



Original article

Looking at the Iron Age in the inland Iberia and the Mediterranean influences: ceramics from the archaeological site of *El Pueyo de Marcuello* (Huesca, Spain)



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ABSTRACT

The archaeological site called El Pueyo de Marcuello (Huesca, Spain) is an Iron Age urban settlement, geographically situated in inland Iberia, and dated of the second half of the first millennium BCE. The nature and manufacture of their archaeological remains allow identifying this site as a contact point for relevant exchanges, with remarkable connections with Central and Western Mediterranean cultures. These cultural influences and exchanges were investigated through the characterisation of the ceramic objects found during the archaeological excavations. More than forty fragments were studied, including some of the most peculiar ceramic types, and analysed by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) and Mass Spectrometry (ICP-MS). The petrographic observations of the thin-sections highlighted two ceramic fabrics, with a similar matrix and mineralogy, but the second one using sparite crystals of crushed calcite as intentionally added temper. The statistical treatment of the chemical data supported the identification of two main compositional subgroups; both included very similar low-calcareous clay bodies. All these data allowed for highlighting a main production, with two body fabrics, but both used to produce all ceramic types, either traditional or ceremonial. These objects could have been largely manufactured in local workshops. The materials from El Pueyo de Marcuello highlighted the extent of the relationships in areas of the Iberian inland, also connected to the rhythms of Mediterranean world, during the Iron Age.

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1. Introduction

For a long time, the life of ancient societies has been interpreted in terms of the material and immaterial exchanges they carried out with other groups. Considering these interactions, the information that the analysis of materials provides to the knowledge of these societies can significantly influence the conclusions. Colonisation theories that unidirectionally brought the light of civilisation to remote lands of the Mediterranean Sea by the hand of a heroic *oikistés* are now outdated. Efforts to analyse material culture are allowing us to see what was going on in the shadows of the spotlight of history and to contemplate a much richer,

more complex and multidirectional picture in terms of cultural exchanges. El Pueyo de Marcuello (Huesca, Spain) is providing us with a unique opportunity, so far, to contemplate the extent of these relationships in areas of the Iberian Peninsula inland, which were thought until now to be unconnected to the rhythms of Mediterranean cultures, at least for a large part of the Iron Age.

The archaeological site called El Pueyo de Marcuello is a small urban settlement excavated since 2012, situated in the north of Spain, between the Pyrenees and the Ebro Valley, in the southern foothills of the Loarre mountain range, on the slopes of a small elevation, relevant between the Gállego River valley and the mountain range (Fig. 1) [1,2]. From the geological point of view, the site is located on the northern margin of the Ebro Basin at the contact with the pre-Pyrenean Exterior Ridges, where continental terrigenous sediments of Lower Miocene age outcrop. The Exterior Ridges

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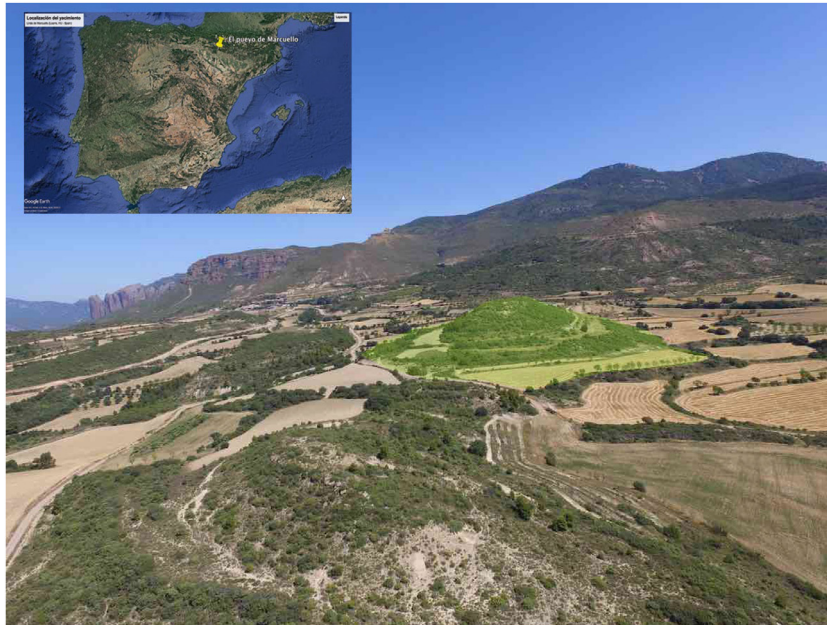


Fig. 1. View of the archaeological site (light-green shadow) and its geographical situation (photo: I. Lafragüeta). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

