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On cover: Stylistic representation of lyre bridge of amber from Early-Medieval Dorestad (Wijk bij Duurstede, the Netherlands) .

Composition, Technology and Functional Features of Chalcolithic Pottery from Perdigões, Reguengos De Monsaraz (Portugal): A Preliminary Report

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Introduction

The Perdigões site is one of the largest known Portuguese Chalcolithic settlements, occupied during the late 4th - 3rd millenium BC in the Reguengos de Monsaraz region, in the south of Portugal. This circular-shaped settlement spreads over an area of 16 ha, and is delimited by two concentric ditches. Work developed so far suggests the existence of several areas, like habitat areas, specialized activities areas (such as metallurgic activity areas) and burial ground areas (Lago *et al.* 1998, Valera *et al.* 2000). The burial remains are diversified and mainly consist of pottery, lithic artefacts, limestone and bone idols, *pecten* shells, bone combs, adorn artefacts, etc. On a global perspective one can say that the group of pottery artefacts includes all the typical morphologies of the Late Neolithic and Chalcolithic of the south west of the Iberian Peninsula and that there are differences between funerary and domestic recipients. According to the main goals of the archaeological project some of the answers can only be reached by an archaeometric approach, specially the ones concerning provenance and production technologies of the funerary ritual pottery, in comparison with domestic function ceramics.

Archaeological Problem

In the technical-scientific description of the work problem, it was our aim to carry out archaeometric work in determining pottery techniques, considered as particularly relevant for one aspect which had never been considered before, namely funerary ritualization: the specific production of pottery recipients used in funerary rituals.

With this particular approach, it was our aim to start with the study of the raw materials. As the Reguengos de Monsaraz region is rich in pottery production, it is important to collect samples in order to identify raw-material sources from which the Perdigões pottery might have come. It will also be our aim to try to understand the exploration strategies of these resources, specifically differences in their type, use and production technology, and whether they have any correspondence in the management and exploring of those same raw materials.

Materials and Methods

Generally the group of pottery artefacts includes all the typical morphologies of the Late Neolithic and Chalcolithic of the south west of the Iberian Peninsula and there are some differences between funerary and domestic recipients. So, it becomes important to realize whether there are specific differences between the raw materials and the production technologies used for the making of those two functional types of recipients.

According to these main objectives, an archaeometric study was performed comprising the chemical analysis of 117 samples: 35 ceramic recipients associated with funerary rituals (Tomb 1); 20 sherds of domestic typologies integrated in Tomb 1 contexts; 40 sherds of domestic typologies from the settlement area; ten domestic pottery samples from a possible pit near Tomb 2; ten funerary recipient ceramics from Tomb 2; two samples of hut-coating clays.

The chemical analysis was done by means of instrumental neutron-activation analysis (INAA). Ceramic samples and standards (sediment GSD 9 and soil GSS 1) were irradiated together in the core grid of the Portuguese Research Reactor (Sacavém) for two minutes (short irradiation) and seven hours (longer irradiation). Details concerning the measurement and processing of the gamma spectra can be found in Prudêncio *et al.* (1986) and Dai Kin *et al.* (1999).

This analysis permits to obtain the concentration of the following 30 elements: Na, K, Fe, Sc, Cr, Mn, Co, Zn, Ga, As, Br, Rb, Zr, Sb, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Dy, Yb, Lu, Hf, Ta, W, Th, U. Most of these elements are used as variables in a multivariate statistical approach (cluster analysis, R-mode factor analysis, discriminant analysis, canonical analysis, etc.) in order to obtain chemical signatures of each group. A detailed analysis of the element distributions was also performed in order to contribute to the establishment of geochemical fingerprints, which enable us to identify, or not, possible artefact-production specificities in funerary ritual pottery, in comparison with domestic-function ceramics.

Results and Discussion

The research reported in this paper only concerns the chemical characterisation of ceramics. Field work had already been done and the same analytical approach is underway for collected clay samples, which will be reported in future papers.

Preliminary results obtained on the chemical composition of pottery point to a diversity of raw materials in the funerary ceramics, in comparison with domestic ones, which have a more homogeneous composition (Fig. 1). The Ba, As, Zn, Ta and light rare-earth elements (LREE) contents have a greater range in the funerary pottery. Some of these ceramics point to a completely different source, especially in the rare-earth elements (REE).

