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Cutillas-Victoria, Benjamin

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Pottery traditions, consumers' choices and exchange networks at Late Bronze Age Cobatillas la Vieja (southeast Iberia)

Benjamín Cutillas-Victoria [a,b,c,*], Peter M. Day [a,d]

[a] Ceramics and Composite Materials Research Group. Institute of Nanoscience and Nanotechnology, NCSR Demokritos. Agia Paraskevi Attikis, 153 10, Athens, Greece
[b] Grupo de Investigación en Arqueología (E041-02). Universidad de Murcia. Campus de La Merced, 30001 Murcia, España
[c] Centre of Excellence in Ancient Near Eastern Empires (ANEE). University of Helsinki. Fabianinkatu 24, 00014 (Helsinki, Finland)
[d] Department of Archaeology, University of Sheffield, Sheffield S1 3NJ, UK

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ABSTRACT

Cobatillas la Vieja is one of the main settlements for understanding the beginning of the Late Bronze Age (14th-13th centuries cal. BC) in the southeast of the Iberian Peninsula. After the macroscopic study of their ceramic assemblage, 30 representative samples were analysed by thin-section petrography, X-ray diffraction (XRD), scanning electron microscopy (SEM) and binocular microscopy to address issues of provenance and technology. The characterization of four different fabric groups and several individuals reveals a more complex picture of production traditions, pottery exchange and consumption than often assumed for this period of supposed recession and socio-cultural transition. Potters' choices in different production locations are discussed, with an examination on the nature of consumption in two households that suggest both regional and inter-regional exchange of ceramics in the Late Bronze Age.

1. Introduction

Research on the complexity of pottery manufacture and consumption during the Late Bronze Age in the Iberian Peninsula remains a largely unexplored topic. While that research based on morphometric, functional or stylistic criteria has made progress in characterising ceramic assemblages from the point of view of typology or chronostratigraphy (e.g., Molina González, 1978; Ros Sala, 1989; Lorrio Alvarado, 2008; García Borja and Pérez Jordá, 2012), aspects of technological strategies, social practices and cultural conditioning involved in the design, manufacture, use and movement of pottery have been investigated in only a few cases.

There are two possible reasons for this. Firstly, the absence of pottery workshops or any archaeological remains related to ceramic manufacture in excavated LBA settlements, in contrast to other periods, has meant that detailed technological study has not been prioritised. Secondly, there exists a scarcity of petrographic or chemical analyses focused on the ceramic assemblages of this period, a prerequisite for the generation of important spatial and technological data for the archaeological study of craft. Although in recent years there has been a specific interest in the characterisation of the pigments used to decorate some late ceramic styles (Celestino Pérez et al., 2018; García Huerta, 2019), the analyses of general assemblages remain rare (Aranda-Contamina et al., 2018; Dorado Alejos, 2019; Galván Martínez, 1986; Olaetxea Elosegi, 2000).

In the Iberian Southeast, special attention has been dedicated to the immediately earlier and later periods, the Argaric Bronze and Early Iron Ages, notably in discussions over the existence or not of craft specialization in ceramic manufacture. This has been rather restrictive in focusing on an evolutionary view of the social, economic and political correlates of the perceived modes of pottery production. On the one hand, the existence of a specialised domestic industry has been suggested in the Argaric culture, but linked to households and whose work would be complementary to the family economy (Colomer, 2005; Aranda Jiménez, 2010; Albero Santacreu and Aranda Jiménez, 2014; Alarcón García and García García, 2019; Padilla Fernández et al., 2020). On the other hand, in the Early Iron Age there has been a traditional association of the manufacture of pottery as a subsistence or domestic activity, until the appearance of the potter's wheel and the double-chambered kiln after the Phoenician colonisation (Coll Conesa, 2000; García Fernández and García Vargas, 2012). This has tended to hold the Late Bronze Age as hostage to the narrative composed in earlier studies of these two periods, as well as being tied to an idea of specialization. However, the immediate appearance of local wheel-made ceramics, previously considered as Western Phoenician pottery, opens new lines of enquiry on autochthonous potteries and their own practices and traditions (Cutillas-Victoria et al., 2021).

* Corresponding author.
E-mail addresses: benjamin.cutillas@um.es, b.cutillas@inn.demokritos.gr (B. Cutillas-Victoria), p.m.day@sheffield.ac.uk (P.M. Day).

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The emphasis on evolutionary technological perspectives, such as the appearance of the potter's kiln, also leaves unexplored a number of other approaches to the study of the location, scale and intensity of production (Calvo Trías and García Rosselló, 2014; Roux, 2019), but especially to the exchange and consumption of pottery, which might shed broader light on the ceramic world of the LBA. While the concept of craft specialization itself is not without its problems, we follow the converging arguments that define it as economic activity limited to a small percentage of the individuals in each community, as a full- or part-time occupation, and in which the consumers are not members of the same household as the producers (Earle, 1981; Costin, 1991; Clark, 1995).

If we are interested in assessing whether pottery specialization existed, there are several aspects that can be explored. Given the lack of excavated production locations, one alternative that has been proposed is the study of the standardisation and homogeneity of ceramic products themselves. Such an approach has been developed for the Argaric Bronze Age to the point of suggesting centralised control of this economic activity (Lull Santiago, 1983; Aranda Jiménez, 2004). Nevertheless, the situation during the LBA is clearly different at a political and territorial level because of the atomisation of territories and the accompanying increased variation in the size and shape of pottery vessels (Ros Sala, 1989; Lorrio Alvarado, 2008). However, while the close correlation of standardisation and specialization has been argued broadly in a variety of chronological geographic contexts (e.g., Benco, 1987) the relationship is by no means universal (Arnold, 2000; Roux, 2003; Aranda Jiménez, 2010). Instead, a much broader view of where and how pottery was manufactured, as well as its post-production life is required.

The start of any such consideration is to determine valid groups within the ceramic assemblage, and to suggest where and how those groups may have been produced. Such a picture allows us to trace the exchange of ceramic products and, crucially, to address the choices that end-users made in consuming pottery. In essence, reconstructing these networks of exchange and consumption is more productive than focusing on the restrictive quest for recognising specialization.

It is in illuminating the place of pottery in terms of *both* its production and consumption, that we present the petrographic and mineralogical characterisation of a ceramic assemblage from the settlement of Cobatillas la Vieja (Santomera, Región de Murcia, Spain). The research programme was based on information from previous excavations and works at the site (Lillo Carpio, 1981; Ros Sala, 1985), and it had three broad objectives:

1. To define the fabrics present at the site, to propose clay catchment areas and, where possible, to suggest provenance.
2. To reconstruct the practices involved in the choice and manipulation of raw materials and the technological choices involved in pottery making, including the firing process.
3. To examine the range of pottery consumed in two households at the site.

Within this framework, the ceramic study led to the characterisation of more than one centre of regional ceramic production, but also the identification of fabrics imported from outside the area, revealing an extensive network of exchange of pottery vessels.

2. Archaeological context of the site

Cobatillas la Vieja (CBV) is located on three contiguous hills in the pre-coastal basin of the Guadalentín-Segura rivers (Fig. 1). It has a substantial, discontinuous occupation sequence from the Argaric Bronze Age to the Late Iberian period (Table 1), with the settled areas shifting between different elevations (Lillo Carpio, 1981; Ros Sala, 1985; Medina

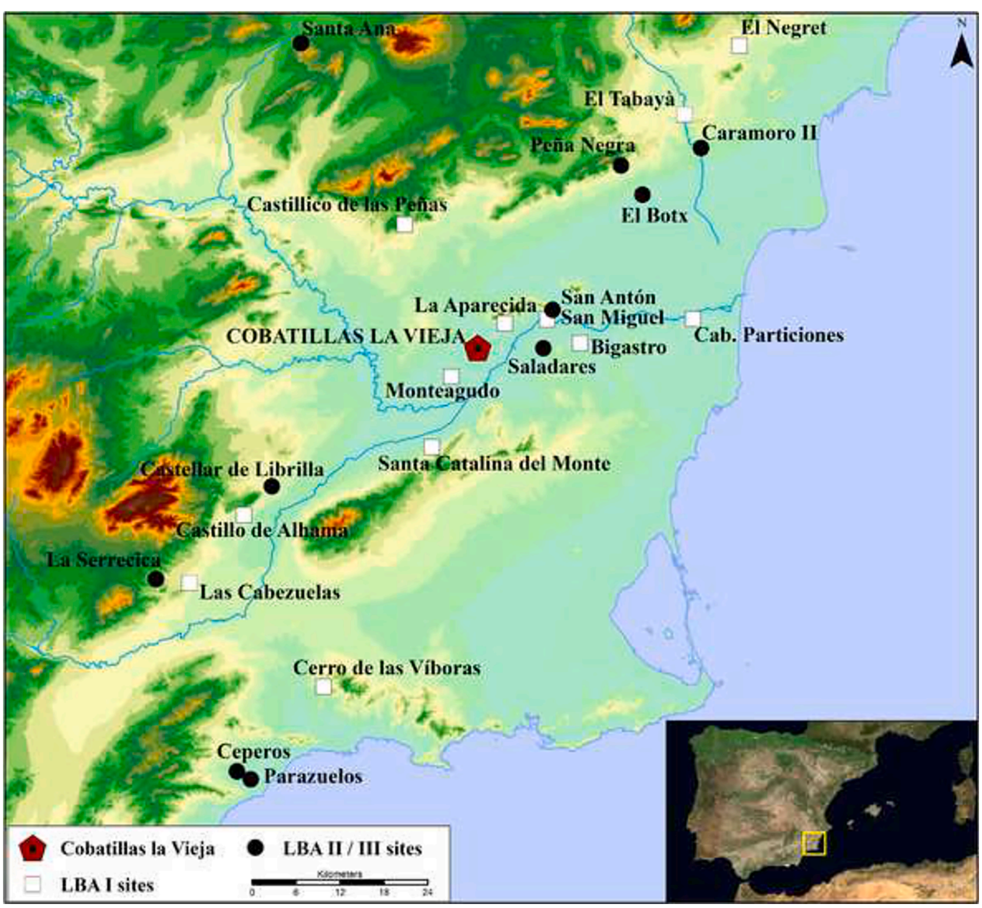

Fig. 1. Location of Cobatillas la Vieja in the context of LBA Southeast Iberia (Source: Cutillas Victoria after MDT Spanish National Geographic Institute).