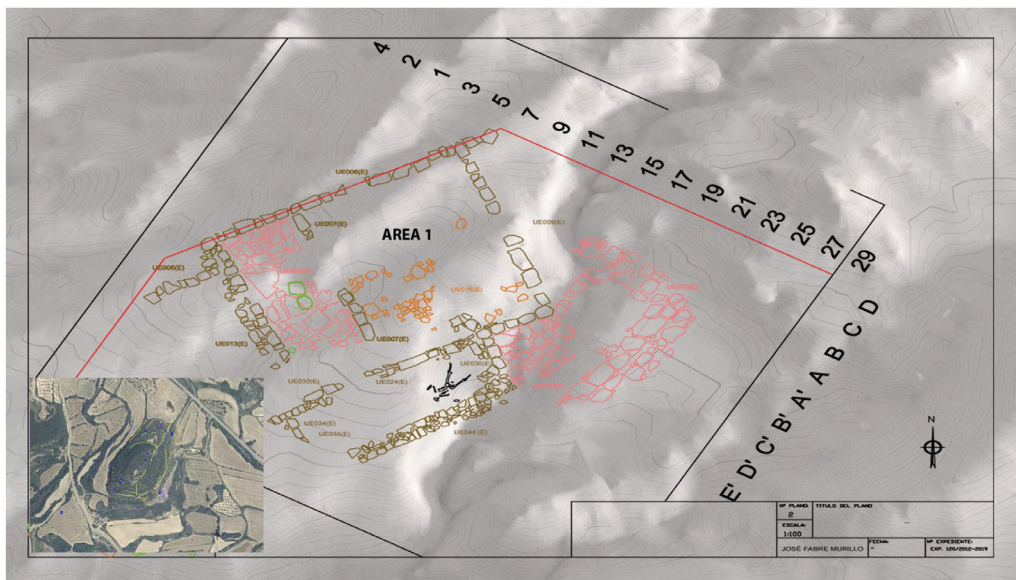


Fig. 2. Map of an area of the archaeological site (inset: aerial view of the small elevation where the site is situated) (photo: J. Fabre).

are made up of predominantly folded and faulted limestone materials, which stand out for their topographic relief over the foothills formed by subhorizontal detrital Miocene sediments, typical of alluvial fans, which include conglomerates, sandstones and lutites. At the archaeological site, these continental sediments consist of alternating sandstones, in palaeochannels, and lutites which are more abundant at the base of the Uncastillo Formation series [3], often covered by Quaternary deposits associated with the alluvial and fluvial systems of the Gállego River and its tributaries.

The urban planning of the site seems to be adapted to the topography, based on the elevation and a ramification of cobbled streets that does not confirm the presence of any central element yet, although it must not be excluded. There have been detected some rectangular areas in shape, whose buildings still keep some stone bases, mud-walls and simple leaned roofs on wooden beams (Fig. 2). At present, no other contemporary settlement with this

type of urban planning is known in the region, providing a source of valuable knowledge of the middle centuries of the 1st millennium BCE. Radiocarbon dating of the abandonment level of the main stage does not allow us to date the site before the middle of the 4th century BCE, although some of the elements found are linked to the European early Iron Age, showing a clear archaic survival [1,4,5]. The nature and manufacture of some of the found archaeological remains allow us to think of a site where elements of social prestige were produced and exchanged, directly or indirectly, over short, medium and long distances. The appearance of goldsmithing moulds [1] indicated the existence of human groups with production capacity. On the other hand, evidence of ceramics whose morphology and decoration are clearly of Etruscan inspiration (Fig. 3) [6,7] would expand the horizon of contacts between the central and western Mediterranean, beyond those relations already well attested so far (for instance, in the area of

