Amphora production in the pre-Roman Northeast of the Iberian Peninsula and evidence of trade with the Balearic Islands

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ABSTRACT A large-scale archaeometric research project is currently underway to study the production and trade of Iberian amphorae in the north-east of the Iberian Peninsula before Romanization. To date, 105 amphorae, mainly dated to the third century BC and recovered at sites in Laietània (to the north of present day Barcelona,) Cossetània (to the south of Barcelona), and the island of Menorca (Balearic Islands), have been characterized chemically and mineralogically by means of X-Ray Fluorescence (XRF) and X-Ray Diffraction (XRD). The results have allowed identification of the production of the Laietània and the Cossetània regions, and provide evidence of trade between the two regions and Menorca.

Introduction

During the Iron Age, in the seventh century BC, the Iberian Culture emerged in the south and east of the Iberian Peninsula. It developed due to the influence of the Greek and Phoenician colonizations, giving rise to many separate Iberian tribes civilized in different ways, speaking a similar but not identical language. The Roman army's occupation of the northeast of the Iberian Peninsula during the second Punic War at the end of the third century BC brought the Iberian culture to an end. This occupation meant the creation of the first Roman province, *Hispania Citerior*, and was the starting point of the romanization of the Iberian nations. Their way of life would become almost completely romanized during the first century BC.

The production and use of amphorae is one of the subjects on which the study of the economic and social forms of the late Iberian culture is based. Even if the Iberian amphorae was inspired generally by the morphological characteristics of Phoenician amphorae, to date, there are archaeological evidences showing that different shapes of rims, and so, can be related to different production areas (Miró, 1983-84, Blánquez and Gailledrat, in press). Moreover, though for a long time it was supposed that the Iberian amphorae were only used for storage, the current belief is that they were also involved in the network of trade between the different regions of Iberia, and even between the Peninsula and the Balearic Islands. There are several basic questions that can be totally or partially answered through archaeometric study. Where were the Iberian amphorae produced? What were they used for? Were they intended for storage, or could they also be used for trade? If there was some kind of trade network, who was involved: the Iberian people or just the Greek and/or Punic colonizers?

To date, few archaeometric studies of Iberian pottery have been carried out, and only one, by González et al. (1985), has focused exclusively on amphorae. Therefore, as part of a broader examination of the transportation and transformation of food products, a large-scale program of archaeometric characterization of Iberian amphorae is currently underway. The program's main aim is to identify production and reception centers of Iberian amphorae in the littoral and pre-littoral zone of the northeast of the Iberian Peninsula, and to study the circulation of this material among the various Iberian regions and also between the Peninsula and the Balearic Islands.

Materials and methods

105 individuals were chemically and mineralogically characterized (Fig. 1, Table 1). Of these, 48 were found at the Iberian settlement of Alorda Park (Calafell, Tarragona) (Sanmartí and Santacana 1992), in the Cossetània region. 41 individuals were selected from three different archaeological sites in the Laietània region: Turó dels dos Pins (an Iberian necropolis in Cabrera de Mar, Barcelona) (García, 1993), Can Bartomeu (an Iberian settlement surrounded by silos in Cabrera de Mar, Barcelona) (García and Zamora, 1993) and Vista Alegre (a possible kiln dump in Mataró, Barcelona) (CODEXX SCCL 1995). As stated, only Vista Alegre could be related to a kiln site, since the dump excavated in the 1990s was close to the Iberian amphorae kiln of Santa Cecília (Riera de Sant Simó) excavated in 1968 (Bonamusa, 1973). Finally, 16 individuals are from the archaeological site of the Talaiotic settlement of Trepucó (Menorca, Balearic Islands).

FIG. 1 – Selected excavation sites per areas.

TABLE 1
Number of individuals per excavation site and geographical areas.