Table 1
Chronology of Bronze and Iron Ages in the Iberian Southeast.

Chronology	
Archaeological Period	Phase/Stage
Argaric Bronze Age	2200–1550/1500 BCE
Post-Argaric Bronze Age	1550/1500–1300/1250 BCE
Late Bronze Age I	1300/1250–1050/1000 BCE
Late Bronze Age II/III	1050/1000–800/750 BCE
Early Iron Age	800/750–500 BCE
Iberian Iron Age	500–200 BCE

Ruiz, 1999). In the case of LBA structures, these appeared together with the Iberian Iron Age occupation (4th century BCE, see Lillo Carpio, 1981), but were separate from the Argaric Bronze Age settlement, identified on the adjoining hill (Ayala Juan, 1981; Medina Ruiz, 1999) (Fig. 2A).

The settlement is considered one of the earliest settlements of the LBA, with a date of c.1298 cal BC (calculated ranges 1400–1195 BCE) obtained by radiocarbon dating of a charcoal sample (Lillo Carpio, 1981; Castro Martínez et al., 1996). This date points to the beginning of a horizon that, in line with the study of the ceramic assemblage developed (Ros Sala, 1985), places the LBA occupation in the initial stage of the period. At that time, the Iberian Peninsula was subject to colder and

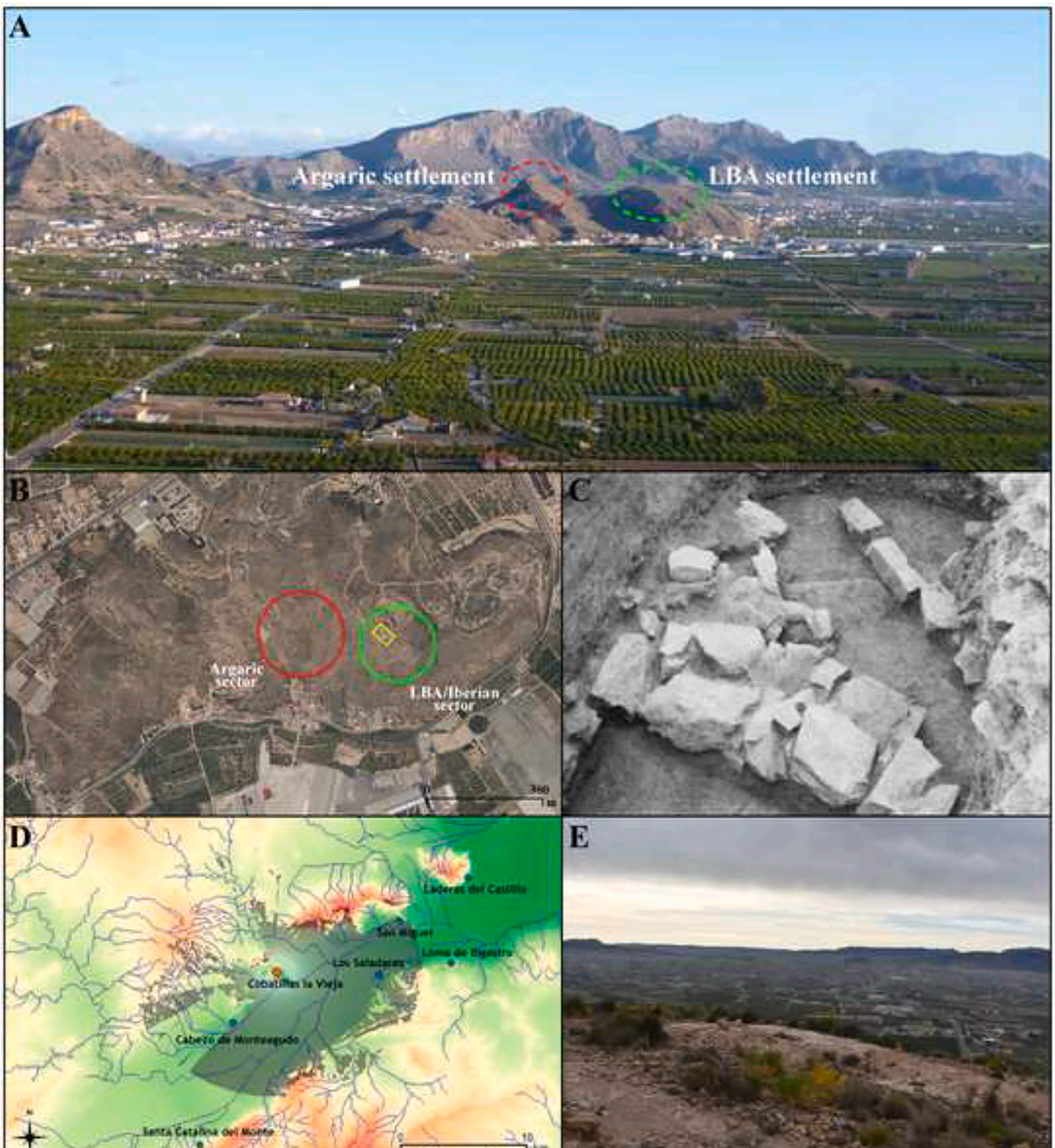

Fig. 2. Cobatillas la Vieja: A) site environment next to the Segura river basin (© J.F. López Ortigosa); B) Distribution of occupied areas on a current aerial image (Source: PNOA Spanish National Geographic Institute). C) LBA structures of Sector Ñ (Lillo, 1976-78: 399); D) Visibility analysis since the LBA occupation (Cutillas and López, 2020: 125); E) View from CBV of the lower basin of the Segura River (© B. Cutillas-Victoria).

drier climatic conditions that coincided with the development of the LBA in other regions of Mediterranean Europe (Navarro Hervás et al., 2014; Iacono et al., 2021). This has been argued to have contributed to the decline evident in Post-Argaric communities and to the reorganisation of the human groups into a new political and territorial landscape in the region from 1300/1250 cal BC. (Castro Martínez et al., 1996; Jover Maestre et al., 2016).

Although some settlements were abandoned during this transitional period, those that continued do not show evidence of drastic change and still others flourished as new foundations, as in our case study. The continuity in the internal layout of settlements and building traditions (Cutillas Victoria and López Ortigosa, 2020) suggests the maintenance of traditions from the Middle Bronze and Post-Argaric periods among these communities, a continuity also evident in ceramic assemblages.

LBA pottery presents a high degree of typological homogeneity, a complete absence of decoration and a series of archaising features that reveal its close link to Argaric forms and aesthetics (Molina González, 1978; Ros Sala, 1985), though with changes in some of the main shapes. In the specific case of CBV, the typological and frequency analysis of the ceramic assemblage (Cutillas Victoria and López Ortigosa, 2020) reveals the importance of jars and large containers intended for storage and possible transport, exceeding 50 % of the identified significant individuals; thereafter, tableware stands out (>33 %), mainly represented by open bowls, although there are also some forms of dishes and a plate. Finally, cooking pots and closed jars linked to cooking and small storage tasks are less frequent, with barely 16 % of the total.

The abandonment of forms linked with the display of food and collective consumption, such as the large troncoconical and carinated bowls, leads to a prominence of individual serving vessels, mainly the small bowl for individual consumption that has a prominence already seen during the Argaric period (Delgado-Raack and Risch, 2015). There were also innovations in food preparation vessels, such as the incorporation of a flat base to the cooking pots. This change has been linked to a growing importance of solid foods in diets (Sánchez Romero and Aranda Jiménez, 2005), but may also be explained by modifications in the cooking strategies, such as the use of grills or cooking by proximity to the fire.

At a territorial and landscape level, CBV should be understood in connection to its geostrategic position, taking advantage of the agricultural resources available in the alluvial plain of the Segura river, as well as the livestock routes associated with the nearby Rambla Salada that connects to the interior of the peninsula (Ros Sala, 1985). The specific position of LBA settlement on a precipitous hill with natural defences allowed for its visual control of the valley it overlooked (Cutillas Victoria and López Ortigosa, 2020), including other settlements and key routes (Fig. 2B). Other activities would also probably be important in the local economy, such as the exploitation of salt of the Rambla Salada salt flats, or mining taking advantage of the nearby iron and copper outcrops of Sierra de Orihuela (Ros Sala, 1985). The identification of galena and iron ore in dwelling Ñ5 could suggest the existence of transformative activities in the settlement (Cutillas Victoria and López Ortigosa, 2020).