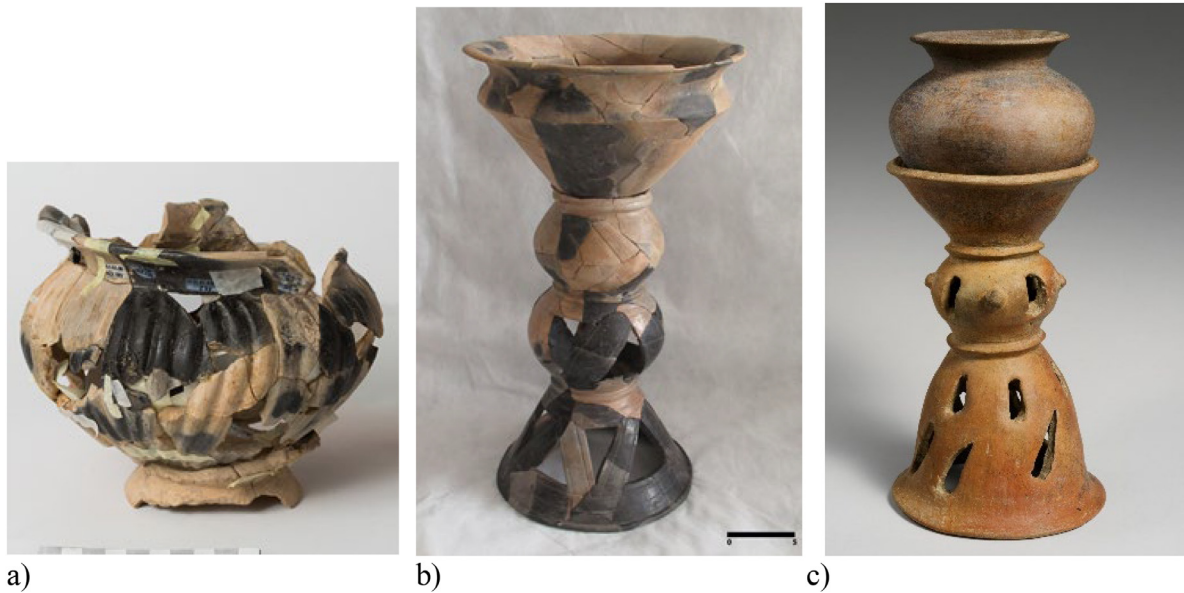


Fig. 3. a, b) Some ceramic objects found in El Pueyo de Marcuello site: a) bowl with a corrugated decoration, 13.5 cm high, diameter of mouth 16 cm, code number: NIG11603 (sample 23), Museum of Huesca (Spain) (photo: J. Garrido); b) holmos, 36 cm high, diameter of mouth 20 cm, code number: NIG11576 (sample 2a), Museum of Huesca (Spain) (photo: M.J. Arbués). c) Etruscan terracotta holmos (the plain flaring top supports an undecorated dinos), late 8th - early 7th century BCE; 27.6 cm high, diameter of mouth 17.2 cm; accession number: 96.18.125, The Metropolitan Museum of Art, New York (www.metmuseum.org).

eastern Languedoc [8], and with lower intensity and importance, but present at least since the 8th century BCE, in a large part of the Ebro valley [9]). Additionally, the finding of a necklace bead, made of glass, of clear Punic inspiration supports the influence of Mediterranean workshops in El Pueyo de Marcuello site [4,10].

These cultural influences and exchanges could be investigated through the characterisation of the ceramic objects found during the archaeological excavations. Archaeometric characterisation approach through chemical analysis and thin-section petrography on ceramics is a well-established method to investigate provenance and technology of ceramic bodies since the early 1970s [11–14]. In addition to vessels and urns, several items proved the singular case of this place. The ceramic assemblage is significant for the number of elements found in situ, but mainly for the variety of typologies, functionalities and possible provenances of these objects. A morphological characterisation of these ceramic wares has lately been carried out [15] that presented common types (urns, lids, bowls or strainers) that coexisted with others of evident inspiration in classical Mediterranean cultures (Greek and Etruscan): ceremonial stands (*holmoi*¹), bowls with corrugated decoration or high-footed cups (Fig. 3) [6,7,16], that would prove the Mediterranean connections. A preliminary conclusion of this study based on the typological comparison would lead us to think that there were two ceramic traditions. The first one would be a local or regional production, similar to the typical productions from the Ebro Valley during the Iron Age [17–20], with types of daily use in which urns, bowls and decorated lids, among others, would be included. Belonging to the second pottery tradition, there would be a group of "special" vessels, such as the *holmoi*, the bowl decorated imitating metallic objects, and some of the cups. This second group could come from the Mediterranean coast by exchange or imitation of Greek or Etruscan forms that circulated through the circuits of the Mediterranean world during the second half of the 1st millennium BCE and that, previously, we could hardly predict their arrival

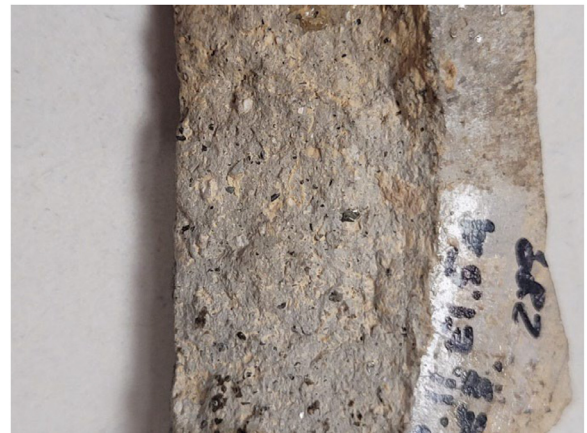


Fig. 4. Image of the cross-section of a ceramic (sample 43).

in these inland Iberian regions. Other examples of isolated *holmoi* have been documented to be found in archaeological sites in the Ebro Valley, but with simpler forms and none with the same style of those from El Pueyo de Marcuello.

2. Research aims

This research brings together the archaeological, chemical and petrographic evidences obtained from ceramic fragments to support the interpretation of the cultural links, influences and exchanges and the role of this inland urban settlement during the Iron Age.

3. Materials and methods

Forty-four ceramic fragments were studied, including some from the most peculiar ceramic types (Table 1S, supplementary material). The selected objects had been removed from the Area 1 of the site (southeast 710 sector) (Fig. 2). The southeast sector is the best archaeologically known of the site, where the largest

¹ Noun: *holmos* (plural *holmoi*), from ancient Greek. An ancient Greek or Etruscan vase with a rounded body, especially a closed vessel of nearly spherical form on a high stem or pedestal, or a drinking cup with a foot and stem.