Area	Site	Number of sample	Total
1. Cossetània	*Alorda Park*	48	**48**
2. Laietània	*Turó dels Dos Pins*	8	
	Can Bartomeu	18	**41**
	Vista Alegre	15	
3. Minorca	*Trepucó*	16	**16**
Total Number			**105**

X Ray Fluorescence analysis was performed using a Phillips PW 2400 spectrometer with an Rh excitation source. After removing mechanically the surfaces, a portion of at least 10 g of powder were homogenized and dried at 100°C for 24 h. Major and minor elements were determined by preparing duplicates of glassy pills using 0,3 g of this powdered specimen in an alkaline fusion with lithium tetraborate at 1/20 dilution. Trace elements and Na_2O were determined by powder pills made out of 5 g of this specimen mixed with Elvacite synthetic resin placed over boric acid in an aluminum capsule and pressed during 60 s at 200 kN. The quantification of the concentrations was obtained using a calibration line performed with 60 standards (International Geological Standards). The elements determined comprised Fe_2O_3 (as total Fe), Al_2O_3, MnO, P_2O_5, TiO_2, MgO, CaO, Na_2O, K_2O, SiO_2, Ba, Rb, Mo, Th, Nb, Pb, Zr, Y, Sr, Sn, Ce, Co, Ga, V, Zn, W, Cu, Ni and Cr. The loss on ignition (LOI) was determined by firing 0,3 g of the dried specimen at 950°C for 3 h.

X Ray Diffraction measurements were performed using a Siemens D-500 diffractometer working with the CuKα radiation (λ=1.5406 Å), at 1.2 kW (40 kV, 30 mA), and using a graphite monochromator in the diffracted beam. Spectra were recorded from 4 to 70°2θ, at 1°2θ/min (step size=0.05°2θ; time=3 s). The evaluation of crystalline phases was carried out using the DIFFRACT/AT program by Siemens, which includes the Joint Committee of Powder Diffraction Standards (JCPDS) data bank.

Analytical results

For the statistical treatment, the chemical data were transformed into logratios (Aitchison, 1986; Buxeda, 1999). The logratio transformation was performed on the following subcomposition: Fe2O3, Al_2O_3, MnO, TiO_2, MgO, CaO, Na_2O, K_2O, Ba, Rb, Nb, Zr, Y, Sr, Ce, Ga, V, Zn, Cu, Ni and Cr. SiO_2 was used as divisor because according to the variation matrix it made the smallest contribution to the chemical variability (Buxeda and Kilikoglou 2003).

The results can be summarized in the dendrogram resulting from the cluster analysis performed on the previous subcomposition, using the Squared Euclidean distance and the centroid algorithm, performed by S-plus2000 (MathSoft 1999) (Fig. 2). The dendrogram reveals a complex structure, identifying three large clusters, **A**, **B** and **C**, and two smaller ones, **MGA**$_1$ and **MGA**$_2$. The means and the standard deviation of these groups are presented in Table 2. However, several individuals (19 out of 105, i.e. 18,1%) cannot be clearly associated with these groups, and due to the lack of knowledge on Iberian amphorae productions they study needs to be further developed.

TABLE 2

Mean and standard deviation for the five groups identified.

