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From the city to the countryside: indicators of artisanal glass production in the central Iberian Peninsula (8th-9th centuries)

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The current work presents the production and distribution of glass in the Emiral period in Spain. The study of the rural areas of the central Iberian Peninsula allows to identify some forms of production in large rural towns. Through the systematic study of the *Dehesa de Navalvillar*, including some archaeometric analyses, we have been able to establish that in the early Emiral period glass was produced in metallurgical workshops that left traces of occasional glass manufacture, probably carried out by itinerant craftsmen. With this article, we would like to contribute to the debate on glass production by introducing a new, multidisciplinary study of the rural world and the transformations that took place in the 8th century with the arrival of the Arabs in the Iberian Peninsula. The findings indicate artisanal production, circulation, and recycling of materials during the Emiral Period, where for the first time we find regional production in rural centres in addition to production in urban centres.

Glass, archaeometric analysis, Emiral period, Iberian central plateau, rural archaeology

INTRODUCTION

Rural towns play an increasingly important role in the production and distribution of materials, a role traditionally reserved for urban centres. Based on the study of large towns in rural areas in the centre of the Iberian Peninsula, it was possible to identify some elements of glass production in a chronological arc between the end of the 8th century and the first half of the 9th century. A key factor in the transmission of productive activity from cities to rural areas is the *Dehesa de Navalvillar*, as this is apparently where glass was first produced outside the traditional centres.

After the Arabs settled in the urban centres, glass production experienced a crisis as imports of raw natron glass from the east to the Iberian

Peninsula declined. During this period of transformation, glass recycling increased steadily.¹ Previous studies have identified a crisis in glass production from the second half of the 7th century, due to a decline in imports and thus consumption in rural areas.² However, ongoing research on the transitional period between the Visigoth and Emiral periods points to a more complex development.³ By the end of the 8th century, there are signs of new typologies in rural areas (bottles, globular bowls with pouring spouts or molded rims, vases,

1. Schibille 2022; Colangeli unpublished; De Juan Ares – Schibille 2020.
2. De Juan Ares *et al.* 2019.
3. Berrica 2023.

large or mold-made plates and cups), replacing earlier traditions.

Rural areas were of course also affected by the Arab expansion and Islamization of the Iberian Peninsula from the second half of the 8th century, and this is clearly reflected in the archaeological record that suggests changes in the manufacture of various materials, including the secondary production of glass.⁴ The systematic study in the mining village of the *Dehesa de Navalvillar* in the centre of the Iberian Peninsula offered the opportunity to identify some elements of glass processing at the end of the 8th century and the first half of the 9th century (fig.1).

THE METHODS

For this study, the archaeological archive and all the materials deposited in the Regional Archaeological Museum of Alcalá de Henares (Madrid) were reviewed and closely examined. The stratigraphy specifies the phases of the buildings, on the basis of which a relative chronology could be established. Three complexes from this excavation were studied diachronically (reconstructing all the stratigraphic units, elaborating all the matrices and reconstructing the phases), analysing 34 rooms, 9447 ceramic fragments (selected and non-selected), 153 fragments of glass, 266 metallic objects, 281 stone objects, 17.75 kg slag (iron, copper and lead), landscape studies, surveys, analysis of stratigraphic walls, reconstruction of the walls with photogrammetry.

The discovery of a sizeable quantity of glass fragments located in two specific areas of the town has led to an archaeometric study of some of these samples to shed light on their compositional features and supply patterns. 15 samples (table 1) were mounted in resin blocks and repeatedly analysed (n=3) by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) at IRAMAT-CEB (Orléans, France). For the analyses, a Thermo Fisher Scientific ELEMENT XR mass spectrometer was used, equipped with a Resonetics M50E eximer laser operating at a wavelength of 193 nm, 5mJ and a repetition rate of 10 Hz. The analytical protocol used is the same as the one described by

Gratuze (2016),⁵ which includes a pre-ablation time of 15 seconds and the acquisition of 9 mass scans over 27 seconds in counts/second for 58 elements. ²⁸Si is used as internal standard. A set of 5 external standard reference materials (NIST610, Corning B, C and D and APL1) were run at the beginning and end of the analytical sequence for the calibration and calculation of the response coefficient (K_v). Accuracy and precision are within 5% relative for most elements and within 10% for some trace elements.

THE ARCHAEOLOGICAL CONTEXT: THE DEHESA DE NAVALVILLAR

Dehesa de Navalvillar is located in the area of Colmenar Viejo, Sierra de Guadarrama, Madrid, in the Basin of the Manzanares River. It is an open area of 1072 hectares, which is located at the foot of Pico San Pedro (1425 m.). The Arroyo de la Tejada is the most important source of water, as it runs through the entire meadow from north to south and is born from the Pico de San Pedro itself. Although today the Dehesa de Navalvillar is presented as an open space with little vegetation, during the medieval period it was more wooded.⁶ The investigation concerning the Dehesa de Navalvillar has involved the study of 13 excavation reports from two different areas⁷, one in the north and the other in the south, separated by the Arroyo de la Tejada; with the new territorial data that allowed us to clearly see some structures between the two excavations, recognizing at least another 43 buildings, it follows that this would be one of the largest villages found so far in the area of the Central Plateau, with at least 343 buildings (fig. 2). In previous work, this site was represented as a single large village, renamed Dehesa de Navalvillar.⁸

The village was involved in mining and in the processing of specialized metallurgical material that was distributed at a regional level (the materials found so far are iron, copper, lead), which implies numerous specialized workmen,

4. Berrica 2021.

5. Gratuze 2016.

6. López Sáez *et al.* 2015.

7. Colmenarejo – Gómez Osuna 2013; Colmenarejo – Gómez Osuna 2015; Colmenarejo – Gómez Osuna 2016.

8. Berrica 2021.

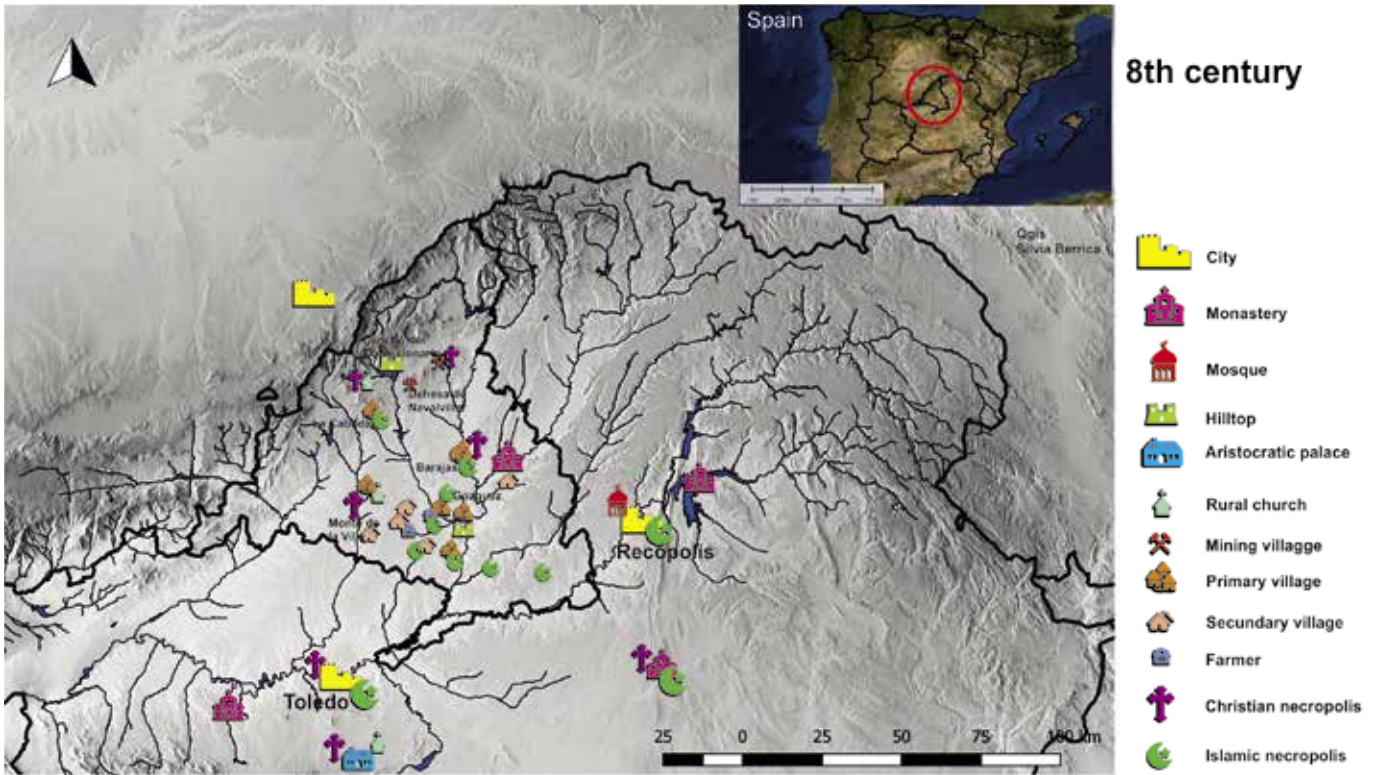


Fig. 1. Settlements of the Emiral Period in the 8th and 9th centuries (image by S. Berrica).