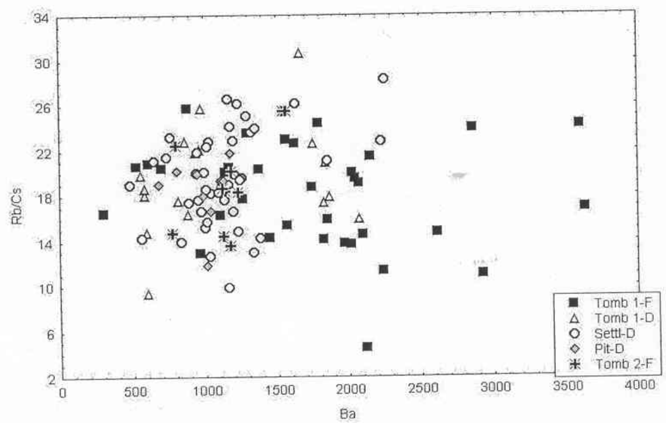

Figure 1 Plot of Rb/Cs against Ba illustrating the chemical heterogeneity of funerary vessels (specially of Tomb 1).

Factor and cluster analysis (tree-clustering method with UPGMA and Wards method as linkage rule, and the Pearson coefficient as distance measure, using chemical elements as variables) turned out to be a difficult approach in establishing separate groups according to their contexts (funerary or domestic), even factor loadings pointed to the importance of some elements, such as factor 1 is marked by high loadings on REE, specially LREE.

Applying the K-means cluster method, again some elements are differentiated between several ceramic samples. Three clusters were obtained, cluster 1 containing 87 cases, 75% of domestic contexts, cluster 2 containing 8 cases, mainly of funerary context (tomb 1) and cluster 3 containing 18 cases, half of each context. Cluster 1 reflects the existence of chemical homogeneity (mainly domestic); cluster 2 clearly is explained by REE, specially LREE, and cluster 3 is explained by Fe, Sc, Cr and Co (see Fig. 2).

In general, discriminant analysis is a very useful tool for detecting the variables that allow to discriminate between different groups, and for classifying cases into different groups with a better than chance accuracy. In the present study discriminant analysis became a very valuable instrument as it was capable to differentiate ceramics according to their archaeological contexts and corresponding usage, being used to determine which variables discriminate between the various naturally occurring groups that in this case were ceramics associated to funerary rituals (Tomb 1-F), to domestic typologies integrated in tomb 1 contexts (Tomb 1–D), to domestic typologies from the settlement area (Settl-D), to domestic pottery from a possible pit near tomb 2 (Pit-D) and to funerary recipient ceramics from tomb 2 (Tomb 2-F).

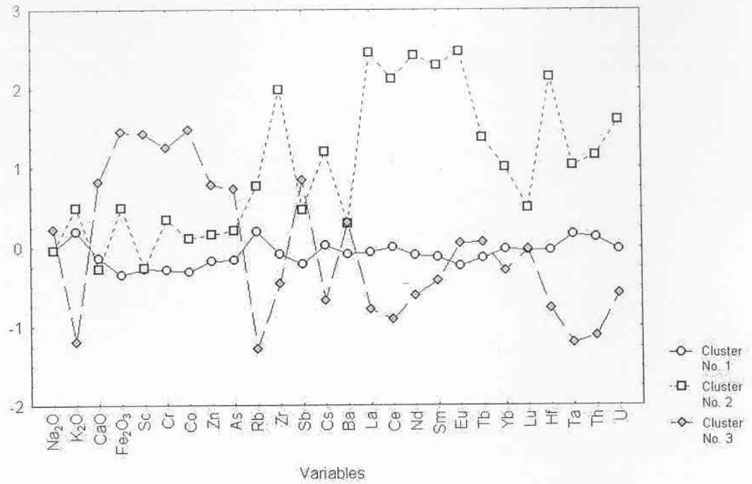

Figure 2 Plot of means for each cluster after applying the K-means cluster method.

The main point is to determine whether groups differ with regard to the mean of a variable (chemical composition), and then to use that variable to predict group membership, so that the classification functions can be used to determine to which group each case most likely belongs.