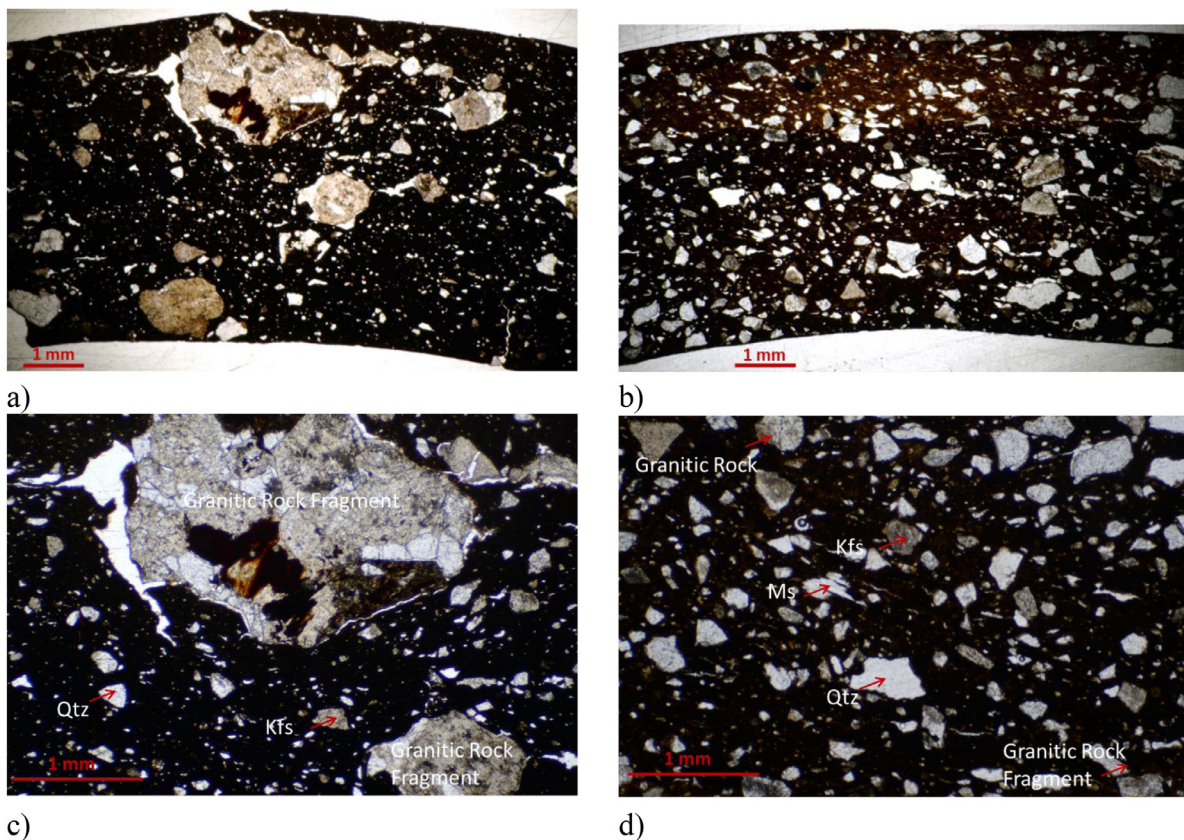


Fig. 5. Photomicrographs of the thin-sections taken in polarized light (parallel polars, PPL), fragments from fabric 1; a) and c) sample 7; b) and d) sample 8. Codes: Kfs, altered K-feldspars; Qtz, quartz; Ms, muscovite.

number of materials are concentrated. Inside southeast sector, Area 1 is where the major number of ceramics were found. The stratigraphic study of this area (levels UE002 and UE003) has revealed a rapid level of destruction by fire [1,2] which led to the collapse of these rooms, fragmenting them, but preserving stone moulds, bronze objects, mortars, and more than 40 ceramic forms. The discovery of a human body in a position of violent death because of the fire supported the idea that the end of these rooms was not ritual, but accidentally or intentionally fired. It is therefore interpreted that Area 1 was a zone for the safekeeping or storage of prestige objects.

The chemical analysis was performed by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), determining ten major and minor elements (Na, Mg, Al, K, Ca, Ti, Mn, Fe, Ba and Sr), and ICP-Mass Spectrometry (ICP-MS), for twenty-one trace elements (due to the superior detection capabilities of this last method). Chemical analysis of major and minor elements of the ceramic bodies was carried out in an iCAP PRO XP Duo Inductively Coupled Plasma-Optical Emission Spectrometer (Thermo Scientific). For ICP-OES analysis, a 27.12 MHz RF was used, and the instrument can work in axial and radial mode. A Perkin Elmer Elan DRC-e Inductively Coupled Plasma-Quadrupole Mass Spectrometer (ICP-QMS), equipped with a cross-flow nebulizer, was used to measure trace elements using the software Total-Quant (©Perkin Elmer). As reference material, a soil (NCS DC 73319, certified by the China National Analysis Centre for Iron and Steel), was used to prove the method accuracy (Table 2S, supplementary material).

Powdered samples were extracted from ceramic bodies by drilling in freshly fractured surfaces of the sherds. Samples (50 mg) were digested in open Teflon vessels. The procedure [14] consisted of successive additions of HNO₃ + HCl, and HF, and a final addition of HNO₃ + HClO₄, heating in every step. After dissolution, every

sample was diluted to 50 mL. Results were submitted to a multivariate statistical treatment: principal components analysis (PCA) and hierarchical clustering analysis (HCA) (using XLSTAT software, 2022.4.1).