Fig. 2. La Dehesa de Navalvillar, excavated areas, mines, and new buildings (image by S. Berrica).

such as miners, transporters, specialized metallurgists, gold producers and merchants.⁹ So far, seven metallurgical workshops have been identified in Dehesa de Navalvillar, of which two can be linked to glass production: Metallurgical Workshop H-3.8 and Metallurgical Workshop C/E-93.

Metallurgical Workshop H-3.8¹⁰

The metallurgical workshop originally had two previous phases: First it was built with perishable material and the metal furnace (USM 38011) was a pit dug in the ground. Then in the late 8th century, a workshop (USM 38006) was built on a stone plinth, with adobe walls and a roof made of curved tiles. The first more primitive furnace USM 38011 has an elliptical shape and is probably double-chambered with dimensions of 30×25×10 cm. At the time of the blockage, remnants of a grey ash layer were found inside the furnace. Far more sophisticated is the USM 38006 furnace (fig. 3). It is a circular furnace built with hewn stones arranged vertically to accommodate the second floor and to which two other chambers were connected. Chamber A is where the bellows were attached to the wall to feed the combustion chamber in the lower part of the furnace. This lower chamber has a floor characterized by a platform of insulating clay and the remains of broken tiles nested with mud. The second chamber B is a small stove with a floor of fragmented tiles and an adobe dome above. The second floor is characterized by perforated adobe bricks, on which the crucibles for the production of metal and glass were probably placed. The top of the furnace was made of clay and tiles, we know this from the perpendicular collapse of the building materials found inside the furnace chamber.¹¹

The materials directly associated with this furnace and the other from the same phase are 430 g of iron slag, two chunks of blue glass (possibly raw glass), two fragments of glass goblets and a fragment of a glass crucible (sample 7) with a three mm layer of molten glass still attached to its inside (fig. 4). A number of glass fragments were

found in the vicinity of this workshop, including cups, bowls and plates with a large diameter. These data are significant because it was during the first half of the 8th century when we find open forms of large dimensions,¹² in fact, the plates of the Dehesa de Navalvillar often exceeded 20 cm in diameter, compared to the earlier period in which the plates ranged between 16 and 18 cm in diameter.

The fragments found are not particularly abundant, but the results indicate that the typologies most common in rural areas were tableware. These data are consistent with the type of glass found in other rural settlements from the Early Middle Ages in the centre of the peninsula.¹³ The most unusual fragment is the bluish plate 3002_13, decorated with spiral waves and made by casting or mould blowing. This is without a doubt the most decorated piece so far, together with the goblet 5204_24 (fig. 5). It is unique in the rural areas of the central Iberian Peninsula at the time. It is a tall-footed goblet with a twisted solid stem. Two glass fragments were found, belonging to Phase 3 and therefore, according to the stratigraphy of the complex, they belong to the second half of the 8th century. One of these is a solid stem of the Foy 27 type,¹⁴ where the stem is slightly modelled at the top. This workshop produced bowls and cups made of glass.

Metallurgical Workshop C/E-93

In building E-93, 4 phases have been identified with a series of rooms that were added successively between the second half of the 8th and the middle of the 9th century. This workshop was also built with perishable material in its first phase, to be modified later (Phase 2). In Phase 2, room C was attached to room B (fig. 6). For this, the walls UUSSMM 931201, 931301 and 931401 were built with medium and large stones locked with mud. The room follows the natural slope of this area, and several layers of clay and stone benches were used to level the room. The roof of the building had curved tiles. In this room, a stone forge was built on the east side, with slabs 60 cm long and 20 cm high. The oven consists of two shelves,

9. Berrica 2020.

10. The metallurgic workshops of this article have been studied thanks to the help and collaboration with Francesco M.P. Carrera (MIC): Berrica – Carrera 2020.

11. Berrica 2023.

12. De Juan Ares *et al.* 2019.

13. De Juan Ares *et al.* 2019.

14. Foy 2003.

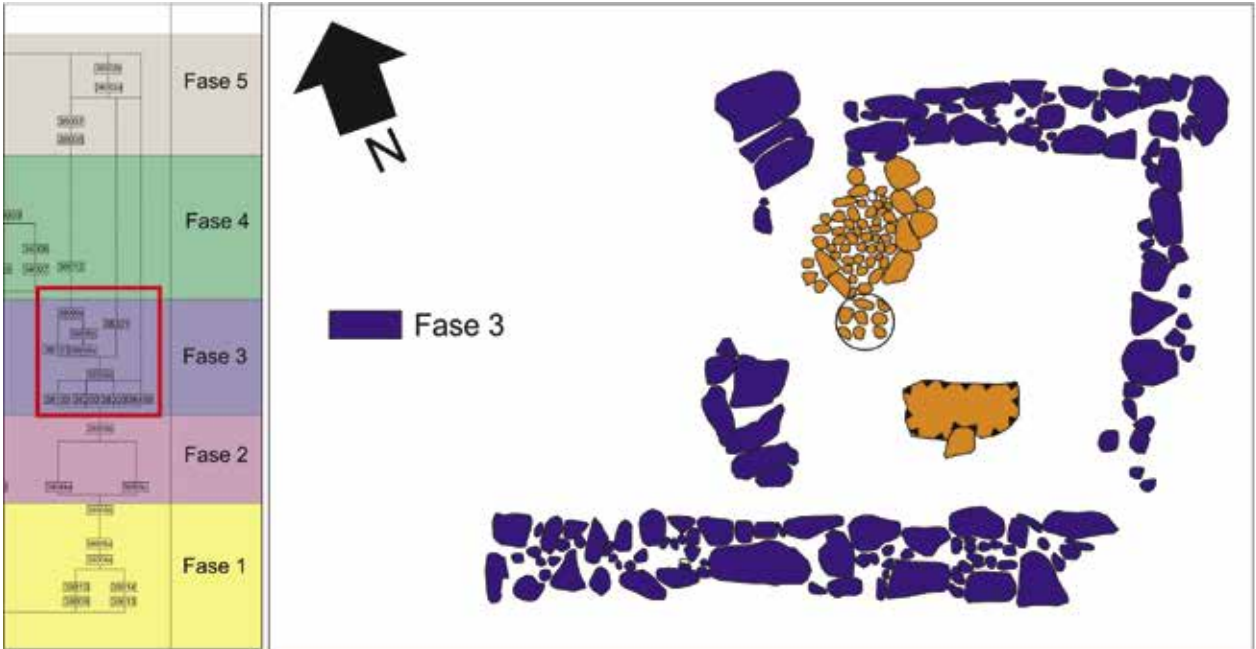


Fig. 3. Metal and glass furnace. Plan drawn by S. Berrica from AutoCAD by Colmenarejo and Gómez Osuna, 2013; Matrix by S. Berrica (image by S. Berrica).

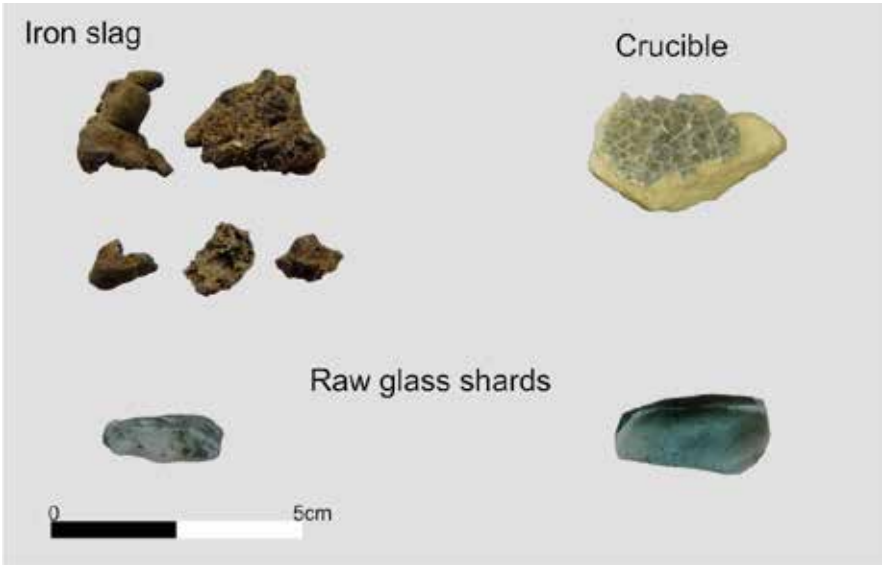


Fig. 4. Production remains found in workshop H3.8 (image by S. Berrica).