	Group A		Group B		Group C		Group MGA_1		Group MGA_2	
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
Fe_2O_3	7,99	0,80	6,02	0,39	8,82	0,56	6,33	0,52	5,58	0,67
Al_2O_3	21,79	1,75	22,57	1,11	20,23	0,80	18,14	2,36	16,37	1,40
MnO	0,05	0,01	0,04	0,01	0,11	0,01	0,07	0,02	0,06	0,01
TiO_2	1,30	0,11	0,87	0,09	1,15	0,06	0,81	0,05	0,66	0,05
MgO	2,35	0,55	1,61	0,20	2,21	0,17	5,84	1,68	2,92	0,84
CaO	7,47	1,65	7,18	1,91	4,78	1,72	8,11	1,96	21,18	4,09
Na_2O	0,31	0,05	0,43	0,08	1,11	0,15	0,41	0,09	0,46	0,11
K_2O	2,01	0,22	2,97	0,38	2,87	0,27	4,85	0,38	2,78	0,43
SiO_2	56,57	1,43	58,14	1,21	58,55	2,05	55,28	2,12	49,82	2,75
Ba	313	44	469	72	655	96	572	53	553	158
Rb	97	9	149	24	142	11	159	32	132	18
Nb	24	2	20	1	22	2	18	1	17	1
Zr	290	19	219	21	219	30	176	15	171	9
Y	47	6	29	3	35	4	25	2	24	3
Sr	198	27	164	34	137	22	281	47	343	103
Ce	110	18	86	14	114	10	75	10	59	10
Ga	24	2	26	2	25	1	23	3	22	2
V	144	8	126	12	143	10	98	7	79	10
Zn	80	7	99	17	113	8	82	17	87	9
Cu	20	2	17	3	14	4	25	9	14	8
Ni	52	5	41	5	18	2	36	4	33	6
Cr	138	11	107	9	61	9	84	6	76	4

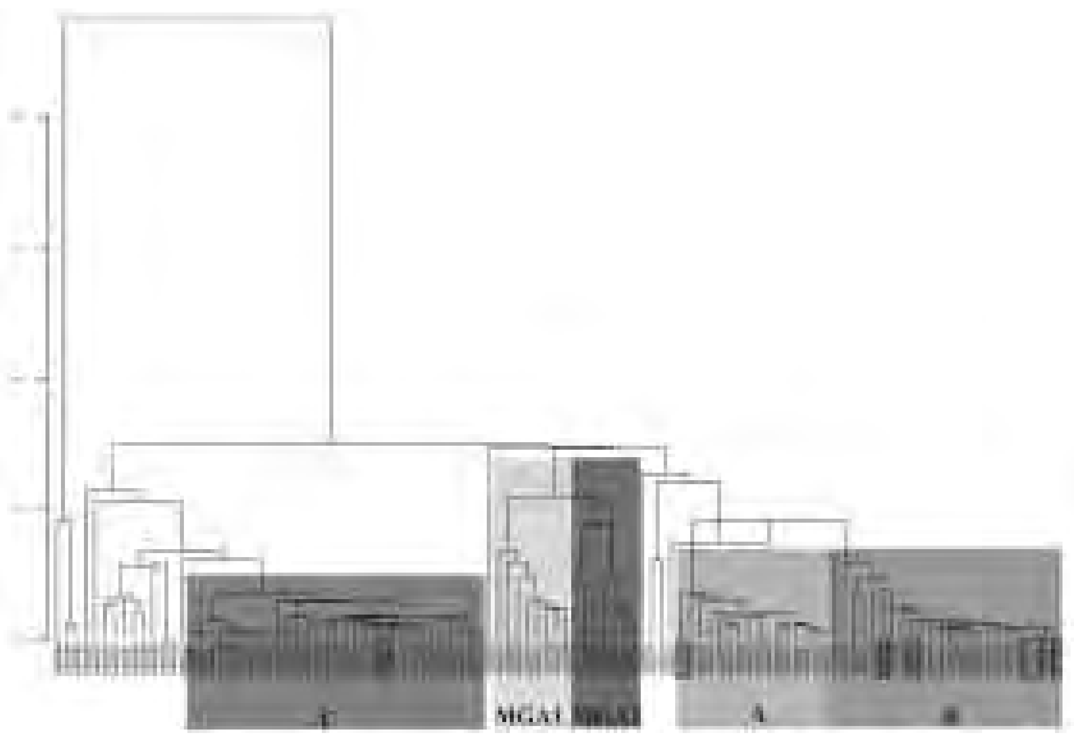

FIG. 2 – Dendrogram resulting from the Cluster Analysis performed using the Squared Euclidean distance and the centroid agglomerative algorithm on the logratio transformed subcomposition: Fe_2O_3, Al_2O_3, MnO, TiO_2, MgO, CaO, Na_2O, K_2O, Ba, Rb, Nb, Zr, Y, Sr, Ce, Ga, V, Zn, Cu, Ni and Cr, using SiO_2 as divisor. In group **C**, the individual found at Alorda Park is highlighted. In groups **A** and **B**, the individuals found at Trepucó are highlighted.

