56076	0.143%
38	Sr	K	84719	0.445%
22	Ti	K	57076	8.218%

Annex 2

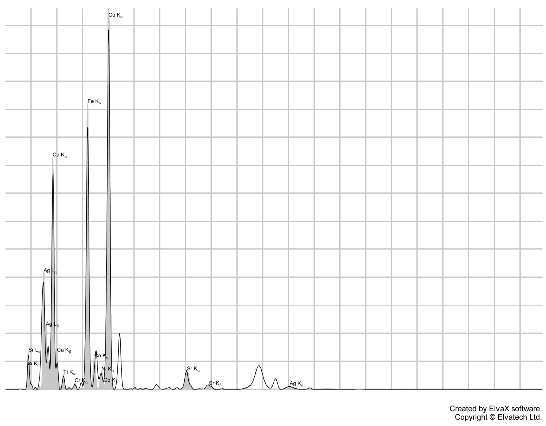
Report of Elemental Analysis
Date of analysis: 4/26/2012, 9:29 AM
Sample: green glass bead
Acquisition time: 1200 seconds
Performed by: C. Stihi / L. Toma



At. numb.	Element	Series	Intensity	Concentration
47	Ag	K	35188	0.277%
33	As	K	4179	0.051%
20	Ca	K	410630	37.792%
27	Co	K	132741	2.681%
24	Cr	K	14926	0.846%
29	Cu	K	1149069	21.740%
26	Fe	K	1043764	27.143%
28	Ni	K	50113	1.113%
14	Si	K	46447	0.131%
38	Sr	K	102514	0.598%
22	Ti	K	54813	7.629%

Annex 3

Report of Elemental Analysis
Date of analysis: 4/26/2012, 1:08 PM
Sample: green glass bead (fragm.)
Acquisition time: 1200 seconds
Performed by: C. Stihi / L. Toma



At. numb.	Element	Series	Intensity	Concentration
47	Ag	K	36279	0.184%
33	As	K	3349	0.027%
20	Ca	K	705365	43.566%
27	Co	K	148418	1.989%
24	Cr	K	25635	1.013%
29	Cu	K	1987756	23.575%
26	Fe	K	1310001	22.642%
28	Ni	K	85178	1.193%
14	Si	K	36785	0.067%
38	Sr	K	136965	0.516%
22	Ti	K	52636	5.229%

Annex 4

findings in Italy (especially in its northern part) (I. Angelini *et al.,* 2005; P. Bellintani, 2011) and Greece, both in the Minoan (M. Tite *et al.,* 2008; 2009; C. M. Jackson, E. C. Wager, 2011) and the Mycenaean (G. Nightingale, 2000; K. Nikita *et al.*, 2009; M. S. Walton *et al.*, 2009) civilisations; findings were also made in the Balkans (A. Palavestra, 1997).

In the eastern North-Pontic area we find beads made of vitreous materials in late Tripolian sites (M. Gimbutas, 1965; I. Manzura, 1994; A. S. Ostroverkhov, 2001-2002), occasionally in Jamnaja, Katacombnaja, Srubnaja funerary complexes (M. Gimbutas, 1965), Sabatinovka (A. S. Ostroverkhov, 2001-2002), much more frequently in the Belozerka culture (S. Agulnikov, 1996; A. S. Ostroverkhov, 2001-2002).

Introductory notes on the technology and chemical composition of prehistoric vitreous materials

Having emerged in the early 70's of the 20th century (A. Aspinal *et al.*, 1972; A. Harding, S. Warren, 1973), though there had also been previous approaches (J. Henderson, 1989), the very present and laborious physicochemical analyses on prehistoric vitreous products (and not only on them) have led, for almost 20 years now, to drawing very useful conclusions for the archaeological discourse. Raw matter used as well as the related technologies, colouring and decolouring agents, substances with influence on transparency could be thus determined. Establishing chemical compositions, technological traditions have led to the identification of several commercial relations, production areas, a number of complex technologies known in Prehistory (J. Henderson, 1995). Modern laboratories have allowed the use of a large number of methodologies and techniques for scientific analyses. Let us mention only a few of the non-destructive techniques which include energy-dispersive X-ray fluorescence (XRF) spectroscopy, neutron activation analysis, and scanning electron microscopy (SEM), Time of Flight Secondary Ion Mass Spectrometry (ToF-SIMS), etc. The micro-destructive techniques are frequently used, commonly used examples are (wavelength-dispersive) electron probe microanalysis (EPMA) and (energydispersive) SEM, etc (J. Henderson, 1989; 1995; 2008; F. G. M. Rutten *et al.*, 2009).