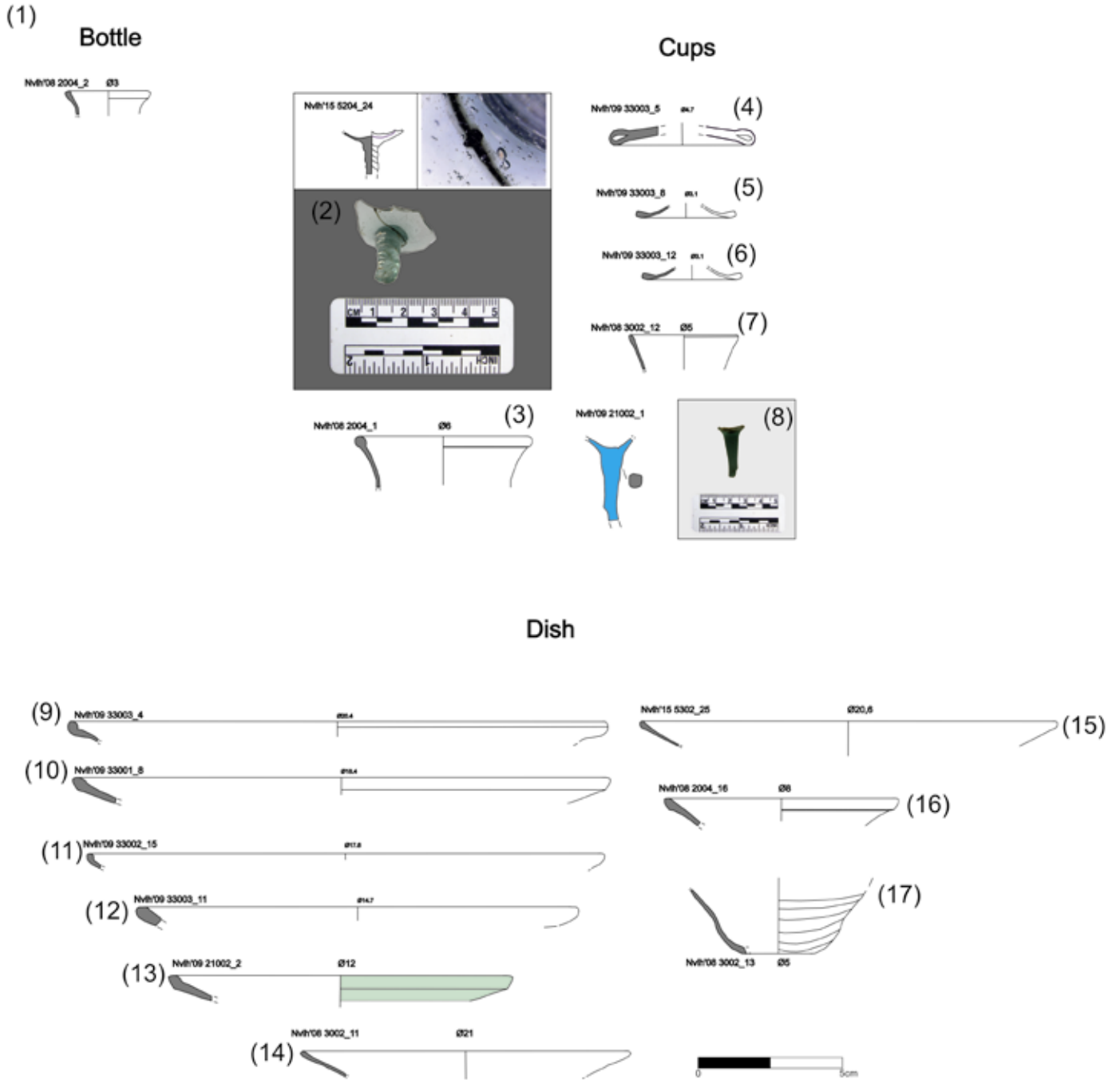


Fig. 5. Materials to produced in the workshop H3.8. (1) 2004_2; (2) 5204_24; (3) 2004_1; (4) 33003_5; (5) 33003_8; (6) 33003_12; (7) 3002_12; (8) 21002_1; (9) 33003_4; (10) 33001_8; (11) 33002_15; (12) 33002_2; (13) 21002_2; (14) 3002_11; (15) 5302_25; (16) 2004_16; (17) 3002_13 (image by S. Berrica).

the upper one and the floor made of broken tiles stuck together with adobe. We found a hole in the wall, UEM 931301 that was used to let air into the furnace. Next to it were the remains of a bellow. In addition, it was possible to delimit the workspace, formed by a stone wall that also delimited the production area. Inside this metallurgical workshop and related to this new blast furnace, semi-finished products (iron ingots), fifteen whole or fragmented knives, iron slag and a porphyry anvil were found (fig. 6).¹⁵ Therefore, it is likely that this workshop was dedicated to the manufacture of knives, as has been observed in the Bagoeta deposits (Bizkaia, Basque Country).¹⁶

It is in phase 4 that the first traces appear that indicate a possible production of glass. The glass remains in this area are the most numerous with 101 fragments and a weight of 152 g. Several bags of glass fragments were found stored separately in the western part of the building (storage space: UUSSMM 933301, 943201, 943501, 943101). Among the production remains are a fragment of cut glass (sample 8), amoil (sample 11) and a probable crucible (fig. 7). The pottery is handmade from local coarse clay interspersed with temper and fired under oxidizing conditions.

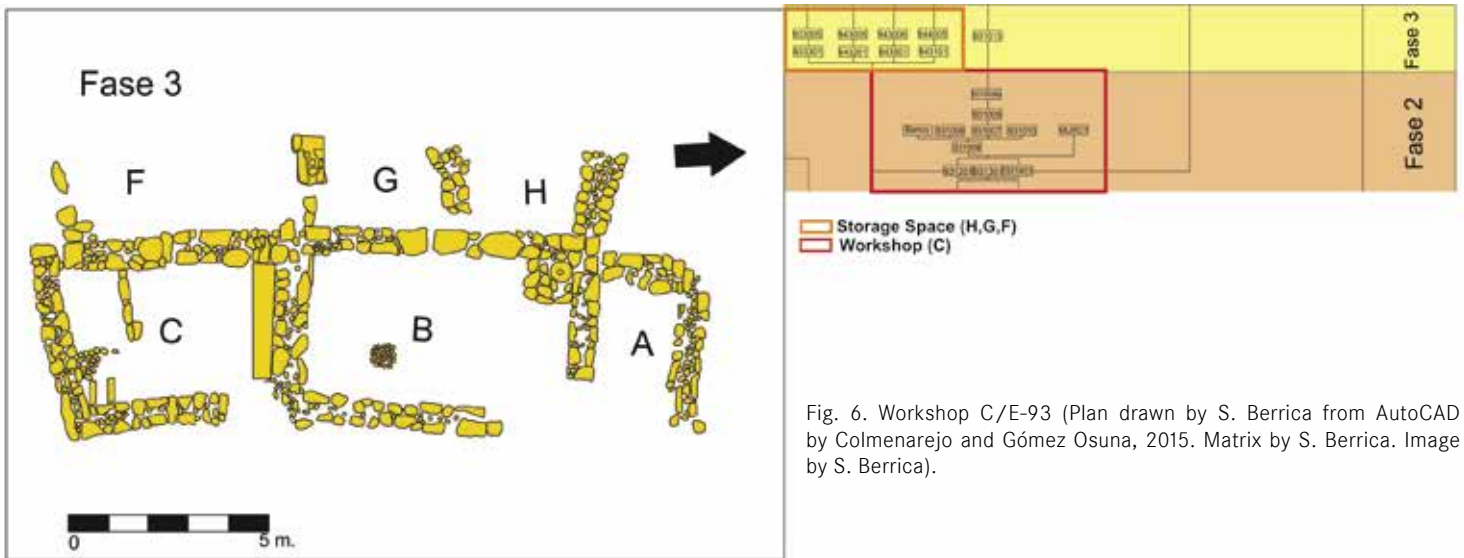


Fig. 6. Workshop C/E-93 (Plan drawn by S. Berrica from AutoCAD by Colmenarejo and Gómez Osuna, 2015. Matrix by S. Berrica. Image by S. Berrica).



Fig. 7. Production remains in the Workshop C/E-93 (photo and image by S. Berrica).