3. Sample and methods

Thirty pottery samples were selected from the lowest levels of the stratigraphic sequences of Sectors M and Ñ (Supplementary material Table 1; Fig. 2C), specifically-two LBA households identified during excavations in 1975 and 1976 (Lillo Carpio, 1976–1978; Lillo Carpio, 1981; Ros Sala, 1985; Cutillas Victoria and López Ortigosa, 2020). Despite the limited excavation data available, the LBA contexts were found close to each other on the hilltop, although their stratigraphic sequences suggest certain differences that allow their consideration as distinct units (Lillo Carpio, 1981). The household remains resting directly on the bedrock, are located in settlement contexts associated with rectangular constructions, similar to those in other sites dating to the transition between the Post-Argaric Period and the first centuries of the Late Bronze Age (Cutillas Victoria and López Ortigosa, 2020). The 17 pottery samples from Sector Ñ come from stratigraphic level Ñ5/Ñ6, associated with a domestic space where the charcoal sample for radiocarbon analysis was obtained (Lillo Carpio, 1976–1978; Castro Martínez et al., 1996), while the 13 samples of levels M3 and M5 derive from another domestic context where daily activities are evidenced by faunal remains and a stone crusher (Lillo Carpio, 1981).

The samples were chosen to be representative of the main ceramic types from the settlement (Ros Sala, 1985), characterised by their shape and consistent pattern of surface finishes, determined in a programme of macroscopic examination (Cutillas, 2020; Cutillas Victoria and López Ortigosa, 2020). The general homogeneity of the ceramic assemblage studied (Ros Sala, 1985; Cutillas Victoria and López Ortigosa, 2020), reflected in the consistency in the analytical samples, shows its close dating to the initial phase of the LBA, without apparent residual or later materials. The individuals represent table, cooking and storage wares (Table 2), most were burnished, regardless of type; in some cases this treatment was very carefully executed, and absent in a few untreated examples. The Almagra surface finish of sample CBV019, is a characteristic thick red slipped and burnished finish ultimately derived from Neolithic traditions and whose continuity has been attested in other LBA settlements (Buero Martínez, 1987–88). Almagra pottery is, however, totally rare in CBV.

After macroscopic study, the samples were analysed by thin-section petrography, X-ray diffraction (XRD), scanning electron microscopy (SEM) and by binocular microscopy. The samples were grouped and described with reference to the system developed by Whitbread (1995). To characterise the mineralogical composition, X-ray diffraction (XRD) was applied with a Bruker D8 ADVANCE (q–goniometer) X-ray powder diffractometer, with Cu K-alpha radiation, equipped with an LynxEye detector with active length of 2°. The sizes were taken from 5 to 45°2Θ with a measure step of 0.05° and an acquisition time of 2 s per step. The identification of the crystalline phases of each sample has also been used to estimate the equivalent firing temperature (EFT) of the analysed ceramics (Roberts, 1963; Picon, 1973; Tite et al., 1982; Heimann and Maggetti, 2014; Gliozzo, 2020).

Finally, a selection of samples, covered with a colloidal silver and a

Table 2
List of analysed samples from Cobatillas la Vieja according to the type of finish: A - Almagra (red slipped and burnished); B - burnished; S - smoothed; U - untreated.

Archaeological Context	Methods	Table Ware ($n = 15$)			Cooking Ware ($n = 4$)	Storage Ware ($n = 11$)		Total
		Bowl	Dish	Plate	Cooking Pots	Open Jar	"S" profile jar	
Sector M ($n = 13$)	XRD-OM-BM	CBV002^{B}, 003^{B}, 005^{B}, 010^{S}	- -	CBV004^{B}	- -	CBV016^{B}, 018^{S}, 020^{B}, 022^{S}	CBV019^{A}, 026^{U}	11
	XRD-OM-BM-SEM	- -	- -	- -	CBV021^{B}	CBV017^{B}	- -	2
Sector Ñ ($n = 17$)	XRD-OM-BM	CBV001^{B}, 007^{B}, 011^{B}, 012^{B}, 014^{B}, 015^{B}	CBV008^{S}, 013^{S}	- -	CBV023^{S}, 024^{B}	- -	CBV027^{S}, 028^{B}, 29^{B}	13
	XRD-OM-BM-SEM	CBV006^{B}	CBV009^{S}	- -	CBV025^{S}	CBV030^{U}	- -	4
Total		11	3	1	4	6	5	30

carbon layer, was examined on an ApreoS Scanning Electron Microscope (Thermo Fisher, MA-USA) in high vacuum conditions, attached to an EDAX octane plus (AMETEK) X-ray energy dispersive spectrometer (EDS).

4. Results

4.1. OM petrographic results

Thin section optical microscopy (Fig. 3) allowed the distinction of four fabric groups containing the majority of samples (Fabrics 1, 2, 3 and 4), with a further four classes formed by loner individuals (Fabrics 5, 6, 7 and 8). Individual samples for each fabric group are listed below in Table 3.

Fabric 1: fine clay with poorly sorted, altered coarse subvolcanic rocks, with added grog and vegetal temper (n = 4. c:f:v: ca. 20:75:5). Aplastic inclusions are distributed according to a bimodal grain-size scheme, close to double spaced. The coarse fraction (<0.03 mm) contains inclusions from coarse silt to rounded and sub-rounded coarse sands. It is composed of metabasites, formed from the metamorphism of basic igneous rocks and altered by chlorite, with added grog temper. Other, less frequent aplastics include quartz, opaque minerals and pyroxenes, and CBV024 contains isolated microfossils (planktonic foraminifera, globigerinids). Voids have a *meso* to *macro* size with elongate and angular shapes, some of which may result from vegetal temper, of which CBV012 contains carbonised remains. The clay matrix and fine fraction are non-calcareous, and contain single to open space quartz and opaque minerals. The colour of the groundmass is very

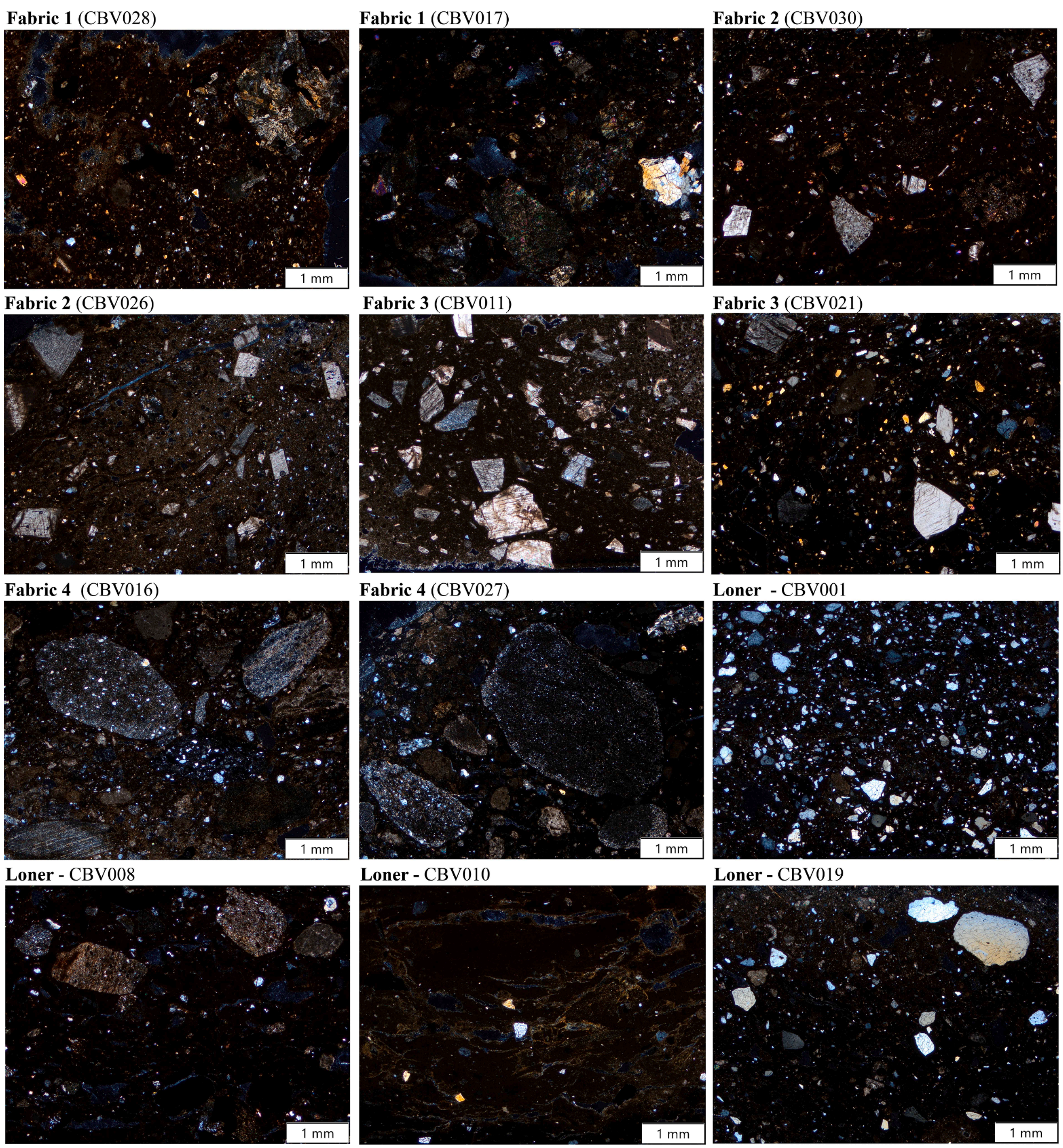

Fig. 3. Representative photomicrographs of fabrics identified in Cobatillas la Vieja, crossed polars (XP).

homogeneous, brown to black in PPL. In terms of typology, the four samples that define this fabric are a table ware bowl, two storage jars and one cooking pot.