The ceramic characterisation was completed with the petrographic study by optical microscopy (OM). Small fragments of ceramics were cut perpendicularly to the surface-body interface to prepare the thin-sections, in order to examine their mineralogical components and microfabric. An alizarin S staining was applied to improve the carbonate observation. The thin-sections were observed under a JENAPOL Carl Zeiss Jena polarizing microscope, coupled to a CMEX-5 Pro camera with ImageFocusAlpha capture and analysis software.

4. Results and discussion

Most of the fragments showed a clear-creamy body with tiny black inclusions, sometimes with metallic shine, and some white grains (Fig. 4). The petrographic observations of the thin-sections confirmed two different ceramic fabrics (see Figs. 5 and 6). Samples from fabric 1 (see samples 7 and 8 in Fig. 5) had the same components, mainly granitic rocks fragments and their minerals (potassium feldspar, plagioclase, quartz, biotite, amphibole), but they were differently tempered in terms of inclusion sizes. The clay matrix seemed to be similar with abundant dispersed iron oxides in all cases. For instance, sample 7 (Fig. 5a) was very poorly sorted with angular to sub-rounded sand-sized inclusions, even in very coarse grain (>2 mm, diameter) to very fine, with weakly bimodal grain size distribution. The estimated percentage of inclusions with respect to the matrix was 20–25 to 80–75%. However, sample 8 (Fig. 5b) was well sorted with abundant angular fine-to-medium sand-sized inclusions, with tendency to unimodal grain size distri-

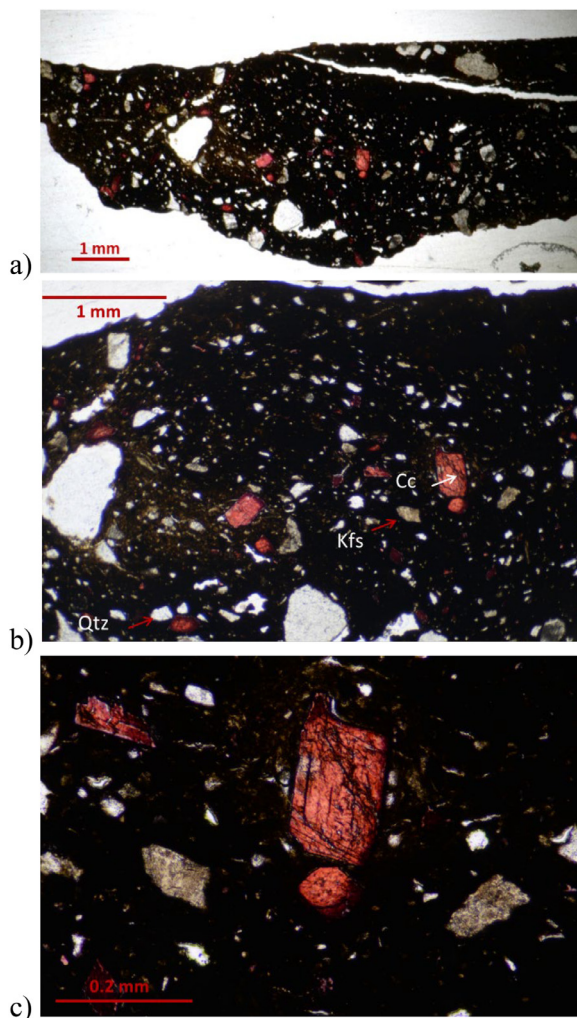


Fig. 6. Photomicrographs of the thin-section taken in polarized light (parallel polars), fragment from fabric 2, sample 19; a), b) and c) in different magnifications. Codes: Kfs, K-feldspars; Qtz, quartz; Cc, calcite.

bution (ranging from about 0.2 to 1 mm, diameter), and an inclusions/matrix rate of 35–40/65–60%.

The mineralogical components of the granitic rocks fragments showed high degree of alteration by hydrothermal fluids (sericitization), which turned the K-feldspar (Kfs) and plagioclase to a cloudy appearance in parallel polars (PPL) (Fig. 5c). The angularity of the inclusions evidenced the manipulation of the tempers, clearly added to the clay paste by the potter. The main components of the granitic rocks are shown in Fig. 5d (Kfs, altered K-feldspars; Qtz, quartz; Ms, muscovite). Very occasionally, these samples also contained small monocrystals of calcite.

Samples from fabric 2 (see sample 19 in Fig. 6) were moderately poor sorted with sub-angular to sub-rounded scarce sand-sized inclusions (ranging from 0.2 to 1.2 mm, diameter). Its inclusions/matrix rate was 10–20/90–80%. The clay matrix seemed to be comparable to the others. The inclusions were similar to the others, but they showed unusual angular sparite monocrystals of calcite (<0.5 mm long), in red in the photomicrographs due to the alizarin S selective staining effect (Fig. 6a). The most peculiar components of this fabric were the small single crystals of calcite (Cc), with great angularity, evidencing their intentional addition as tempers (Fig. 6b). The sparitic nature of calcite in monocrystals and their shapes evidenced the fragmentation following the perfect cleavage (Fig. 6c).