15. Berrica – Carrera 2020.

16. Azkarate Garai – Solaun 2016.

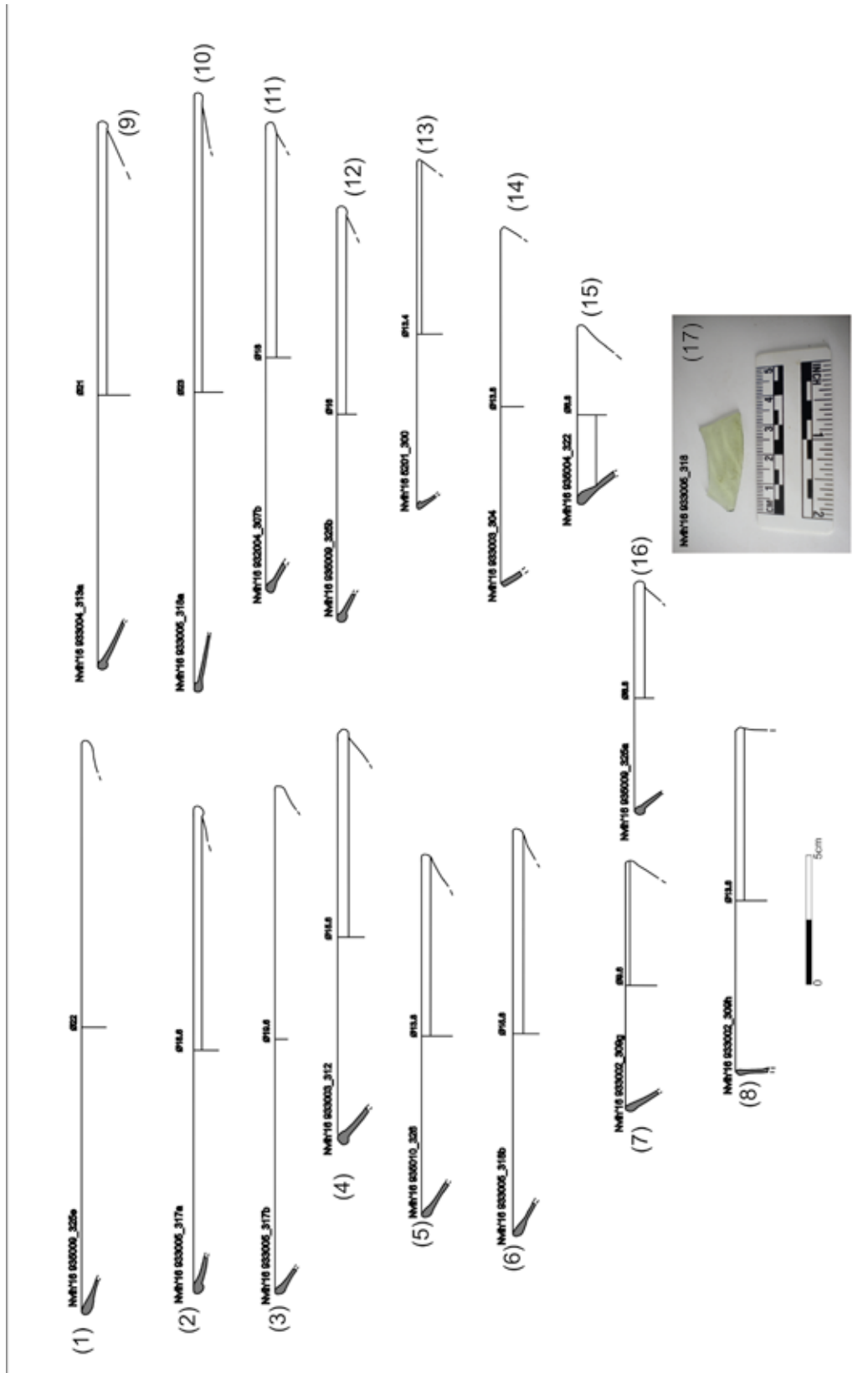


Fig. 8. Materials to produced in the workshop C/E-93. (1) 935009_325a; (2) 935005_317a; (3) 935005_317b; (4) 933003_312; (5) 935010_326; (6) 933005_318b; (7) 933002_309g; (8) 933002_309h; (9) 933004_313a; (10) 933005_318a; (11) 932004_307b; (12) 935009_325b; (13) 5201_300; (14) 933003_304; (15) 935004_322; (16) 935009_325a; (17) 933005_318. (image by S. Berrica).

This workshop produced glass plates and beakers. The plates in this phase are all yellowish (samples 1-5, 13, 15) and have medium dimensions of 13 to 15 cm in diameter and large dimensions of 16 to 22 cm in diameter. The set includes blue beakers (samples 9 and 14), olive green bowls (samples 10 and 12), a pitcher, and a bottle. The only case 933005_318 of a decorative element is the fragment of a plate decorated with spherical waves and made by casting or mould blowing from a light-yellow fabric (fig. 8 [17]). Stored in the warehouse F and G, some sets of glass fragments separated by color have been found (fig. 9). The broken glass was evidently collected, sorted, and stored for later recycling.

THE ANALYTICAL RESULTS

The results of the LA-ICP-MS analysis (table 2) show that the 15 fragments can be classified as natron-type glass, although some of the samples have K_2O and MgO concentrations of more than 1.5% (fig. 10), which is normally defined as the threshold for distinguishing between natron and soda-rich plant ash glass.¹⁷ As far as is currently known, the primary production of natron glass in the first millennium CE took place exclusively in the Levant and Egypt, from where at least ten major primary glass production groups are known to have originated.¹⁸ These different glass groups have been characterised based on elements related to the silica source such as aluminium and titanium (fig. 9).

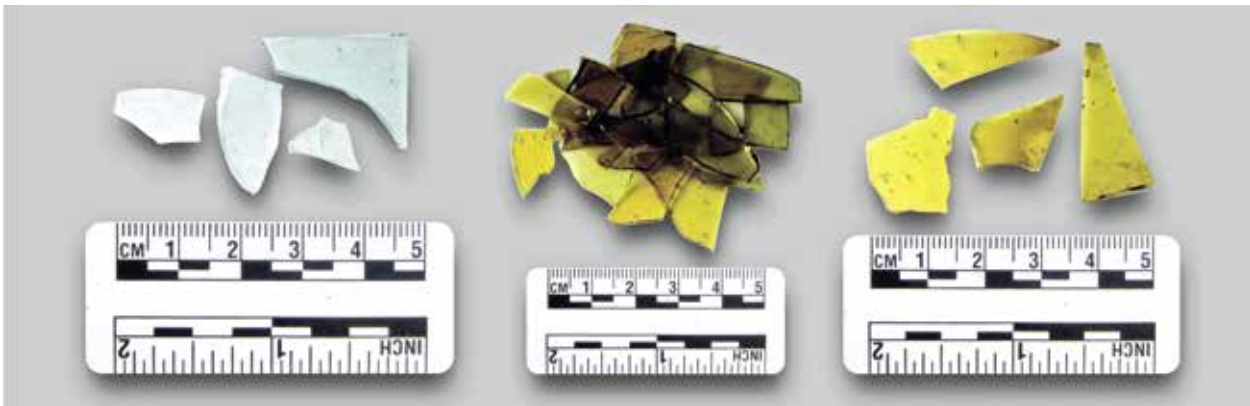


Fig. 9. Broken glass found stored in the workshop storage area for recycling (image by S. Berrica).

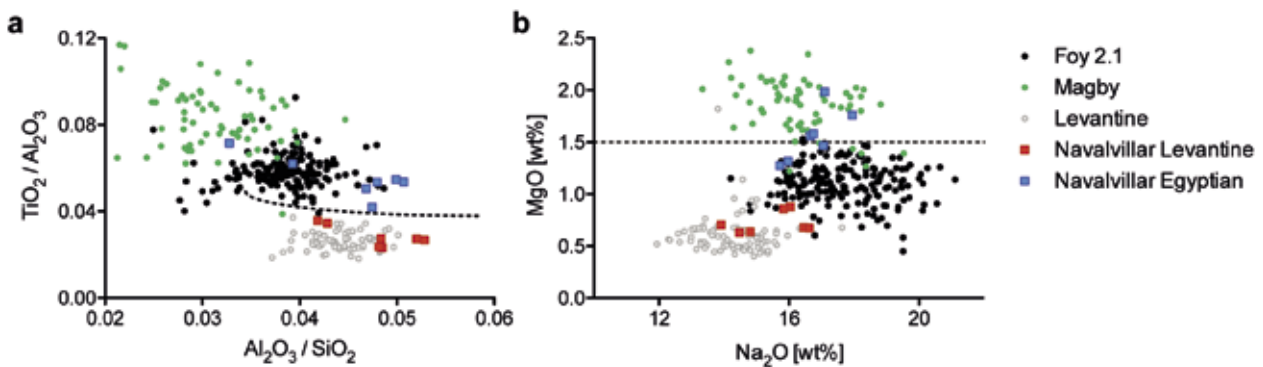


Fig. 10. Base glass characteristics of the samples from Navalvillar compared to glass reference groups from the Levant and Egypt. (a) Al_2O_3/SiO_2 versus TiO_2/Al_2O_3 reflect the silica source and separate Levantine and Egyptian production groups; (b) differences in the magnesium and sodium oxide levels distinguish different glassmaking recipes and indicate the possible addition of a plant ash component to some of the Egyptian glass from Navalvillar (Image by N. Schibille).