Fabric 2: fine clay with altered subvolcanic rocks, and added calcite, vegetal and grog temper (n = 2. c:f:v: ca. 20:75:5). The aplastic inclusions have a bimodal grain-size distribution and the coarse fraction comprises double to open spaced, coarse silt to coarse sand. The coarse fraction is composed of altered igneous rocks, mainly metabasites with chloritic alteration, and common grog and calcite temper. Less frequent inclusions include quartz, pyroxene, and opaque minerals. The clay matrix is non calcareous, with quartz and opaque minerals, and a groundmass that varies in colour between the inner and outer surfaces. Voids are few, *meso* to *macro*, rounded and elongate, some of which contain remnants of vegetal temper. The colour of the groundmass is very similar to the previous group: homogeneous and brown to black in PPL. This group is composed of two untreated vessels: an open storage jar and an "S" profile jar.

Fabric 3: very fine clay with dominant, poorly sorted added calcite, and vegetal and grog temper (n = 12/c:f:v: ca. 10:85:5). The aplastic inclusions have a bimodal pattern of grain-size, with a single to double spaced coarse fraction ranging from coarse silt to angular granules. The inclusions are dominated by angular added calcite, and less frequent grog temper. Coarse aplastic inclusions also include quartz, pyroxene, and opaque minerals. Voids, some with secondary calcite lining, are of *meso* and *macro* size with elongate shape, associated with vegetal temper, confirmed by carbonised remains in CBV007. The clay matrix is non calcareous, with greyish brown to black colour in PPL, varying between the inner and outer surfaces. The fine fraction contains open to double spaced quartz, calcite and opaque minerals. Microfossils occur in samples CBV013 and CBV022 (planktonic foraminifera, ostracods). This fabric is quite homogeneous and comprises a significant proportion of the Cobatillas la Vieja assemblage, especially the tablewares, although there is also a cooking pot and two storage jars amongst the twelve samples in this group.

Fabric 4: very coarse low-grade metamorphic and sedimentary rocks, with added grog and vegetal temper (n = 8. c:f:v: ca. 40:50:10). The groundmass and aplastic inclusions are very homogeneous in this fabric, with a bimodal grain-size pattern of single to double spaced inclusions. The coarse fraction is dominant, with low-grade metamorphic and sedimentary rocks, such as schist, mica schist, or quartz arenites, and coarse grog temper. Additionally, quartz, dolomite, opaque minerals, phyllites and biotite were observed. Some dolomite inclusions show signs of greenish colouration. *Micro* to *meso* size voids have elongate shapes and, together with the carbonised remains in CBV002 and 018 demonstrate the use of vegetal temper. The clay matrix is non calcareous and contains single to double spaced quartz. The groundmass is consistently brown to black in PPL. Despite including varied vessel types - two tablewares, two cooking pots, and four storage jars -, the members of this fabric are very consistent in their composition and texture.

Fabric 5: clay rich in quartz, grog and vegetal temper (n = 1. c:f:v: ca. 30:68:2). Coarse fraction contains single to double spaced, coarse silt to coarse sand of dominant quartz, few opaque minerals, small grains of grog, and very few remains of vegetal temper. The fine fraction is non calcareous and has common quartz and few opaque minerals, while the colour of the groundmass is homogeneous, brown to black in PPL. There are *micro* to *meso* sized vughs and channels, some of the latter containing remains of vegetal temper. This sample is a burnished low carinated bowl, unique at the site.

Fabric 6: coarse, low-grade metamorphic and sedimentary rocks with added grog (n = 1. c:f:v: ca. 30:60:10). The aplastic inclusions have a bimodal grain-size distribution with a single to open spaced coarse fraction comprising coarse silt to very coarse sand. It includes metamorphic rock fragments (with quartz, white mica), coarse quartz-arenites, opaque minerals probably related with ferruginous rock, and rounded grains of grog temper. The fine fraction contains quartz, opaque minerals, epidote and muscovite. The groundmass is homogeneous, dark brown to black in PPL. Voids are common, *micro* to *meso* vughs and channels. The sample belongs to a group of smoothed dishes found in Sector Ñ.

Fabric 7: fine, loosely packed clay with very few quartz inclusions (n = 1. c:f:v: ca. 10:85:5). The microstructure of the section is characterised by the loosely packed groundmass, with open-spaced quartz and opaque minerals. Aplastic inclusions range from fine silt to coarse silt, in a homogeneous groundmass that is dark brown to black in PPL. There are frequent vughs and vesicles. This sample is a smoothed bowl.

Fabric 8: aeolian quartz in a microfossiliferous clay with added grog, calcite and vegetal temper (n = 1. c:f:v: ca. 20:75:5). The bimodal distribution of aplastic inclusions features a non-calcareous fine fraction with common quartz, and a single to open spaced coarse fraction of coarse silt to very coarse sands, containing common monocrystalline aeolian quartz with few ostracod microfossils and fossilised shell fragments. Vegetal temper, grog and rare angular crystals of calcite appear to be added by the potter. Few, *micro* to *meso* size voids are rounded and elongated, some containing carbonised remains of vegetal temper. Aeolian quartz is typical of inland or coastal aeolian deposits, but not with the area around CBV. This reinforces the suggestion of this vessel as an import, something already suspected, as the only example in the settlement with an Almagra surface finish.

4.2. Mineralogical and microstructural analysis

The mineralogical compositions of the 30 individuals analysed by X-ray diffraction (XRD) allow further comment on the nature of the four main groups and four individuals classified by petrography. XRD can be useful to characterise the mineral phases and microstructures of the samples (Buxeda i Garrigós and Madrid, 2017), and as the basis for the reconstruction of pottery firing processes (Roberts, 1963; Picon, 1973; Tite et al., 1982; Gliozzo, 2020). The study of the diffractograms of the four groups and individuals indicates a generally low equivalent firing temperature (EFT), although there are small differences, allowing further characterisation of each fabric at the mineralogical level (Table 3).

In consideration of fabric groups 1 and 2, which are very similar in petrographic terms, XRD-Group 1 (n = 4) and XRD-Group 2.1 (n = 1) exhibit consistent mineral phases: illite-muscovite, chlorite, quartz, alkali feldspar, quartz, calcite, albite, amphibolite and hematite. Only XRD-Group 2.2 (n = 2) differs due to the absence of albite, amphibolite and hematite, although chlorite peaks are clearly present. In our case, moreover, the identification of chlorite matches with its recognition in thin section. The latter suggests a very low EFT of below 700 °C, a temperature at which these minerals should have been thermally decomposed (Fig. 4). The same conclusion is drawn from SEM examination, where the individuals examined no evidence for sintering, even at the initial stage (Fig. 5).

XRD-Group 3 (n = 12) confirms the frequency of calcite observed as in thin sections of Fabric 3, where it appears as calcite temper, and secondary calcite. Group 3.1 (n = 7) contains illite-muscovite, quartz, alkali feldspar, and calcite, while group 3.2 (n = 4) also presents peaks of dolomite (Table 3). The absence of firing phases suggests a low EFT (Fig. 4), below < 800 °C for Group 3.1, and certainly below < 700 °C for Group 3.2, as suggested by the presence of dolomite. SEM images show no vitrification and confirm the low estimate of EFT (Fig. 5). An exception is Group 3.3 (n = 1) which also contains pyroxene, particularly visible at 3.01 Å (29.60°2θ), which coexists with the three characteristic peaks of illite, as well as the absence of gehlenite, indicating an EFT in the range of 800–850 °C. Although higher than the EFT for other samples, these latter estimates are achievable in bonfires or pit firing (Maggetti et al., 2011).

Table 3
Mineralogical fabrics, sintering state and estimated EFT of the analysed samples from Cobatillas la Vieja based on XRD and SEM results. Afs: alkali feldspar; Ab: Albite; Amp: Amphibolite; Cal: calcite; Chl: Chlorite; Dol: Dolomite; Ep: Epidote; Hem: hematite; Ilt: illite-muscovite; Mnt: Montmorillonite; Pl: plagioclase; Px: pyroxene; Qz: quartz. Abbreviations according to Whitney and Evans (2010). *Individuals observed by SEM ($n = 6$). *NV*, no vitrification.