The use of crushed calcite as added temper is well known in the Mediterranean world since ancient times, including the Iberian Peninsula and the Balearic Islands [21–23]. The petrographic study of Neolithic ceramics found in pre-Pyrenean contexts, such as Chaves and Forcas (Huesca, Spain) [24], revealed the use of sparite calcite tempers in some pottery pastes of well-defined chronology due to their archaeological levels dated by ^{14}C (ages around 6770–6460 BP in Chaves and 5340 BP in Forcas). The introduction of crushed calcite as pottery temper was also documented in archaeological sites of La Rioja, Navarra and Álava, only few hundreds of kilometres far from El Pueyo de Marcuello, dated in the Late Bronze Age [25] and in the Early Iron Age (EIA) [26]. However, the characterisation of the pottery from other EIA archaeological sites, like Cabezo de la Cruz (Zaragoza, Spain) [17], or El Morredón (Zaragoza, Spain) [18], in the Middle Ebro Valley, highlighted the use of a completely different tempering in its ceramic fabric (with the addition of grog), even though the finding of a smaller *holmos* was also documented in this last site [19].

These compositional differences were also evidenced by the data measured by ICP-OES and ICP-MS (see supplementary material). The chemical data determined by these techniques were statistically treated, considering the 31 variables (elements) measured. For the HCA, the data were previously standardised and then the squared Euclidean distance was calculated; complete linkage was used, and entropy as clustering algorithm [27]. For the PCA, the data were also standardised, and the method of correlation (Pearson) was selected to perform the analysis. The first two principal components (PCs) accumulated about 55 % of the total variance, and if the first three components were considered, the total variance would increase until about 70 %. The statistical treatment of all the chemical data presented two main compositional subgroups, with only few singletons (Fig. 7a). Their average compositions showed that both subgroups included low-calcareous clay bodies (around 5–11 %wt CaO) with diverse elemental compositions in some major, minor and trace elements (Table 1). However, except the seven samples out of these subgroups, both clusters were chemically quite alike, this strong similarity was also highlighted by principal component analysis (Fig. 7b), where aluminium, magnesium, calcium and manganese were the elements responsible of the separation in two subgroups. If PC3 was also taken into account, in order to increase the accumulated total variance, the projection of the three first PCs would not improve the visualisation of the subgroups (Figs. 1S and 2S, see supplementary material). The first subgroup (marked with green lines in Fig. 7) corresponded to fabric 1 and the second one (with blue lines in Fig. 7) matched fabric 2. The slightly compositional differences between them would be justified for the presence of crystalline calcite and the different sizes and mineral compositions of granitic-rock tempers. The similarity of trace elements proportions would demonstrate a single clay source for the ceramic paste.

These analytical data will allow the future comparison between the chemical compositions of ceramic objects found in the site and other production centres or cultural areas with influence in the region. Unfortunately, there are not many published analytical data to compare them; taken into account the historical period and the ceramic typology, only few examples of archaeological pottery from the Iberian Peninsula have been characterised [17,18,20,21,25,26].

In order to reinforce the specificity of these two main subgroups, as an example of the distinguishing fabric of the objects considered out of the subgroups, thin-section of sample 22 (with non-calcareous paste, 1.21 wt% CaO), probably from the top of a ceramic stand or *holmos* (potter's wheel-shaped, unlike the other three examples), is shown in Fig. 8. Visually, it has a much more refined paste and a wheel technique that achieved walls of much less thickness, giving the piece a more slender and modern look