17. Lilliquist *et al.* 1993.

18. Foy *et al.* 2003; Freestone *et al.* 2018; Freestone 2021; Schibille 2022.

The 15 samples from Navalvillar have highly variable features, but they can be broadly divided into Levantine and Egyptian glass groups. The samples with higher TiO_2/Al_2O_3 ratios are consistent with Egyptian glasses of the Foy 2.1 or Magby type,¹⁹ while the glass with lower TiO_2/Al_2O_3 ratios corresponds to Levantine glass from Apollonia-Arsuf.²⁰ The Levantine glasses match the reference material quite well, but the Egyptian glasses cannot be clearly classified due to contradicting attributes. They appear closely aligned with the so-called Foy 2.1 glass type in terms of their content of alumina, titanium and zirconium (fig. 10; table 2). Foy 2.1 was produced and circulated widely between the second half of the fifth to the sixth century CE.²¹ However, the samples from Navalvillar have on average somewhat higher magnesium and phosphorus contents, and to a lesser extent also potassium (fig. 10, 11). In this respect they resemble more the so-called Magby group, also an Egyptian glass that is intimately related to Foy 2.1 but that mostly dates to the late sixth and seventh century CE. On account of its higher magnesium, potassium and phosphorus

levels it is assumed that these Magby glasses contain a plant ash component.²²

The deviation of the composition from the reference data is probably related to the degree of recycling evident in the Egyptian glasses from Navalvillar (fig. 10). Recycling markers are pronounced in all of the Egyptian glasses, reflected in the colouring and opacifying elements in excess of natural impurities in sand raw materials, particularly antimony (> 30 ppm) as well as copper and lead (> 100 ppm).²³ The elevated phosphorus concentrations may also have been caused in part by fuel ash vapour. However, the high magnesium clearly suggests the incorporation of an ash component. In contrast, the Levantine glasses do not show any clear signs of recycling in the form of colorant or opacifying related elements with the exception of 2 samples (009, 014). Nevertheless, the phosphorus levels are also somewhat increased in direct comparison with the reference group (fig. 11). It is therefore likely that these Levantine glasses have also been subjected to recycling or at least that the glass was exposed to fuel vapour for a prolonged period of time.

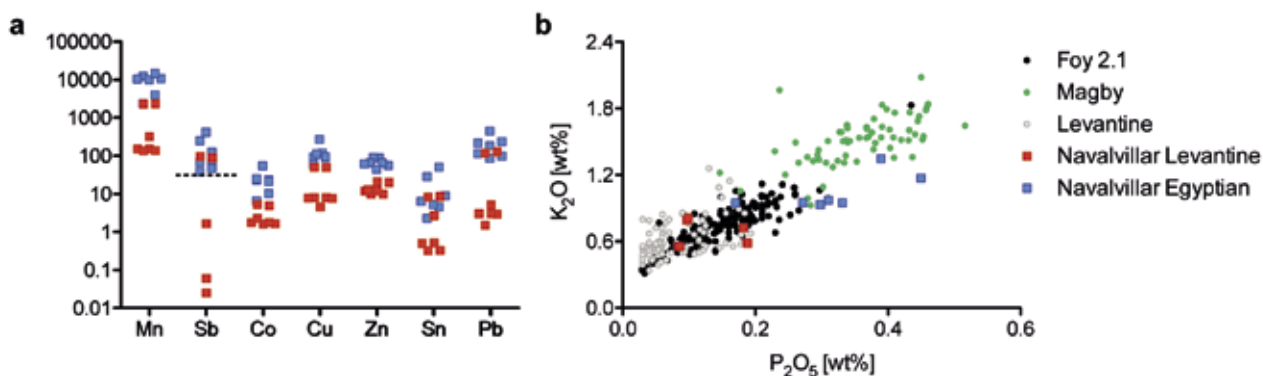


Fig. 11. Recycling markers in the samples from Navalvillar. (a) Elevated transition metals particularly in the Egyptian base glasses indicate a certain degree of recycling; (b) somewhat elevated potash and phosphorus levels in some of the Navalvillar samples suggest the contamination by fuel ash vapour or incorporation of some plant ash component similar to the so-called Magby glass category. (Data sources: [De Juan Ares *et al.* 2019a; Freestone *et al.* 2008; Schibille *et al.* 2016] for Magby; [Ceglia *et al.* 2019; Foy *et al.* 2003b; Schibille *et al.* 2016] for Foy 2.1; Brems *et al.* 2018; Freestone *et al.* 2008b; Phelps *et al.* 2016] for Apollonia (Image by N. Schibille).

19. Foy *et al.* 2003; Ceglia *et al.* 2019; Schibille *et al.* 2016.

20. Freeston 2020.

21. Freeston 2020.

22. Schibille *et al.* 2016.

23. Degryse 2014.

DISCUSSIONS

Studies of glass furnaces throughout the Mediterranean have shown that there is no single type of furnace,²⁴ but rather various circular²⁵ or quadrangular-rectangular shapes,²⁶ and glass furnaces have even been found positioned attached to the workshop wall.²⁷ Therefore, it is more than likely that the differences in the furnaces are due to the requirements of the glazier and the construction possibilities, in addition to the type of specialization that the workshop had.²⁸

In this study, however, we must take into account the fact that the furnaces at Dehesa de Navalvillar were not built specifically for glass working. Dehesa de Navalvillar was known in the region for its metallurgical furnaces, which had unprecedented blast furnace technology at a surprisingly early date (mid-8th century) and for its prolonged craft activity. It is therefore possible that itinerant glass workers flocked to the village and made use of the available facilities. In other areas residues of glass and iron work have been found in the same workshop, although the data is quite sparse and at times inconclusive, such as at Aiano Torraccia, Chiusi;²⁹ Crypta Balbi;³⁰ Comacchio;³¹ Faragola, Monte Gelato, Pieve del Manerba, San Felice-Gravina.³² The Dehesa de Navalvillar presents a different scenario, because here it is not only about sharing the same workspace, but also about using the same furnace.

Evidence of production has been found in the Dehesa de Navalvillar, and while not abundant, it is significant. Two fragments of the same crucible were found in workshop H3.8 with glass still adhering to the ceramic body. The glass layer (007) corresponds to the composition of the Foy 2.1 and/or Magby glass category, but has slightly higher lithium contents compared to the reference glasses (table 2). This was observed in relation to the glass

processing activities at El Tolmo de Minateda³³ and appears to be indicative of contamination caused during secondary glass working and/or recycling. The Workshop C-E93 contains fragments of glass cut during the production process, amoil from a blow pipe, and glass kept in the storage areas for later recycling. In addition, they were separated by color (yellow glass and colourless glass).

However, it seems that the production of the Dehesa de Navalvillar was particularly associated with decorated dishes, although, some imported elements were found as well. The blue plate 3002_13, decorated with spherical waves and made by casting or mould blowing is without a doubt the most adorned piece up to now, together with goblet 5204_24. We have also found this type of mould decoration in Building E-93. However, the difference is in color, while in Building 1 the plate is blue, in building E-93 it is yellowish. Additionally, it should be underlined that the two pieces belong to a different chronology. The blue-plate fragment is from the second half of the 8th century, while the yellow fragment is from the first half of the 9th century.

This type of moulded decoration on rural tableware is unexpected and has not been recorded outside urban centres. It has been found at Recópolis in the 6th-century stratigraphy in both closed forms such as cups, as well as open forms (e.g. plates).³⁴ In rural areas, however, this is a novelty, because the tableware recovered in other villages in the centre of the peninsula does usually not have any decoration.³⁵ It is therefore likely that these fragments came from an urban centre such as Recópolis or similar.