Petrographic fabric	XRD group	Mineralogical assemblage	Individuals	Sintering stage	EFT
Fabric 1 (n = 4)	CBV-1 (n = 4)	Ilt, Chl, Qz, Afs, Cal, Ab, Amp, Hem	CBV012, 017*, 024, 028	NV	<700 °C
Fabric 2 (n = 2)	CBV-2.1 (n = 1)	Ilt, Chl, Qz, Afs, Cal, Ab, Amp, Hem	CBV030*	NV	<700 °C
	CBV-2.2 (n = 1)	Ilt, Chl, Qz, Afs, Cal, Amp	CBV026	–	<700 °C
Fabric 3 (n = 12)	CBV-3.1 (n = 7)	Ilt, Qz, Afs, Cal	CBV003, 005, 006*, 013, 014, 015, 022	NV	<800 °C
	CBV-3.2 (n = 4)	Ilt, Dol, Qz, Afs, Cal	CBV007, 011, 021*, 029	NV	<700 °C
	CBV-3.3 (n = 1)	Ilt, Px, Qz, Afs, Cal	CBV004	–	800–850 °C
Fabric 4 (n = 8)	CBV-4.1 (n = 7)	Ilt, Dol, Qz, Afs, Cal	CBV009*, 016, 018, 020, 023, 025*, 027	NV	<700 °C
	CBV-4.2 (n = 1)	Ilt, Qz, Afs, Cal	CBV002	–	<800 °C
Fabric 5 (n = 1)	Loner CBV001	Ilt, Qz, Cal	CBV001	NV	<800 °C
Fabric 6 (n = 1)	Loner CBV008	Ilt, Ep, Qz, Afs, Cal	CBV008	–	<800 °C
Fabric 7 (n = 1)	Loner CBV010	Ilt, Qz, Afs, Cal, Pl	CBV010	–	<800 °C
Fabric 8 (n = 1)	Loner CBV019	Ilt, Qz, Afs, Cal	CBV019	–	<800 °C

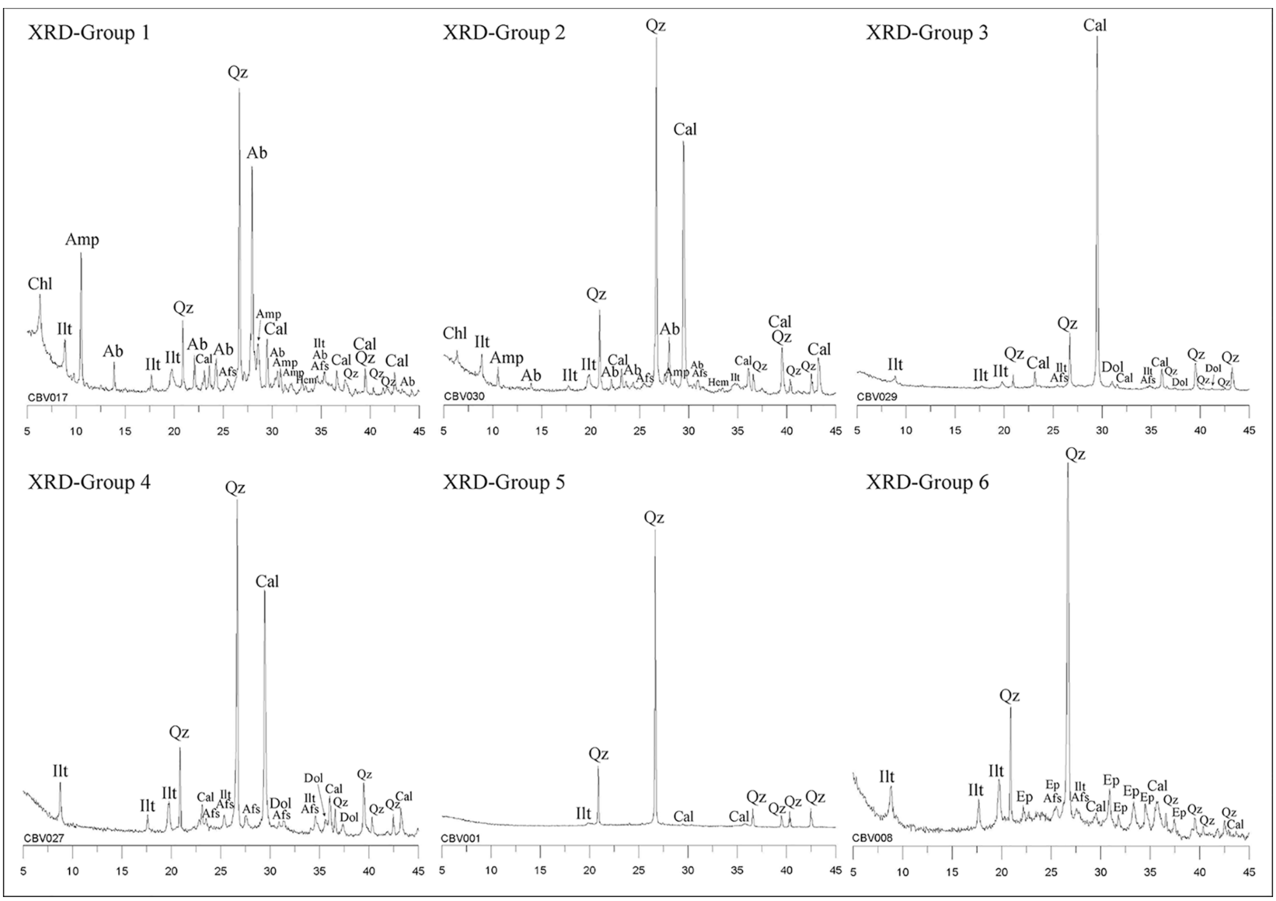

Fig. 4. XRD patterns for the categories of association of crystalline phases as detected by XRD. Afs: alkali feldspar; Ab: Albite; Amp: Amphibole; Cal: calcite; Chl: Chlorite; Dol: Dolomite; Ep: Epidote; Hem: hematite; Ilt: illite-muscovite; Qz: quartz. Abbreviations according to Whitney and Evans (2010).

XRD-Group 4.1 (n = 7) and XRD-Group 4.2 (n = 1) both exhibit illite-muscovite, quartz, alkali feldspar and calcite, but are differentiated by dolomite (Fig. 4). The presence of dolomite peaks in the first group suggests a very low EFT, confirmed by SEM (Fig. 5), while its absence in G-4.2 suggests a slightly higher EFT, perhaps explaining the lower angles of the illite-muscovite peaks.

The four individual samples do not exhibit firing phases, and the presence of chlorite or dolomite (Fig. 4; Table 3) suggest an EFT below 700 °C, and seem similar to the rest of the LBA assemblage. It is important to note that CBV008 has epidote peaks (JCPDS #01–089–0460), and CV001 almost no crystalline phases (Fig. 4; Table 3), which reveals the existence of different mineralogical compositions. Therefore, the loner samples are suggested to have EFTs below 800 °C, in line with the most common data for firings conducted in open structures or pit firings (Roux, 2019; Gliozzo, 2020).

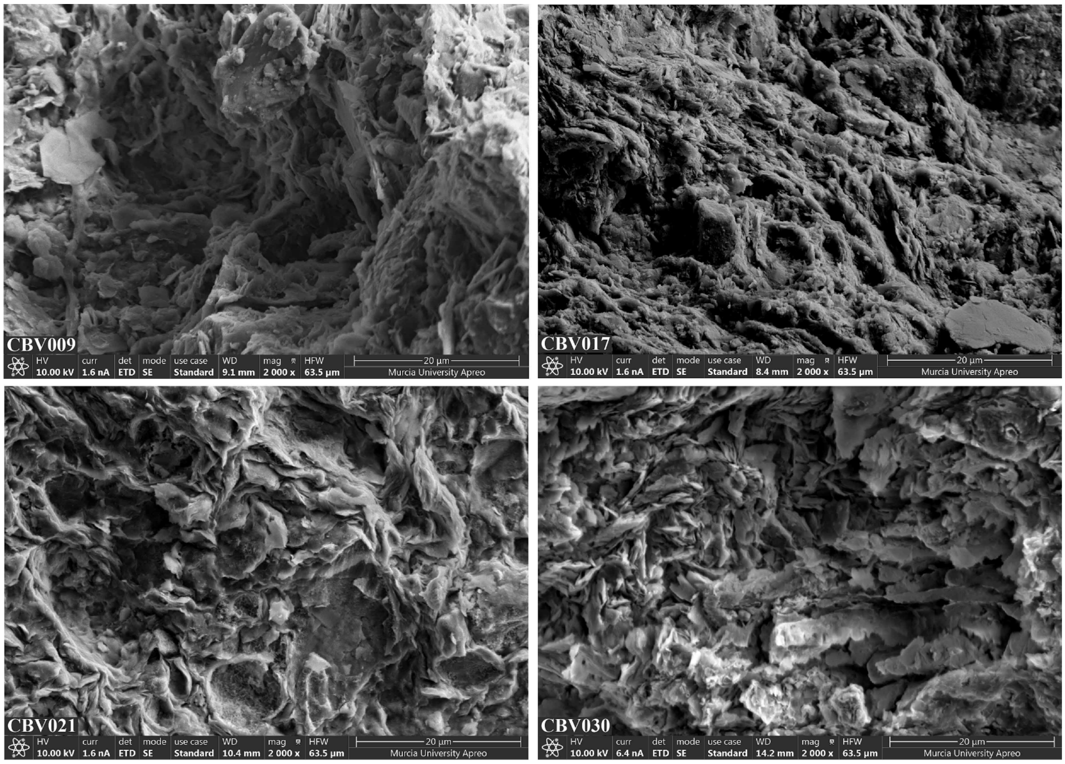

Fig. 5. SEM photomicrographs showing the ‘no vitrification’ stage in individuals from Cobatillas la Vieja: (A) CBV009 (CBV-F4, XRD group 4.1); (B) CBV017 (CBV-F1, XRD group 1); (C) CBV021 (CBV-F3, XRD group 3.2); (D) CBV030 (CBV-F2, XRD group 2.1).