Centering our attention on the identified groups, the chemical group **C** accounts for most (75%) of the individuals from the three sites of the Laietània region (Table 1, Figure 1), with the sole exception of individual **AMI053** (Figure 2) recovered at the Alorda Park site in the Cossetània region (Fig. 1). It does not include individuals from Menorca (Balearic Islands). Besides the slightly reliable abundance criterion, considering the existence of a kiln dump, this group corresponds, most probably, to the Laietànian production. On the other hand, groups **A** and **B** mainly include individuals recovered at the site of Alorda Park, in the Cossetània region (Table 1, Fig. 1). In addition, group **A** includes the individual **AMI100**, and group **B** the five individuals **AMI099**, **AMI093**, **AMI101**, **AMI092** and **AMI102** (Fig. 2) recovered at Trepucó (Menorca). These last groups do not contain any of the individuals found in the Laietània region, and they are both considered as probable Cossetànian productions. Since, to present, there are no Iberian amphorae kiln sites excavated in this area, this hypothesis is only sustained by the abundance criterion and by the archaeological evidence (Sanmartí et al., in press) and should be further explored in the future. Interestingly, the smaller chemical groups, **MGA**$_1$ and **MGA**$_2$, included individuals from all the sites. Few individuals (19 out of 105, i.e. 18,1%) remain ungrouped.