In residential building 2, only two glass fragments have been found, which can be attributed to the second half of the 8th century. One of them is a solid stem of the Foy 27 type, where the stem is slightly modelled in the upper part. There are many examples of this type of goblet in the Iberian Peninsula during the early medieval period,³⁶ and they are also found in rural areas in the centre of the peninsular.³⁷ The piece has a translucent

24. Foy 2000.

25. Saguí – Lepri 2016; Gómez 2012; Sánchez Pardo 2014
Sánchez Pardo 2018.

26. Foy 2020; Rodríguez Martorell *et al.* 2020.

27. Ferri 2021.

28. Foy 2000.

29. Del Trente – Orlandi 2016.

30. Saguí – Lepri 2016.

31. Ferri 2021.

32. Munro 2010.

33. Schibille *et al.* 2022.

34. Gómez 2017.

35. De Juan Ares *et al.* 2019.

36. Sánchez de Pardo 2018.

37. De Juan Ares *et al.* 2019.

aquamarine blue-green color that may indicate a Levantine origin of the base glass.³⁸

Goblet 5204_24 is currently a *unicum* in the rural areas in the centre of the peninsula. It is a high-footed cup with a solid and twisted stem. The only roughly similar objects are known from Gózquez, where a slightly modelled stem has been found,³⁹ while an example of the twisted decoration has been documented in the city of Zaragoza⁴⁰ the chronology of which coincides with that of the Dehesa de Navalvillar (first half of the 8th century). Outside the Iberian Peninsula, this decoration has come to light at Sabra al-Mansuriya in the form of stems of hanging glass lamps.⁴¹ On the whole, it cannot be considered a very common type of decoration. A dark blue thread can be seen embedded in the vitreous matrix of the goblet, but we do not know if this was a firing defect or a decoration indented by the glassmaker, as the piece is too fragmented.

Of particular interest are the glass fragments that were stored in the warehouse ready to be recycled. Remains of broken glass have been found in other contexts of the Iberian Peninsula, which were preserved because they were pieces that had already fallen into disuse and were broken.⁴² Similar finds are known, for example, from Recópolis, where a heap of broken glass was recovered from next to the second workshop (late 7th-early 8th century),⁴³ and a unique case is that of Monte de la Villa (Villaviciosa de Odón), where two handfuls of glass were kept in a cabin in a small village where no craft activity was recorded.⁴⁴ This could be an important piece of information for the collection and subsequent sale of cullet to itinerant glass workers who moved from village to village to collect material for recycling. This then would seem to reflect a local or regional exchange and closed circuit of broken glass. The village of Monte de la Villa is contemporaneous with Dehesa de Navalvillar, and both villages were abandoned in the middle of the 9th century. It is therefore a legitimate hypothesis that part of the work of itinerant

glass workers was to buy up glass cullet in nearby villages and bring them to Dehesa de Navalvillar to be processed and transformed into new vitreous objects.⁴⁵ Not only were these practices widespread at the local or regional levels, but the circulation of broken glass for recycling also took place on a large scale, as evidenced by the cargo of copious quantities of broken glass from sunken ships.⁴⁶

If we assume that the glass workers sourced their material from a wide variety of contexts, we can more easily explain the different recycling patterns that we observed in the Levantine and Egyptian base glasses. This could mean that some of the recycling effects we see, such as the enhanced colouring and opacifying elements in the Egyptian glass, derive from earlier times and previous recycling processes. This also makes sense with regard to the relative availability of coloured glass, which could have ended up in the recycling pot. Foy 2.1 that has systematically higher recycling markers is a slightly older glass group,⁴⁷ when coloured (Cu, Pb) and decolourised (Sb) glass may still have been more widely available. There is no increase in colourants, decolourants or opacifiers in the Levantine glass. The exception are two samples that seem to correspond to earlier Roman glass, more precisely a mixture of Roman Mn and Roman Sb glass (table 2). The Levantine samples of the Apollonia-type were not adulterated by the accidental admixture of elements related to colours or opacifiers (fig. 10a). They represent the last glass imports from the eastern Mediterranean in the sixth or perhaps seventh century CE.

CONCLUSIONS

The archaeological and analytical studies have determined that the glass that was processed in the workshops of Dehesa de Navalvillar was recycled glass, although there were some fragments of possible raw glass and some fragments made with yellow Levantine glass that is typically of a bluish colour. The production of glass in villages is a new branch of research, as it was previously assumed

38. Freestone 2020.

39. De Juan Ares *et al.* 2019.

40. Sánchez de Pardo 2018.

41. Foy 2020.

42. Sánchez de Pardo 2018.

43. Gómez 2012.

44. Berrica 2022.

45. Berrica 2022.

46. Keller 2004.

47. Ceglia *et al.* 2019.

that glass working was pursued exclusively in urban centres. We know from archaeological studies that the cities were going through a period of crisis that manifested itself as early as the second half of the 7th century. The adaptation of a mining village to meet the needs of itinerant glass workers may have been the answer to the demand for glass tableware when there were no longer distribution centres in the cities of the central Iberian Peninsula. Glass production findings are clear enough, but not so abundant as to indicate continued or large-scale production. Finding production remains in

different workshops suggests seasonal production. We conclude that there was no permanent glassmaker in the village, but that the metallurgical furnaces were probably rented out to itinerant glassmakers who produced glass according to demand and/or availability of cullet. A question that remains is whether this demand came from the village or whether the blacksmiths rented out the workshop to itinerant glassmakers to produce their glass and then sell it to other rural areas. This question will probably be resolved only with future research.

TABLE 1. GLASS SAMPLES SAMPLES ANALYSED BY LA-ICP-MS.

		Levantine					Levantine recycled		Foy 2.1 / Magby						
		Nava 001	Nava 003	Nava 004	Nava 005	Nava 011	Nava 009	Nava 014	Nava 002	Nava 007	Nava 008	Nava 010	Nava 012	Nava 013	Nava 015
wt%	Na₂O	14.8	14.5	16.5	16.6	13.9	16.0	15.8	17.1	15.7	17.9	17.1	16.7	16.0	16.8
wt%	MgO	0.64	0.63	0.68	0.67	0.71	0.88	0.86	1.99	1.27	1.76	1.47	1.56	1.32	1.58
wt%	Al₂O₃	3.38	3.37	3.45	3.40	3.34	2.98	2.92	2.46	3.25	2.10	3.04	3.19	3.05	3.14
wt%	SiO₂	69.8	70.1	65.4	65.3	69.0	69.5	69.7	62.5	68.5	64.1	63.5	62.8	65.1	62.8
wt%	P₂O₅	0.08	0.09	0.19	0.19	0.18	0.10	0.10	0.39	0.17	0.45	0.27	0.30	0.33	0.31
wt%	Cl	0.92	0.96	0.79	0.78	0.81	0.77	0.81	0.55	0.72	0.85	0.79	0.73	0.83	0.85
wt%	K₂O	0.55	0.56	0.59	0.58	0.72	0.79	0.81	1.35	0.95	1.17	0.95	0.93	0.95	0.97
wt%	CaO	9.10	9.09	11.6	11.6	10.4	7.65	7.72	9.45	7.24	10.2	8.20	8.99	7.23	8.11
wt%	TiO₂	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.15	0.14	0.15	0.16	0.17	0.15	0.17
wt%	MnO	0.02	0.02	0.02	0.02	0.04	0.30	0.30	1.91	0.52	0.10	1.35	1.30	1.60	1.40
wt%	Fe₂O₃	0.53	0.53	0.65	0.64	0.61	0.71	0.71	1.84	1.26	0.91	2.97	3.07	3.25	3.61
ppm	Li	3.98	3.60	4.54	4.55	4.76	9.45	9.28	7.34	28.0	11.6	5.79	5.31	4.34	6.52
ppm	B	86.9	85.8	91.6	92.3	106	110	105	188	118	142	185	187	197	197
ppm	V	9.61	9.49	15.3	15.4	13.8	14.4	14.8	38.9	21.1	18.0	62.1	61.9	69.3	80.7
ppm	Cr	15.3	14.9	27.1	26.5	17.3	17.5	18.3	17.2	17.8	16.4	14.8	14.7	14.8	19.3
ppm	Co	1.63	1.62	1.78	1.78	2.29	4.94	5.19	55.1	10.3	6.63	23.0	21.3	23.2	24.9
ppm	Ni	5.29	5.19	9.95	9.80	7.48	7.85	7.67	42.4	12.1	8.78	30.9	30.8	34.5	33.6
ppm	Cu	7.93	4.51	7.95	7.76	7.59	49.3	48.6	60.2	271	95.1	91.4	91.0	118	114
ppm	Zn	9.89	9.91	12.0	12.1	12.9	20.0	20.7	62.0	88.5	44.8	66.0	89.0	55.7	65.4
ppm	Ga	3.74	3.89	3.97	3.93	3.82	3.53	3.54	4.63	4.50	3.37	5.28	5.79	5.22	5.27
ppm	As	1.45	1.33	1.41	1.42	0.80	2.20	2.68	7.59	6.14	3.25	16.65	18.22	22.3	24.3
ppm	Rb	7.94	7.96	7.15	7.18	8.22	11.3	11.9	9.64	31.3	15.6	11.4	13.5	10.0	8.41
ppm	Sr	448	455	436	439	517	431	445	831	409	629	649	656	581	677
ppm	Y	6.96	7.17	8.23	8.10	7.38	6.45	6.78	9.78	8.00	6.53	12.9	14.3	12.7	14.6
ppm	Zr	36.2	37.1	41.2	40.9	41.8	56.1	59.1	86.3	65.0	72.9	97.1	110	92.0	98.9
ppm	Nb	1.47	1.49	1.72	1.72	1.75	1.77	1.88	2.59	2.47	2.47	3.04	3.25	2.82	3.21
ppm	Mo	0.33	1.40	0.57	0.57	1.01	0.94	1.01	6.09	1.76	0.89	3.01	2.85	3.42	2.74
ppm	In	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.01	0.00	0.22	0.06	0.01	0.00	0.02
ppm	Sn	0.51	0.50	2.68	0.32	0.33	8.35	8.54	2.30	50.9	28.3	6.38	5.23	4.57	8.93
ppm	Sb	0.06		0.03	0.00	1.64	96.4	88.5	38.6	420	254	68.8	74.3	125	47.4
ppm	Cs	0.08	0.05	0.04	0.05	0.04	0.15	0.20	0.20	1.34	0.56	0.16	0.21	39.3	0.19
ppm	Ba	241	243	353	355	285	229	237	360	265	198	231	242	230	231
ppm	La	6.33	6.57	7.15	7.22	7.09	6.45	7.07	10.3	9.59	7.56	14.2	16.5	13.6	16.8