5. Discussion and archaeological implications

5.1. Production units and provenance

The geology of the lower valley of the Segura River is made up of Neogene and Quaternary deposits, the latter resulting from sedimentation and marked subsidence since the Pliocene. There are also occurrences of the Alpujárride complex in the northern part of the basin, specifically in Sierra de Orihuela and its western foothills, as well as from the Alpujárride and Maláguide complexes in the south of the Sierra de Carrascoy (Aldaya et al., 1982).

Small outcrops of the Ballabona-Cucharón complex are also of note near the site of CBV. This complex is made up of a series of differentiated units within the lower Alpujárrides units, characterised by very low-grade regional metamorphism and hydrothermal activities associated with a late stage of the Alpine orogeny (Arana Castillo and Ortiz, 1981). One of the more important characteristics of this geological formation is the at times abundant altered basic igneous rocks such as metabasites. Indeed, there are important outcrops of this type of rock on the northern slopes of CBV (Fig. 6) with their related minerals such as chlorite and amphibolite (Arana Castillo and Ortiz, 1981; Jaén García et al., 1987).

In this regard, the petrographic and mineralogical characteristics of

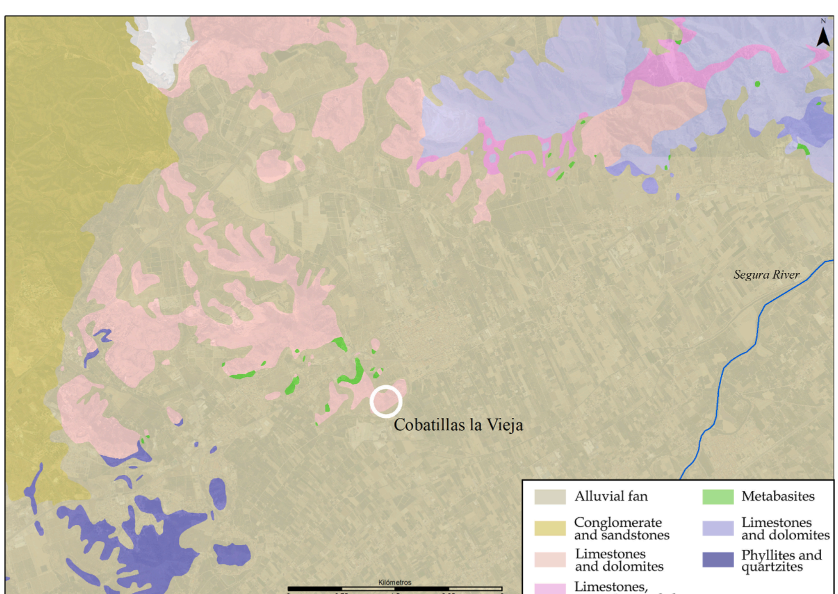

Fig. 6. Geological map of Cobatillas la Vieja (Source: Cutillas Victoria after Geological and Mining Institute of Spain).

Fabrics 1 and 2 are compatible with the production of ceramics from the clays available around the settlement. The peaks of chlorite, albite and amphibolite detected in XRD results are also present in the metabasite outcrops of the area (Jaén García et al., 1987). In thin section, the characteristics of some aplastic inclusions are also compatible, mainly the coarse subvolcanic rocks – metabasites – and the alteration products of their constituent plagioclase and amphibole, which appear altered to chlorite. These inclusions are similar to those analysed from nearby outcrops, and their origin is probably due to hydrothermal activity (Arana Castillo and Ortiz, 1981; Jaén García et al., 1987).

The fine clay matrix in both Fabrics 1 and 2, which has few aplastic components, is compatible with the alluvial fan that borders this group of hills to the east, coinciding with the mouth of the Rambla Salada, and to the south, with the Segura basin. The addition of crushed calcite as temper allows the separation of Fabric 2, but is a technological choice that does not preclude a shared source of the main clay body with that of Fabric 1.

Fabric 3 is characterised by an even finer clay matrix, with only rare inclusions in the coarse fraction, other than the intentional addition of calcite, grog and vegetal matter as temper. This also is compatible with Neogene and Quaternary deposits, raising an important question about provenance, since the characteristics of the matrix and groundmass suggest that its catchment area could be similar to the previous groups. Importantly, however, the subvolcanic inclusions are absent in Fabric 3, and the mineralogical data from XRD also suggest a clear difference. Therefore, while these ceramics are compatible with Quaternary deposits and alluvial fans of the broader area, the lithological differences sets them apart from Fabric 1 and 2, and clearly represent a different production unit.

In contrast, in thin section Fabric 4 is dominated by very coarse, low-grade metamorphic and sedimentary rocks. Although such a lithology is not atypical of the lower Segura basin, without comparative material from other contemporary sites, it is difficult to suggest a source for this distinctive fabric. Even though XRD and petrography testify to the presence of dolomite, the identification of quartz arenite, metamorphic rocks and phyllite indicates a geological environment more conditioned by cones and alluvial fans, probably located in foothills of higher mountain ranges. This environment could be compatible with the westernmost foothills of Sierra de Orihuela (Fig. 6), which are well connected with the settlement of CBV. Therefore, in this case also, there is the possibility of a broadly local provenance, though it too comprises a distinctive clay recipe which contrasts with the other three main fabrics. Fabric 4 represents a type of pottery clearly brought in from outside the locality of CBV, illustrating the exchange of pottery between nearby communities in a *micro*-regional orbit.

Finally, while it is difficult to suggest the precise provenance of the ungrouped individuals (CBV001, CBV008, CBV010 and CBV019), their petrographic composition and mineralogical structure indicate an origin outside of the immediate area. In terms of morphology and surface modification, the low carinated bowl (CBV001) and the storage jar with Almagra finish (CBV019) stand out, with no other examples in the site assemblage. Both macroscopic study and analysis indicates that these were exchanged through the developing intra-regional networks of these time period. The fact that three of these individuals are tableware suggests the value of LBA pottery an exchange item for its own sake, rather than any potential contents.

5.2. Technological aspects

Besides some 'imported' pottery at the site, the characterisation of the ceramic assemblage has led to the recognition of four distinct main fabric groups, representing at least three different sources and a number of different clay recipes. Such choices in the selection and combination of raw materials comprise an important component of skilled practice and tradition. With time, such analyses allow the investigation of the transmission of knowledge and the expression of identity (Lemonnier, 1993; Gosselain 1998). As such, an approach which characterises and interprets the fabrics identified here in terms of their technology, and therefore the practices of the potters behind them, is of importance for the study of this region at the beginning of the LBA.

Perhaps the most obvious technological feature of the main fabrics at CBV is the addition of grog temper across the entire assemblage, with the exception of one of the imported individuals (CBV010). Regardless of shape or finish, grog is a constant choice in the preparation of clays and shared by different production units, not only here, but also in other contemporary sites of the lower valley of the Segura River, such as Peña Negra (Seva Román, 1995) and Santa Catalina del Monte (Cutillas, 2020). Clearly this tempering practice was an important routine in the technical behaviour of the LBA potters, although it seems not to have been an innovation of this period. Despite the limited compositional analyses of prehistoric pottery in the area, it is clear that the use of grog temper is part of a broader regional tradition since the Neolithic (Seva Román, 1995; Del Pino Curbelo et al., 2021), and its continuity has been attested during the Argaric and Post-Argaric periods in ceramic assemblages from Laderas de Callosa, Caramoro I and Illeta dels Banyets (Seva Román, 1995). Calcite tempering has also been detected in other LBA settlements from the north of the Iberian Peninsula (Olaetxea Elosegi, 2000; Aranda-Contamina et al., 2018–2019).

Fabrics 2, 3 and 8 have crushed calcite added, in addition to grog and vegetal matter (Fig. 8). The presence of angular calcite differentiates Fabrics 1 and 2, which otherwise have the same, possibly Neogene, base clay with subvolcanic rocks. In this regard, there are two possible interpretations: two groups of potters using the same clays available around Cobatillas la Vieja, but applying different preparation patterns depending on whether or not calcite was added; or the same group of potters using different recipes in a relatively unstructured manner, as there is no clear correlation to shape and probable function. Here, the first option is considered more likely as, despite being a restricted number of samples, the members of Fabric 2 are the only pots in the CBV assemblage with untreated surfaces, in contrast to the burnished members of Fabric 1 (Fig. 7). Therefore both the deliberate tempering and the finishing of the ceramics allow us to propose clearly different technical choices.

Another additive used during the preparation of these clays was vegetal matter, recognised in 6 of our 8 fabrics, although with a generally low frequency. In some cases, the very low EFT of these ceramics allowed the preservation of vegetal remains, either as carbonised remnants or voids which have fine, elongate shapes (Fig. 8).