Computing the linear combination of dependent variables that results in the best discrimination between groups, we obtain linear combinations (or roots) that, as seen in Figure 3, easily differentiate the main pre-defined groups, namely ceramics from funerary contexts of tomb 1 (where most of the vessels are not broken), from the domestic ones of the settlement, and also from those with domestic characteristics (very small fragmented pieces of ceramics, most with domestic typologies) of the same tomb. It is also important to emphasize that ceramics from the probable pit have a chemical composition similar to the ceramics of the settlement. Funerary vessels of tomb 2 do not have chemical similarities with the funerary vessels of tomb 1, as well as with all the other analysed ceramics. In this latter case more ceramics should be analysed.

The classification matrix is a common result that one looks at in order to determine how well the current classification functions predict group membership of cases. The matrix shows the number of cases that were correctly classified and those that were misclassified. In Table 1 we can see that ceramics of tomb 1 and of the settlement present a correct classification of 80 to 90%, and in general for all the groups above 70%.

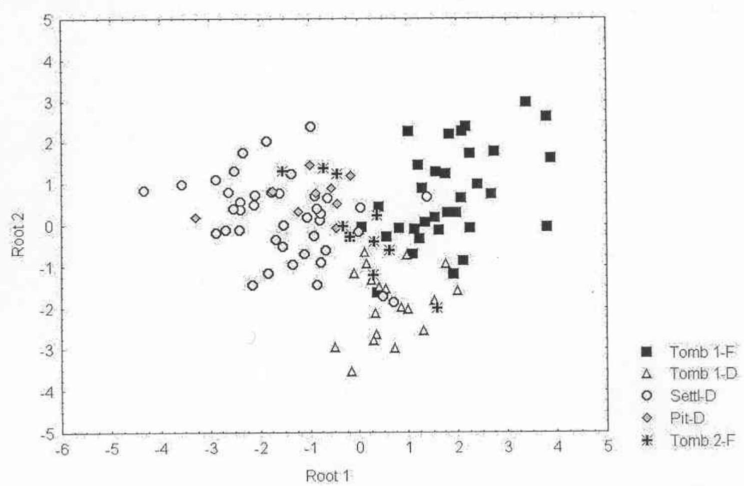

Figure 3 Discriminant function analysis of ceramics from the several defined archaeological contexts and corresponding functional types of recipients.

Table 1 Classification matrix (discriminant analysis), with horizontally the observed classifications and vertically the predicted classifications.

	Percent correct	Tomb 1-F	Tomb 1-D	Settl-D	Pit-D	Tomb 2-F
		p = 0,30088	p = 0,16814	p = 0,36283	p = 0,0796	p = 0,08850
Tomb 1-F	80	27	3	2	0	2
Tomb 1-D	84	1	16	0	1	1
Settl-D	93	1	2	38	0	0
Pit-D	78	0	0	2	7	0
Tomb 2-F	70	1	1	0	1	7
Total	84	30	22	42	9	10

After computing the Mahalanobis distances (of the respective case) from each of the group centroids, again we would classify the case as belonging to the group to which it is closest, that is, where the Mahalanobis distance is smallest, and misclassified ceramics were revealed for each group.
A posterior probabilities classification was also done (probability that a case belongs to a particular group) and a new reference group was proposed for those ceramics with corresponding percentage of membership, and for some of the ceramics, that percentage was below 50%, which can point to different provenances.

Final Remarks

Considering the results obtained so far, the chemical differences observed, namely a more chemical heterogeneity of recipients connected with funerary rituals, two non-exclusive hypotheses can be drawn: (1) the archaeological research suggests the possibility that the Perdigões necropolis has been used by people of the local settlement as well as from smaller and peripherical ones, so that the chemical heterogeneity could then reflect this eventual different provenance of burial remains; (2) the chemical heterogeneity of ceramics related to funerary rituals could reflect different technological procedures in the making of the pots, even a tendency of coarser pastes in habitat/domestic contexts occurs, in contrast with the observed tendency in funerary contexts, which mainly present thinner walls and thinner and less non-plastic grains (although coarser pastes also occur).
Further studies with more ceramics of several archaeological contexts and with clay samples from the area can lead us to better conclusions about ceramic provenance and production technologies of the funerary ritual pottery, in comparison with domestic function ceramics, finding out if there are specific differences between the raw materials and the way potters used it on the making of those two functional types of recipients.

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