		Levantine					Levantine recycled		Foy 2.1 / Magby						
		Nava 001	Nava 003	Nava 004	Nava 005	Nava 011	Nava 009	Nava 014	Nava 002	Nava 007	Nava 008	Nava 010	Nava 012	Nava 013	Nava 015
ppm	Ce	11.6	11.9	12.1	12.3	12.5	11.3	12.4	13.3	16.2	13.5	16.3	19.8	14.0	16.5
ppm	Pr	1.44	1.50	1.58	1.58	1.55	1.46	1.56	2.11	2.12	1.62	3.04	3.52	2.87	3.50
ppm	Nd	6.31	6.55	6.73	6.73	6.62	6.22	6.61	9.30	8.71	6.75	13.22	14.93	12.58	15.08
ppm	Sm	1.27	1.46	1.36	1.35	1.34	1.29	1.29	1.90	1.72	1.35	2.77	3.03	2.62	3.17
ppm	Eu	0.40	0.41	0.45	0.41	0.41	0.36	0.37	0.47	0.44	0.33	0.67	0.66	0.62	0.76
ppm	Gd	1.35	1.32	1.40	1.39	1.28	1.28	1.24	1.91	1.68	1.20	2.61	2.84	2.56	2.96
ppm	Tb	0.19	0.20	0.21	0.21	0.20	0.19	0.20	0.30	0.25	0.19	0.43	0.44	0.40	0.47
ppm	Dy	1.14	1.18	1.25	1.23	1.17	1.09	1.15	1.76	1.43	1.13	2.46	2.72	2.37	2.77
ppm	Ho	0.24	0.25	0.26	0.26	0.26	0.23	0.24	0.36	0.29	0.23	0.52	0.55	0.48	0.58
ppm	Er	0.66	0.69	0.73	0.74	0.71	0.65	0.65	1.02	0.81	0.65	1.36	1.52	1.28	1.56
ppm	Tm	0.09	0.09	0.10	0.10	0.10	0.09	0.09	0.15	0.11	0.09	0.20	0.20	0.18	0.22
ppm	Yb	0.61	0.62	0.72	0.68	0.66	0.61	0.66	1.04	0.79	0.65	1.31	1.48	1.24	1.41
ppm	Lu	0.09	0.09	0.10	0.10	0.10	0.09	0.09	0.19	0.11	0.10	0.20	0.20	0.17	0.21
ppm	Hf	0.92	0.96	1.06	1.05	1.09	1.39	1.47	2.10	1.57	1.76	2.45	2.76	2.19	2.42
ppm	Ta	0.09	0.34	0.10	0.10	0.11	0.11	0.11	0.16	0.17	0.15	0.20	0.20	0.16	0.19
ppm	W	0.05	0.05	0.06	0.07	0.09	0.67	0.15	0.47	0.52	0.20	0.38	0.41	0.35	0.44
ppm	Pb	5.10	1.50	2.93	3.03	3.00	125	117	116	446	218	238	98.9	87	185
ppm	Bi	0.00	0.00	0.00	0.00	0.51	0.02	0.02	1.95	0.76	0.37	0.23	0.04	0.04	3.23
ppm	Th	0.77	0.82	0.94	0.94	0.97	1.00	1.11	1.40	1.34	1.31	1.82	2.47	1.43	1.69
ppm	U	0.63	0.64	1.28	1.31	1.16	0.89	0.96	1.39	0.93	1.31	1.36	1.44	1.07	1.45

TABLE 2. DESCRIPTION OF THE SAMPLES ANALYZED
 (Image by N. Schibille and S. Berrica).

Context	Typology	Colour
<i>S.001 =US 933005_318a</i>	Dish	Yellow
<i>S.002 =US 933005_318b</i>	Dish	Yellow
<i>S.003 =US 933005_318c</i>	Dish	Yellow
<i>S.004 =US 933005_318d</i>	Dish	Yellow
<i>S.005 =US 933005_318e</i>	3Fragments	Yellow
<i>S.006 =US 5603_186</i>	likely crucible	White
<i>S.007 =US 10002_17</i>	Crucible	Green
<i>S.008 =US 933005_316</i>	Production waste	Uncoloured
<i>S.009 =US 932004_308</i>	Cup	Blue
<i>S.0010 =US 935009_325</i>	Bowl	Green
<i>S.0011 =US 935009_325b</i>	Moil	Yellow-Brown
<i>S.0012 =US 935009_325c</i>	Bowl	Green
<i>S.0013 =US 935009_325d</i>	Dish	Yellow
<i>S.0014 =US 935009_325e</i>	Cup	Blue
<i>S.0015 =US 935009_325f</i>	Dish	Yellow