Firing conditions across the assemblage do not show obvious differentiation. In the case of all fabrics, EFTs are low, below 800 °C or 700 °C, with no evidence for sintering revealed by SEM. This is also shown by the presence of chlorite and dolomite peaks in the XRD diffractograms, and by the identification in thin section of carbonised remains of vegetal temper. The one exception, sample CBV004 of Fabric group 3, has incipient peaks of pyroxene, that may indicate direct exposure to fire during firing. Fire clouding is common on many of the sherd surface, through contact with fuel (Fig. 7), while some dark cores in cross-sections are indicative of incomplete oxidation, perhaps in short firing episodes (Fig. 8). These macroscopic observations combined with the XRD and SEM determinations suggest the pottery was produced in open or pit firing, though it is notable that no fine bloating pores were observed in the core that would be suggestive of very steep temperature gradients.

Overall, the CBV assemblage is largely undifferentiated in terms of shape and surface finish and the small differences in production technology suggested, as with the more obvious differences in provenance, do not correlate with shape, surface modification or presumed function (with the exception of the untreated finishes of Fabric 2). These characteristics define the early LBA ceramic assemblage, and reveal the specific shared practices of the potters of this period in the Iberian Southeast. This relative lack of structure in the assemblage has also been identified in the LBA settlement of El Sequero, in the middle Ebro valley (Aranda-Contamina et al., 2018–2019).

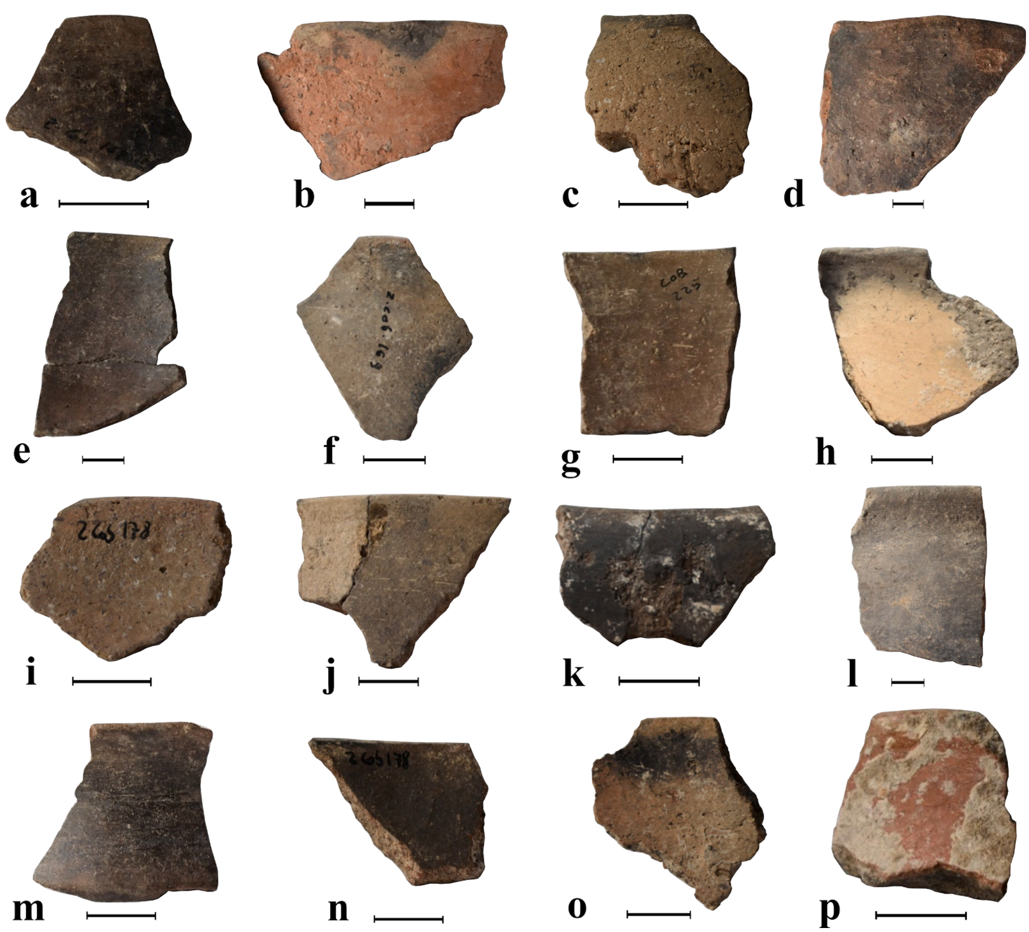

Fig. 7. Examples of LBA wares analysed from Cobatillas la Vieja. a. Burnished bowl CBV012 (Fab. 1). b. Burnished “S” profile jar CBV028 (Fab. 1). c. Untreated “S” profile jar CBV026 (Fab. 2). d. Untreated open jar CBV030 (Fab. 2). e. Burnished bowl CBV006 (Fab. 3). f Burnished bowl CBV014 (Fab. 3). g. Burnished cooking pot CBV021 (Fab. 3). h. Burnished “S” profile jar CBV029 (Fab. 3). i. Smoothed dish CBV009 (Fab. 4). j. Burnished open jar CBV020 (Fab. 4). k. Smoothed cooking pot CBV025 (Fab. 4). l. Smoothed “S” profile jar CBV027 (CLI-D, Fab. 2). m’ Burnished low carinated bowl CBV001 (Fab. 5). n. Smoothed dish CBV008 (Fab. 6). o. Smoothed bowl CBV010 (Fab. 7). p. Almagra “S” profile jar CBV019 (Fab. 8). Bar = 2 cm. (Photos: B. Cutillas-Victoria).

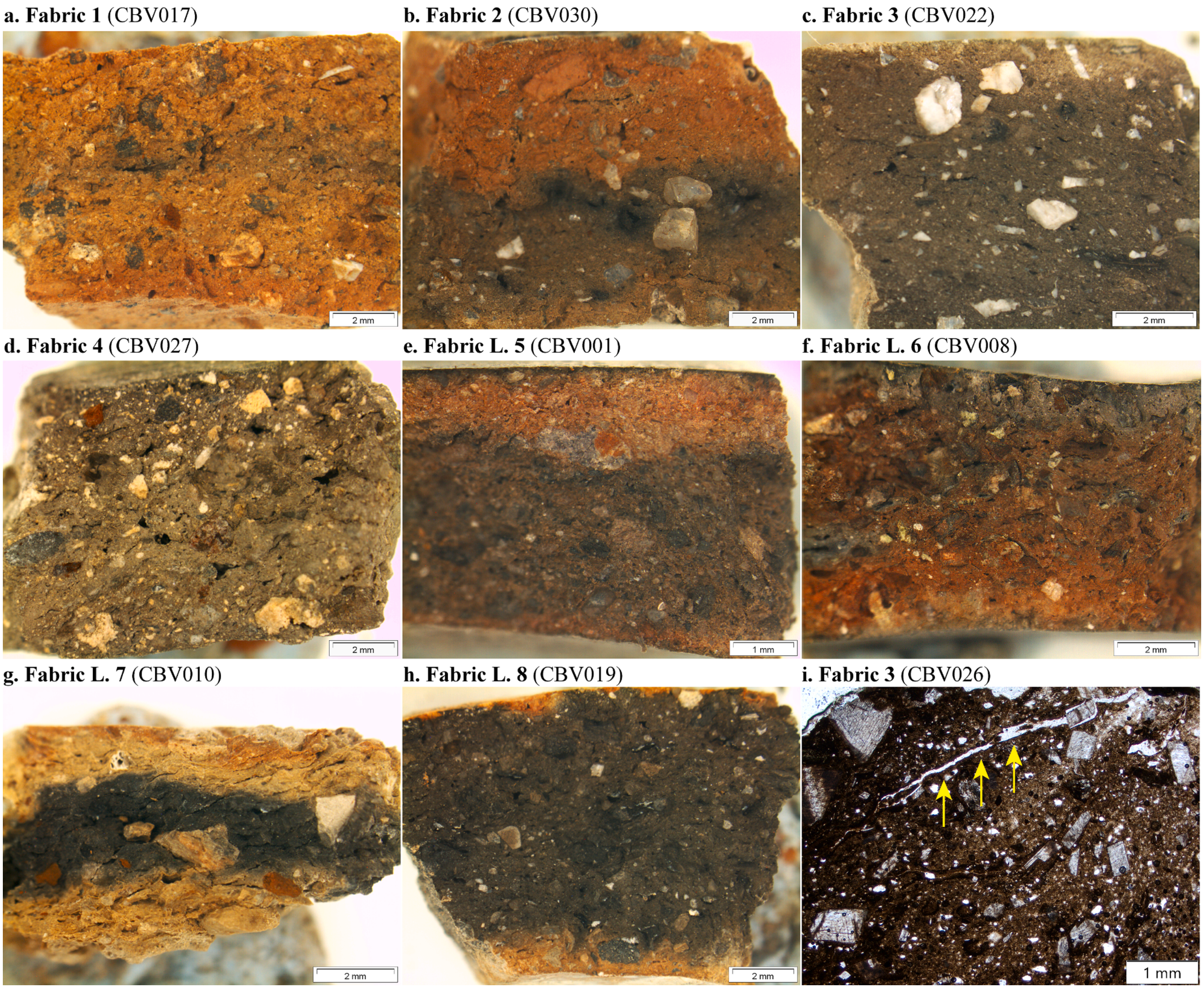

Fig. 8. Photographs of fresh breaks representing the main macroscopic fabric groups identified in the Cobatillas la Vieja assemblage, and example of thin section where remains of vegetal temper (8.i) has been identified (yellow arrows), plane polarized light (PPL).