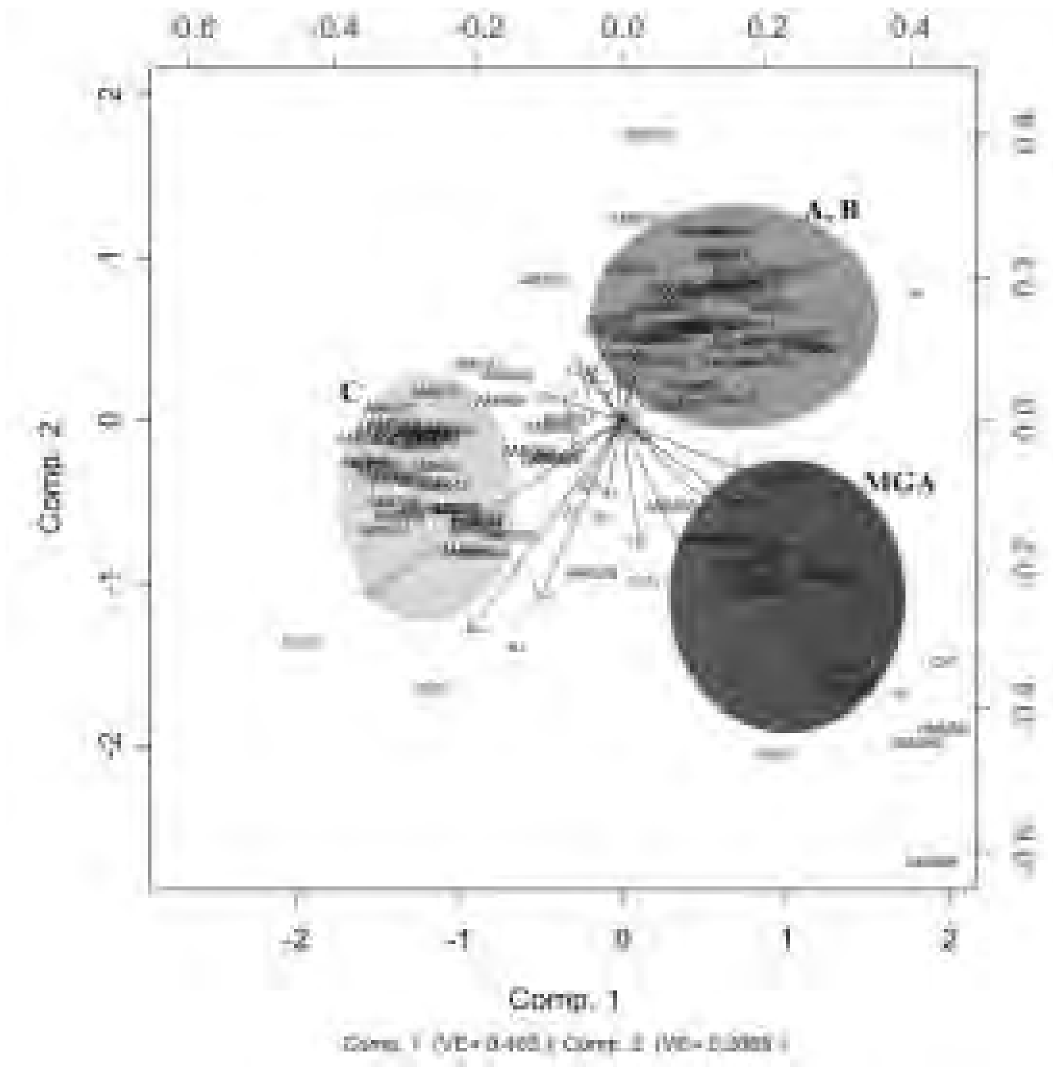

FIG. 3 – Biplot of the first and second principal component after a PCA analysis performed on the logratio transformed subcomposition: Fe_2O_3, Al_2O_3, MnO, TiO_2, MgO, CaO, Na_2O, K_2O, Ba, Rb, Nb, Zr, Y, Sr, Ce, Ga, V, Zn, Cu, Ni and Cr, using SiO_2 as divisor. The two principal components account for 66,95% of the variance explained.

In the biplot of the first and second principal components after a Principal Component Analysis performed on the covariance matrix of the previous subcomposition, without axes rotation, using S-plus2000 (Fig. 3), it is easy to see that group **C** has been separated from the rest of the material due to its higher Na and Mn relative content, while groups **A** and **B** are distinguished mainly because of the differences in Cr and Ni. These last two groups, though shown to be separable by Cluster Analysis, exhibit several chemical similarities, due probably to their similar regional origin. Finally, groups **MGA**$_1$ and **MGA**$_2$ exhibit higher relative concentration in Ca, Sr and Mg. These two groups, which show significant differences in all the trace elements and are therefore separable (Fig. 2), appear here as a single cluster because of their higher CaO and MgO relative contents.

Though from the technological point of view most of the Iberian amphorae under study are made mainly of low/border calcareous clays, a few are also clearly calcareous. Due to the variety of the pastes — low calcareous/border calcareous (groups **A**, **B**, **C** and **MGA**$_1$) and calcareous (group **MGA**$_2$) — the results are summarized in three wide categories of Equivalent Firing Temperature (Table 3) as follows (Maggetti, 1981; Heimann, 1989):

- Low-fired (<800-850°C): only primary phases are present; no clear firing phases are formed.
- Well-fired (800/850-950/1000°C): illite-muscovite can still be observed together with clear firing phases (like gehlenite, plagioclasse, spinel and pyroxen).
- Overfired (1000-1100°C): further changes in mineralogical phases. Illite-muscovite has totally decomposed and, in some cases, new firing phases are observed (like spinel and hercynite).

TABLE 3
Categories of Equivalent Firing Temperature and number of classified individuals belonging to the different categories.