Bibliography

- Berrica 2020 = S. Berrica, *¿Quién vivió aquí? Análisis de un edificio altomedieval (Hoyo de Manzanares, Madrid)*, in *ArkeoGazte: Revista De Arqueología*, 9, 2020, p. 241-269.
- Berrica 2021 = S. Berrica, *Paesaggio minerario nella zona nord di Madrid (Spagna) tra VII e VIII secolo*, in D. Gangale, I. Raimondo (eds), *Landscape: Una sintesi di elementi diacronici. nuove metodologie per l'analisi di un territorio*, Oxford, 2021, p. 197-204.
- Berrica 2022a = S. Berrica, *Presentando el Paisaje Altomedieval de la Sierra de Guadarrama a través de dos casos de estudio: Cancho del Confesionario y la Dehesa de Navalvillar*, in *Revista Cuadernos de Arqueología de la Universidad de Navarra*, 30/2, 2022, p. 73-106, <https://doi.org/10.15581/012.30.2.005>.
- Berrica 2022b = S. Berrica, *Realidades sociales en la Alta Edad Media: dicotomía de un territorio rural en la Meseta Sur (Madrid, España)*, in *Territorio, sociedad y poder*, 17, 2022, p. 17-39, <https://doi.org/10.17811/tsp.17.2022.17-39>.
- Berrica 2023 = S. Berrica, *Formación y consolidación del paisaje andalusí (sig. VIII-XI) en la zona centro-occidental de la Marca Media*, PhD, Universidad de Alcalá.
- Berrica – Carrera 2020 = S. Berrica, F.M.P. Carrera, *Mines and metallurgy in the centre of the Iberian Peninsula: A new view from the archaeology landscape*, in *International Congress European Association of Archaeologists – EAA 2020 – Virtual Annual Meeting*. (24/08/2020-30/08/2020), PowerPoint f Congress.
- Brems et al. 2018 = D. Brems, I.C. Freestone, Y. Gorin-Rosen, R. Scott, V. Devulder, F. Vanhaecke, P. Degryse, *Characterisation of Byzantine and Early Islamic Primary Tank Furnace Glass*, in *Journal of Archaeological Science: Reports*, 20, 2018, p. 722-735.
- Ceglia et al. 2019 = A. Ceglia, P. Cosyns, N. Schibille, W. Meulebroeck, *Unravelling provenance and recycling of late antique glass from Cyprus with trace elements*, in *Archaeological and Anthropological Sciences*, 11/1, 2019, p. 279-291.
- Colangeli 2022 = F. Colangeli, *Il riflesso dei vetri: oltre la ceramica per la comprensione dei mutamenti culturali ed economici. Il caso della Sicilia nei secoli VI-XIII*, PhD thesis, Università degli Studi di Roma Tor Vergata, 2022.
- Colmenarejo – Gómez Osuna 2013 = F. Colmenarejo, R. Gómez Osuna, *Memoria de Excavación Navalhija 2013*, Consulted document in Museo Arqueológico y Paleontológico, unpublished.
- Colmenarejo – Gómez Osuna 2015 = F. Colmenarejo, R. Gómez Osuna, *Memoria de Excavación Navalhija 2015*, Consulted document in Museo Arqueológico y Paleontológico, unpublished.
- Colmenarejo – Gómez Osuna 2016 = F. Colmenarejo, R. Gómez Osuna, *Memoria de Excavación Navalhija 2016*, Consulted document in Museo Arqueológico y Paleontológico, unpublished.
- Degryse 2014 = P. Degryse, *Glass Making in the Greco-Roman World: Results of the Archglass project*, Leuven, 2014.
- De Juan Ares et al. 2019 = J. De Juan Ares, A. Guirado, Y.C. Gutiérrez, N. Schibille, *Changes in the supply of eastern Mediterranean glasses to Visigothic Spain*, in *Journal of Archaeological Science*, 107, 2019, p. 23-31.
- De Juan Ares – Schibille 2020 = J. De Juan Ares, N. Schibille, *El vidrio en al-Andalus: una historia fragmentada*, in S. Gómez Martínez (ed.), *Las Artes del Islam II: Vidrios, marfiles, metales, cerámica y tejidos*, Sevilla, 2020, p. 45-70.
- Deltenre – Orlandi 2016 = F.D. Deltenre, L.M. Orlandi, *Rien ne se perd, rien ne se crée, tout se transforme. Transformation and manufacturing in the Late Roman villa of Aiano-Torraccia di Chiusi (5th-7th cent. AD)*, in *PCA Post Classical Archaeologies*, 6, 2016, p. 71-90.
- Ferri 2021 = M. Ferri, *Le officine produttive*, in S. Gelichi, C. Negrelli, E. Grandi, *Un emporio e la sua cattedrale. Gli scavi di piazza XX Settembre e Villaggio San Francesco a Comacchio*, Sesto Fiorentino, 2021, p. 463-474.
- Ferri 2021 = M. Ferri, *I vetri dallo scavo di piazza XX settembre*, in S. Gelichi, C. Negrelli, E. Grandi, *Un emporio e la sua cattedrale. Gli scavi di piazza XX Settembre e Villaggio San Francesco a Comacchio*, Sesto Fiorentino, 2021, p. 403-415.
- Foy 2000 = D. Foy, *Un atelier de verrier à Beyrouth au début de la conquête islamique*, in *Syria*, 77, 2000, p. 239-290.
- Foy 2003 = D. Foy, *Le verre en Tunisie : l'apport des fouilles récentes tuniso-françaises*, in *Journal of Glass Studies*, 45, 2003, p. 59-89.
- Foy 2020 = D. Foy, *Le verre de Sabra al-Mansuriya – Kairouan, Tunisia – milieu X^e-milieu XI^e siècle. Production et consommation : vaisselle – contenants – vitrages*, Oxford, 2020 (*Archaeology of the Maghreb*, 1).
- Foy et al. 2003 = D. Foy, M. Picon, M. Vichy, V. Thirion-Merle, *Caractérisation des verres de la fin de l'Antiquité en Méditerranée occidentale : l'émergence de nouveaux courants commerciaux*, in D. Foy, M.D. Nenna (eds), *Échanges et commerce du verre dans le monde antique*, Aix-en-Provence-Marseille, 2003, p. 41-85.
- Freestone et al. 2018 = I.C. Freestone, P. Degryse, J. Lankton, B. Gratuze, J. Schneider, *HIMT, glass composition and commodity branding in the primary glass industry*, in D. Rosenow, M. Phelps, A. Meek, I.C. Freestone (eds), *Things that Travelled: Mediterranean Glass in the First Millennium CE*, London, 2018, p. 159-190.
- Freestone et al. 2008a = I.C. Freestone, M.J. Hughes, C.P. Stapleton, *The composition and production of Anglo-Saxon glass*, in V.I. Evison (ed.), *Catalogue of Anglo-Saxon Glass in the British Museum*, London, 2008, p. 29-46.
- Freestone et al. 2008b = I.C. Freestone, R.E. Jackson-Tal, O. Tal, *Raw glass and the production of glass vessels at late Byzantine Apollonia-Arsuf, Israel*, in *Journal of Glass Studies*, 50, 2008b, p. 67-80.

- Freestone 2020 = I.C. Freestone, *Apollonia glass and its markets: an analytical perspective*, in O. Tal (ed.), *Apollonia-Arsuf Final Report of the Excavations, Volume II: Excavations Outside the Medieval Town Walls*, University Park (Penn.), 2020, p. 341-348.
- Freestone 2021 = I.C. Freestone, *Glass Production in the First Millennium CE: A Compositional Perspective*, in F. Klimscha, H.J. Karlsen, S. Hansen, J. Renn (eds), *Künstlichen Stein zum durchsichtigen Massenprodukt / From artificial stone to translucent mass-product*, Berlin, 2021 (*Berlin Studies of the Ancient World*, 67), p. 245-263.
- Gómez 2012 = A. Gómez de la Torre-Verdejo, *La producción de vidrio en época visigoda: El taller de Recópolis*, in *Zona Arqueológica*, 15, 2012, p. 257-280.
- Gómez 2017 = A. Gómez de la Torre-Verdejo, *El vidrio en la submeseta sur en época visigoda, siglos VI y VII. tipología, producción y uso en ámbitos urbano y rural*, PhD Universidad de Alcalá, 2017.
- Gratuze 2016 = B. Gratuze, *Analysis of Vitreous Archaeological Materials by LA-ICP-MS*, in L. Dussubieux, M. Golitko, B. Gratuze (eds), *Recent Advances in Laser Ablation ICP-MS for Archaeology*, New York, 2016, p. 137-139.
- Keller 2005 = D. Keller, *Social and Economic Aspects of Glass Recycling*, in *TRAC Theoretical Roman Archaeological Conference*, University of Newcastle, 2005, p. 65-78.
- López Sáez et al. 2015 = J.A. López Sáez, R. Gómez Osuna, S. Ruiz, F. Alba, C. González, S. Núñez, F. Colmenarejo, *Paisaje visigodo en la Cuenca Alta del Manzanares Sierra de Guadarrama: Análisis arqueopalinológicos del yacimiento de Navalvillar (Colmenar Viejo, Madrid)*, in *ARPI, Arqueología y Prehistoria Del Interior Peninsular*, 2, 2015, p. 133-145.
- Munro 2010 = B. Munro, *Recycling in Late Roman villas in Southern Italy: Reappraising hearts and kilns in final occupation phases*, in *Museion*, ser. 3, 10, 2010, p. 217-242.
- Phelps et al. 2016 = M. Phelps, I.C. Freestone, Y. Gorin-Rosen, B. Gratuze, *Natron glass production and supply in the late antique and early medieval Near East: The effect of the Byzantine-Islamic transition*, in *Journal of Archaeological Science*, 75, 2016, p. 57-71.
- Rodríguez Martorell et al. 2020 = F. Rodríguez Martorell, M. Díaz García, J.M. Macías i Solé, J.F. Roig Pérez, I. Teixell Navarro, *Los últimos edificios domésticos, de servicio portuario y productivos del suburbio de «Tarragona» (s. VII-VIII): Un ensayo holístico*, in C. Doménech, S. Gutiérrez (eds), *El sitio de las cosas: La alta edad media en contexto*, Alicante, 2020, p. 67-82.
- Saguí – Lepri 2016 = L. Saguí, B. Lepri, *La produzione del vetro a Roma: Continuità e discontinuità fra Tardo Antico e Altomedioevo*, in A. Molinari, R. Santangeli (eds), *L'Archeologia della Produzione a Roma (secoli V-XV)*, Rome-Bari, 2016, p. 225-243.
- Sánchez de Prado 2014 = M.D. Sánchez de Prado, *La producción de vidrio en Valentia. El Taller de la Calle Sabaters*, in *Lucentum*, 33, 2014, p. 215-242.
- Sánchez de Prado 2018 = M.D. Sánchez de Prado, *La vajilla de vidrio en el ámbito suroriental de la Hispania romana. Comercio y producción entre los siglos I-VII d.C.*, Alicante, 2018.
- Schibille 2022 = N. Schibille, *Islamic Glass in the Making: Chronological and Geographical Dimensions*, Leuven, 2022.
- Schibille – Colangeli 2021 = N. Schibille, F. Colangeli, *Transformation of the Mediterranean Glass supply in Medieval Mazara del Vallo (Sicily)*, in A. Molinari, A. Meo (eds), *Mazara/ Māzar: nel ventre della città medievale (secoli VII-XIV). Edizione degli scavi (1997) in Via tenente Gaspare Romano*, Sesto Fiorentino, 2021 (*Biblioteca di Archeologia Medievale*, 32), p. 491-505.
- Schibille et al. 2016 = N. Schibille, A. Meek, B. Tobias, C. Entwistle, M. Avisseau-Broustet, H. Da Mota, B. Gratuze, *Comprehensive chemical characterisation of Byzantine glass weights*, in *PloS One*, 11-12, 2016, p. 168-289.