Faience and glass have both a vitreous composition (M. Tite, 1987; J. Henderson, 1989; 2000). It has been established that faience beads appeared in a previous stage as compared to the glass ones, being present in the early phase of the Bronze Age (A. Harding, 1971; J. Henderson, 1988; 2008; I. Angelini *et al*., 2005; N. Venclova, 2008; N. Venclova *et al.*, 2011); although they could also be found in the middle period of the Bronze Age, it was in the late stage that they were largely developed (N. Venclova, 1986; N. Venclova *et al.*, 2011; J. Henderson, 1988; 2008).

The different chemical composition and relationships between the identified elements have generated conclusions regarding the existence of production areas (works) both in Western Europe and the Circummediterranean area. In Late Bronze Age what was characteristic to Europe was the *mixed-alkali glass (LMHK)* - low magnesium – high potassium, but with a low calcium oxide also (J. Henderson, 1988; 1988a; 1995; R. H. Brill, 1992; A. Towle *et al.,* 2001; I. Angelini *et al.*, 2005; 2009; N. Venclova *et al.*, 2011), as opposed to that in the Near East, Egypt, as well as southern and insular Greece (including Crete and Cyprus), southern Italy where *plant ash glasses (HMG)* high magnesium glass (HMG) (J. Henderson, 2000; K. Nikita *et al.*, 2009) prevailed.

During the 2nd millennium BC, there is evidence that a mixed alkali plant ash was used in the production of faience in Egypt and in Western Europe. This plant ash is characterised by potash contents that are usually a little higher than those of soda, and by low lime and magnesia contents. In the later Bronze Age, a similar mixed alkali plant ash was used in the production of glass that is found throughout Western Europe (M. Tite *et al.*, 2006), the most important production centre found being that of Frattesina, northern Italy (J. Henderson, 1993; R. H. Brill, 1992; I. Angelini *et al.*, 2004; 2009).

As regards raw matter used to produce glass, the main sources determined were: silica, alkalies, calcium, lead, wast glase (culled); colouring agents such as Co, Cu, Fe, Mg, Ni, Cu-Sn (bronze) and decolouring agents such as Mg, Sb; opaquing elements like Ti (A. Aspinal *et al.*, 1972; J. Henderson, 1985; 1988a; 1989; 2000; M. Tite, 1987; G. Rapp, 2009).

Scientific analyses have resulted in significant data on the trade carried out during the Bronze Age in the Circummediterranean area

(A. Shortland *et al.*, 2007; M. S. Walton *et al.*, 2009; J. Henderson *et al.*, 2010; C. M. Jackson, E. C. Wager, 2011), while the discovery, in the Ulu Burun vessel (south coast of Turkey), of 85,000 glass and faience beads, many ingots produced in Egypt (P. T. Nicholson *et al.*, 1997; M. S. Walton *et al.*, 2009; C. M. Jackson, P. T. Nicholson, 2010) points to the significance and circulation of these materials and technologies.

Conclusions

Energy Dispersive X-ray Fluorescence (EDXRF) technique is a promising analytical technique for simultaneous determination of chemical composition in different samples as an alternative to the classical destructive analytical methods. Although they were of immediate interest for drawing conclusions on cultural and chronological relations, such elements as Mg, K, Na could not be determined, as their concentration was below the detection limit. That does not mean that these elements are absent, they shall be determined by some other more sensitive method. The interpretation limits are related to the inexistence of a reference material to set up a method of analysis for archaeological samples, a certified test which, knowing the concentrations, could help us to use the relation of determining the concentration of elements for any archaeological sample. According to the laws of relations, taking into account experimental errors, the concentration relation must be close to reality, but the individual concentration is not accurate.

The results of analyses have indicated the existence of several elements typical of vitreous materials. The presence, in significant quantities, of Ca may be an indication of the raw matter source (organic or inorganic), elements like Fe, Cr, Cu, Ni, Ti, etc. may be connected with obtaining colouring or, possibly, opaquing agents.

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