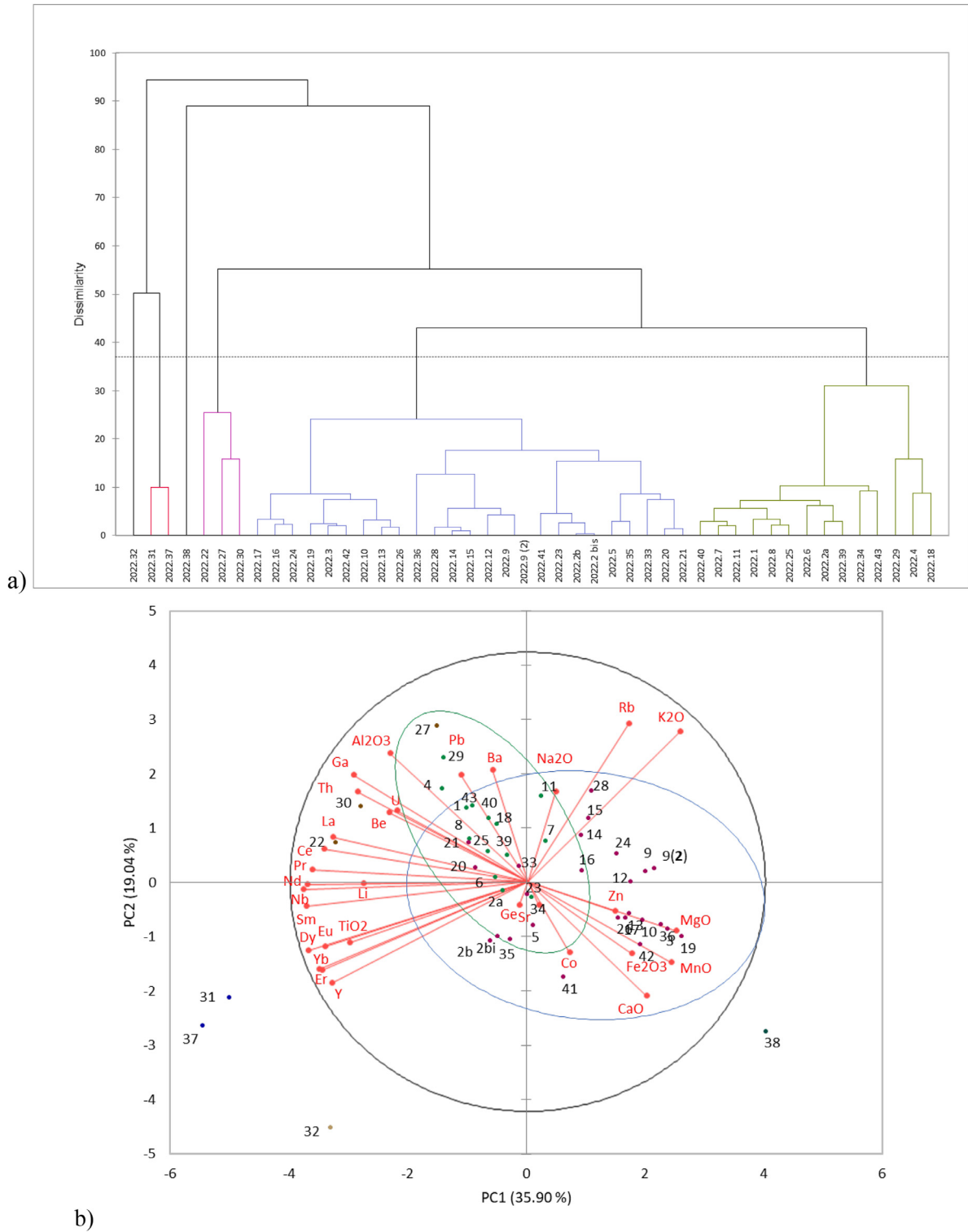


Fig. 7. a) Hierarchical cluster analysis using the analytical results. Dendrogram: squared Euclidean distance and complete linkage; b) Principal Components Analysis of the chemical results, ellipses of the 95 % confidence level (the plot of the loadings of the 31 variables is superimposed in the first-two-PCs plot).

compared to the rest of the ensemble. By optical microscopy, it was pretty well sorted with abundant sub-angular to rounded very fine tempered inclusions (<0.3 mm), mainly of monocrystalline quartz (Fig. 8a). The estimated percentage of inclusions to matrix was 25–30 to 75–70%. The clay matrix showed two parts parallel to the surfaces with different optical behaviour, which seemed to be related to the oxidation–reduction firing conditions. It had a

very homogeneous fabric with predominant very fine quartz in a clay matrix with sporadic muscovite (Ms) flakes (Fig. 8b).

At present, considering petrography and chemical data, it is impossible to be sure that the two main subgroups were made with local raw materials or not. However, it can be assured that the local Miocene clays, as well as the aggregates from the bed of the Gállego River itself or even from the sediments of its quater-

Table 1
Average chemical composition and standard deviation (s) of both compositional ceramic subgroups (G1, green lines in Fig. 7, and G2, blue lines in Fig. 7) of samples from El Pueyo de Marcuello (Huesca, Spain). The results of major and minor elements are given as oxide wt% (Fe₂O₃ represents the total Fe); trace elements composition is expressed in μg/g.

(wt%)	G1 (n = 14)		G2 (n = 23)		(μg/g)	G1 (n = 14)		G2 (n = 23)	
	s		s			s		s	
Na₂O	1.27	0.24	0.877	0.25	Sr	566	185	567	142
MgO	2.55	0.40	3.04	0.72	Y	17	2	17	2
Al₂O₃	16.4	1.0	14.3	0.8	Nb	13	1	12	1
K₂O	3.76	0.38	3.57	0.35	Ba	535	108	493	87
CaO	6.79	1.63	9.26	2.13	La	33	4	29	3
TiO₂	0.606	0.073	0.577	0.075	Ce	71	8	62	6
MnO	0.0480	0.0101	0.0633	0.0178	Pr	8.7	0.9	7.7	0.8
Fe₂O₃	4.81	0.95	4.86	0.48	Nd	32	3	29	3
(μg/g)					Sm	6.3	0.6	5.7	0.6
Li	96	11	85	12	Eu	1.4	0.2	1.3	0.1
Be	4.6	0.8	3.8	0.5	Dy	4.2	0.5	3.8	0.4
Co	17	4	16	4	Er	2.0	0.3	1.8	0.2
Zn	98	32	94	16	Yb	1.9	0.3	1.8	0.2
Ga	24	2	22	2	Pb	32	9	30	8
Ge	3.3	0.6	2.9	0.4	Th	12	2	10	2
Rb	180	30	177	35	U	2.1	0.3	1.9	0.3