5.3. LBA ceramic production, consumption and exchange networks

The macroscopic, petrographic and mineralogical study of pottery from CBV reveals an assemblage relatively undifferentiated by form, surface modification and function. Yet the analytical programme provides clear evidence for the manufacture of pottery in different production areas, and varied locations both within the region and beyond. In addition, as the samples were chosen from two different households, we have the potential to examine consumption choices in a society where pottery was clearly being widely exchanged.

There is clear evidence for local production to the site of CBV itself, demonstrated by the Fabrics 1 and 2, characterised by the presence of metabasites in a relatively fine clay matrix. The two fabrics are differentiated in the current grouping by the addition crushed calcite in Fabric 2, which matches differences in their respective surface finishes. It is common in ceramic studies for the addition of calcite to be used in very specific pottery types in terms of chronology, style or presumed function. However, in the case of CBV there is no differentiation of shape that would make us more confident of the calcite indicating a functional choice. Instead, Fabrics 1 and 2 suggest a slightly different choice of temper and surface finish by two groups of potters who used the same or similar raw clay deposits close to the site and who also shared the practice of grog and vegetal tempering.

Fabric 3 features an even finer clay matrix with dominant added calcite, as well as vegetal and grog temper. Its lithology is compatible with the alluvial fans of the Segura river or the Rambla Salada, and therefore to a location that may have been relatively close to CBV. However, the absence of metabasites in this fabric shows that its source is distinct from Fabrics 1 and 2, and that it therefore represents a different regional production unit.

Fabric 4 is more distinctive, with very coarse low-grade metamorphic and sedimentary rocks alongside the grog and vegetal temper (n = 8). It shares tempering practices with the other main fabrics, and while its lithology certainly is reflected in deposits within c. 3 km of CBV, it is difficult to ascribe provenance without analytical work on neighbouring contemporary site assemblages. There is no obvious differentiation of pottery shape, surface finish or function that would make this fabric group stand apart and therefore it indicates a different regional production unit, whose tableware products were consumed by the inhabitants of CBV.

The four ungrouped samples also represent non-local fabrics, notably in the case of CBV019 with the Almagra slip, which is distinctive in petrology, and the quality of firing and surface finish and is likely to have been imported from some distance. The existence of regional exchange networks for LBA ceramics has previously been demonstrated elsewhere in the South of the Iberian Peninsula, notably in the settlement of Los Cabezuelos (Dorado Alejos, 2019).

Thus, the results from Cobatillas la Vieja show the existence of two

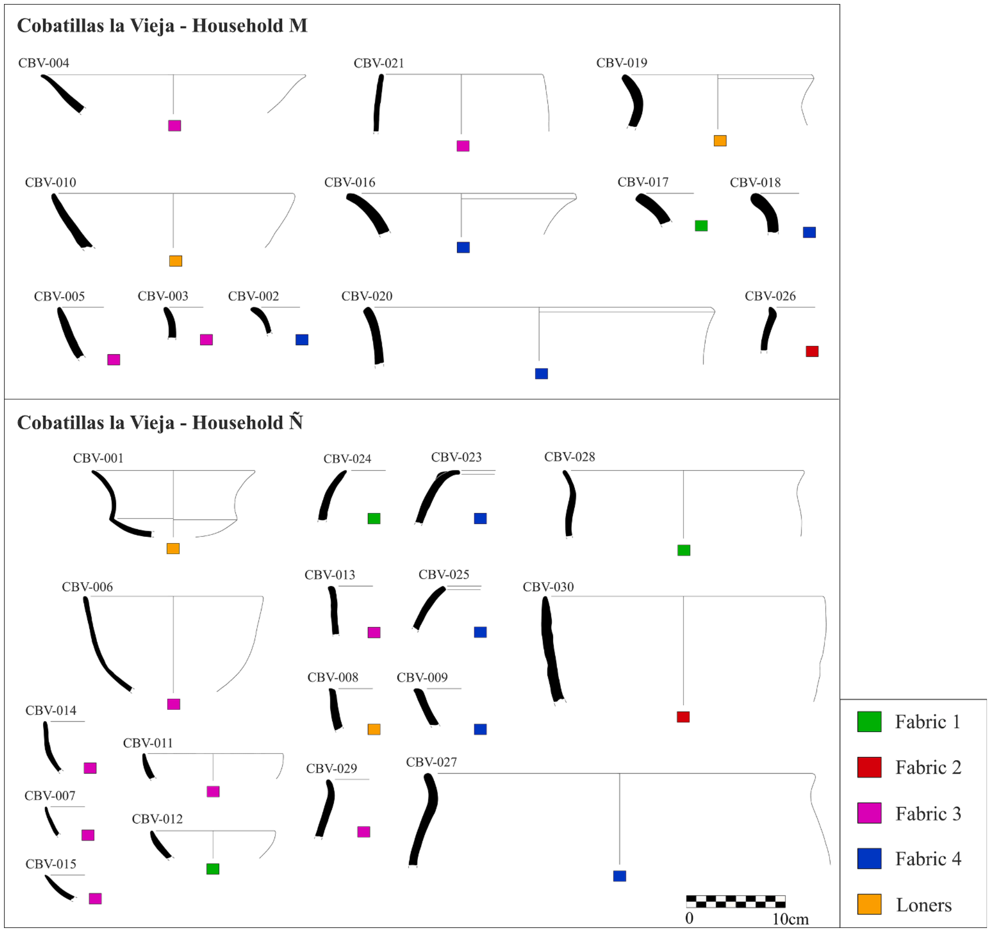

Fig. 9. Representative ceramic forms identified in Cobatillas la Vieja and their assignment according to their belonging to petrographic groups and archaeological context.

levels of exchange. One represents the movement of pottery between a number of production units within the local area, with perhaps a possibility of Fabric 4 coming from further afield than the other three main fabrics. Another scale shows the exchange of smaller numbers of vessels from perhaps greater distances, and where there may have been other factors linked to the mobility of certain individuals or groups, or to the quality of the products or contents. In many ways this should not surprise us, as even very early ceramics are often exchanged widely in the region (Del Pino Curbelo et al., 2021). In fact, in an example from elsewhere, the first ceramic phase in Early Neolithic Knossos shows very marked ceramic exchange from a variety of centres, of pottery which varies little in its shapes and finish (Tomkins and Day, 2001). Early pottery vessels were crucial in facilitating social interaction and therefore prone to be exchanged.

If this, then, is a world where pottery moves regularly from specific communities producing it, we are offered the chance to examine a world of choice beyond that of the producers, which have dominated the discourse on the existence or otherwise of specialization. We turn to the end user, the consumer of pottery and the choices that they made. As this project has sampled two households, M and Ñ, it is possible to examine pottery consumed in each.

The first observation to be made is that there is no pattern in the types of pottery being produced by the different production units. In other words, we do *not* see jars made in one fabric, cooking vessels and serving vessels in yet other materials. We do not seem to have what has been termed resource specialization or specialist products of specific centres. Indeed, LBA craftsmen seem to have manufactured a range of pottery to fulfil different functions, each of our main fabrics occurs in tableware, cooking pots and storage jars.

The two households consume the products of these different production units (Fig. 9). The very availability of different products indicates a more complex and everyday level of exchange than some have envisaged. Yet these fabrics occur in the same shapes and presumed functions, so on what grounds are choices made about pottery consumption? How are the members of each of our households making choices, the agency which results in the assemblages we study? If people are choosing beyond strictly local production, this suggests that ceramics are tied into a whole range of social, political and economic ties which would influence consumption choices and it is this complex material world which has much to teach us about the Iberian Late Bronze Age.

6. Final remarks

The analytical characterisation of different ceramic fabrics and groups in the Cobatillas la Vieja ceramic assemblage has highlighted the importance of ceramic manufacture in the socio economic activities of the Iberian LBA settlements. While the pottery assemblage remains in some ways rather undifferentiated and the product of relatively simple technology with open firing methods, the picture is perhaps more complex than anticipated, featuring the movement within the region of sometimes large quantities of pottery.

The results obtained show the dynamics and mechanisms developed around the production, consumption and exchange of ceramics, revealing a dynamism that occurred at different scales and levels during this period, and which may contribute to correct the traditional attribution of the Late Bronze Age as a period of socio-cultural recession and transition between periods.

That the production units defined all produce similar products invites the consideration of choices and agency of local communities in their consumption of pottery vessels. In addition to more long-distance networks of exchange, this shows a real complexity of the ceramic system which perhaps goes beyond a desire to label production as specialized or unspecialized. The discipline is instead reaching a point where we can aim to use ceramics to examine a whole array of social action and interaction, reconstructing the lives and practices not only of producers, but also of the consumers of pottery vessels.

CRediT authorship contribution statement

Benjamín Cutillas-Victoria: Conceptualization, Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Funding acquisition. **Peter M. Day:** Conceptualization, Investigation, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jasrep.2022.103560.

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