	Groups					
Equivalent Firing Temperature	**A**	**B**	**C**	**MGA1**	**MGA2**	**Total**
<800/850°C	1	1	2	—	1	5
800/850-950/1000°C	15	22	22	7	6	72
1000-1100°C	—	1	7	1	—	9
Total	16	24	31	8	7	86

As can be seen, 72 out of the 86 individuals (84%) associated with the groups identified are classified in the well-fired category. Only 5% are low-fired and the rest (11%) overfired. Group **C** (Laietanian production) in which 23% of the individuals are fired over 1000°C, presents the highest number of over-fired amphorae. A plausible explanation is that one of the sites in the Laietània region, Vista Alegre, is a possible kiln dump, in which 4 out of the 7 overfired amphorae have been recovered.

Conclusions

The results identify at least two distinct productions for Cossetània (groups **A** and **B**) and one for Laietània (group **C**). These productions are based on low calcareous/border calcareous pastes fired in the 800/850-950/1000°C range. Comparison with their morphological types shows that groups **A** and **B** contain amphorae belonging to the Cossetanian morphological type

2C (Fig. 4, left). In contrast, group **C** contains individuals typologically characterized as Laietanian type 2B (Fig. 4, right); this is, clearly in accordance with the archaeological results, but highlights the existence of two chemically different productions in the Cossetània region.

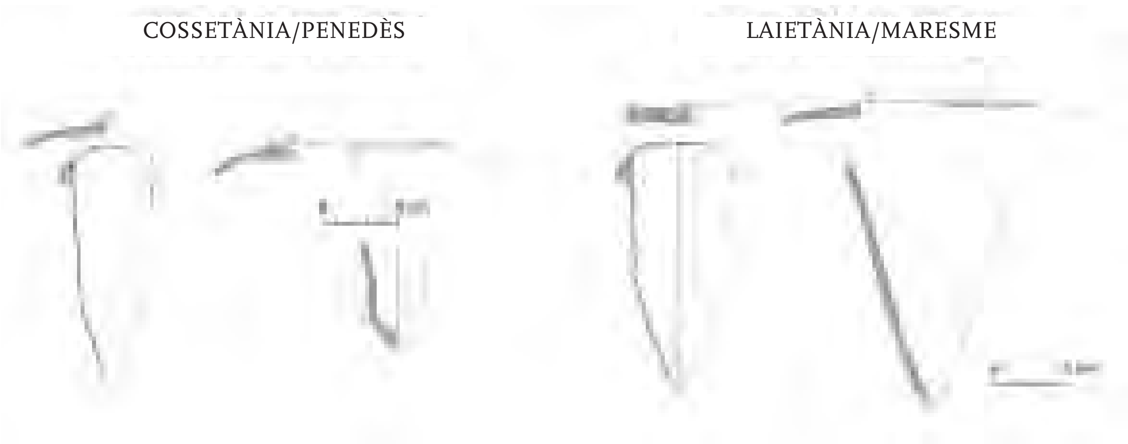

FIG. 4 – Typology of the Iberian amphorae of the Cossetània and the Laietània production.

Other productions (groups **MGA**$_1$ and **MGA**$_2$) were also identified, in lower amounts, in the studied sites. These amphorae are fired at the same range as the previous ones but, unlike the Cossetanian and Laietanian pieces, are made out of border calcareous/calcareous clays.

The presence of Laietanian amphorae in the Cossetània region, and especially the wide presence of Cossetanian amphorae in the Balearic Islands, reveals the circulation of amphorae between these two coastal zones and between the Peninsula and the Balearic Islands. Moreover, groups **MGA**$_1$ and **MGA**$_2$ contain individuals from all sites and, although at present they cannot be linked to any specific production areas, their wide distribution points to a complex trade-network involving all the studied areas.

So we conclude that there was a "*clear movement*" of Iberian amphorae between these geographical areas. However, the number of the individuals analysed is limited and at the current stage of the study we are unable to determine whether these types of amphorae were really used for long distance trade, or were used mainly for storage and were only occasionally exchanged. That is, does this "*movement*" of the Iberian amphorae really imply *trade*? And if so, can it be connected to a developed *trade-network*? And if there was trade, who was involved, and what role did the Iberians play in this *trade network*? We hope that further archaeometric research will provide answers to these questions.

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NOTES

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