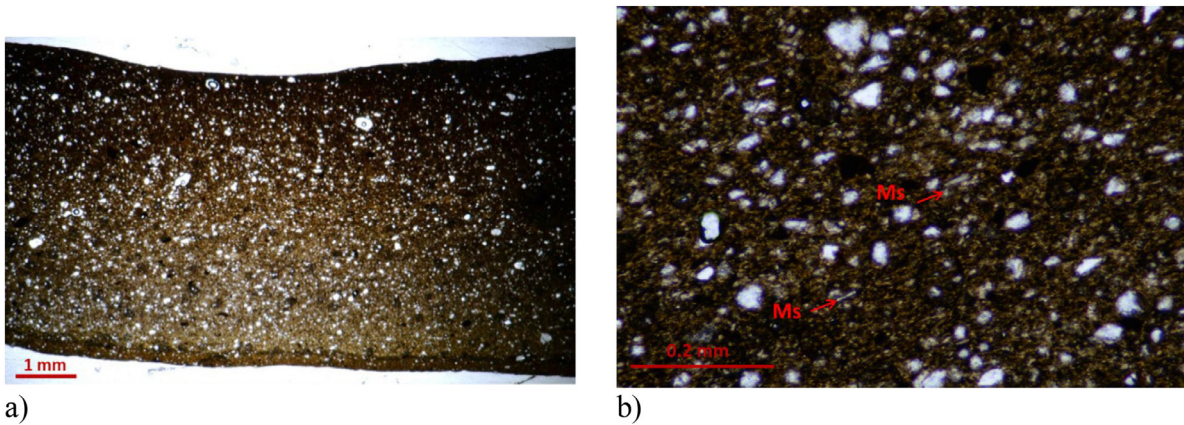


Fig. 8. Photomicrographs of the thin-section taken in polarized light (parallel polars), fragment from sample 22; a) and b) in different magnifications (Ms, muscovite).

nary terraces outcropping very close to the archaeological site, are totally compatible with those characterized in their body fabrics. Indeed, the Gállego River, coming from the axial Pyrenees, flows from north to south, just 6 km from the site. This river, a tributary of the Ebro River, carries detrital sediments along, which granitic rocks are easily distinguishable. Furthermore, between the river and the site there are Quaternary terraces where gravels alternate with finer silts and sands, which also contain polymictic pebbles of palaeozoic lithology and granites [28]. With regard to the clearly added inclusions of sparite calcite, they usually correspond to fragments of crushed speleothems abundant in the calcareous caves of the pre-Pyrenean mountain ranges. Therefore, it can be concluded that there are petrological evidences to support the hypothesis of their local or nearby origin.

Although the preliminary typological comparison could lead us to a simplified interpretation that would speak of two sets (local and foreign productions), in light of the analyses carried out, the second set should be observed with an additional variable. We are dealing with imitations of recognizable forms that, due to their ritual significance and prestige, were replicated by local or regional workshops in the area around El Pueyo de Marcuello.

5. Conclusions

In summary, we can conclude that most of the ceramic fragments from El Pueyo de Marcuello site correspond to a main pro-

duction with a similar matrix and mineralogy, but where two subgroups can be distinguished, especially in terms of the tempers. One subgroup, with granitic rock fragments and their minerals (with different sizes), intentionally added, and a second group (similar in matrix and inclusions), but, in addition, including sparite crystals of calcite, also added by the potters during the ceramic paste preparation.

Until now, the archaeological studies had revealed the existence of at least three ceramic traditions, the first two of supposed local provenance, in this site. The first one was archaizing, according to its dating, with traditional forms from the early Iron Age, such as bowls and urns. A second tradition, modernising the previous one, can be seen in the objects made on a potter's wheel. The third one, whose classical forms – *holmoi* and bowls with corrugated decoration – proved new contacts between the inhabitants of the middle valley of the Gállego River and the Mediterranean cultures during the 4th century BCE.

However, the ceramic characterisation let us to see only a main production, with two body fabrics, but both used to produce all ceramic types, either traditional or ceremonial, such as the *holmoi*. The chemical and petrographic study almost certainly clarifies that these objects could have been largely manufactured in local workshops, providing us with a hypothesis on technical and communicating capacities of these societies that had always been considered. The material knowledge of these inland communities provided them the suitable ability to understand the fashions and

industrial uses of the coastal circuits to replicate the characteristic elements of the social elites of that time with adequate mastery. The materials from El Pueyo de Marcuello highlighted the extent of the relationships in areas of the Iberian inland, also connected to the rhythms of Mediterranean world, during the Iron Age. It can only be emphasised once again that the chronologies yielded by ^{14}C spoke of a modern stage for this replication, but one that undoubtedly ended up, century by century, penetrating the Iberian hinterland. However, the questions about the Mediterranean source or the influence paths remain open, because the current results should be compared with future analyses of other ceramic productions, especially from the Iberian Mediterranean coast.

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“And even distant antiquity shows us that there have always been close bonds between Etruria and Iberia”.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.culher.2024.07.004](https://doi.org/10.1016/j.culher.2024.07.004).

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