Identifying manufacturing groups through the mineralogical analysis of prehistoric pottery: the example of the Cantabrian region (north of Spain)

Identifikace výrobních skupin prostřednictvím mineralogické analýzy pravěké keramiky: případ Kantábrie, severní Španělsko

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Earliest pottery evidence in Cantabrian Spain materialises the way this new technology was adopted on the threshold of the 5th millennium cal BC. These ceramic assemblages have rarely been the object of specific study owing to their limited representativeness from both numerical and morpho-decorative points of view. This paper presents an update on the archaeological evidence, chronology and technological characteristics of the first pottery in the Cantabrian region. It summarizes recent research on this topic focused on technological analysis of some paradigmatic pottery assemblages. It focuses on the importance of the technological study of the first ceramic assemblages in the Cantabrian region (northern Spain) as a way to approach the social significance of this technological innovation. The available information supports the assertion that the appearance of ceramics in the region does not correspond to an exchange of products, but rather to a transfer of technology, and summarizes the nature of this technology and the main activities related to it.

south-western Europe – Cantabrian Spain – cultural transfer – Neolithic – thin-section – XRD – provenance – raw material

Nejstarší známé doklady keramiky ve španělské Kantábrii dokumentují způsob převzetí nové technologie na prahu 5. století cal BC. Tyto keramické soubory byly vinou své malé reprezentativnosti jak co do kvantity, tak po morfologicko-dekorativní stránce jen výjimečně předmětem specifického studia. Článek se zaměřuje na technologické studium nejstarších lokálních keramických souborů z Kantábrie (severní Španělsko), jehož prostřednictvím lze přiblížit společenský význam této technologické inovace. Studie, které jsou o těchto artefaktech k dispozici (mineralogické – analýzy výbrusů a rentgenová difrakční analýza, a geochemické – skenování elektronovou mikroskopií s energo disperzní rentgenovou spektrometrií), umožnily určit zdrojové oblasti surovin a různé výrobní postupy používané k výrobě těchto nejstarších nádob. Ve světle dostupných informací se článek kloní k závěru, že výskyt keramiky v tomto regionu nesouvisí se směnou výrobků, ale spíše s přenosem technologie, a shrnuje podstatu této technologie a hlavní aktivity s ní spojené.

jihozápadní Evropa – Kantábrie – kulturní přenos – neolit – výbrus – XRD – provenience – suroviny

1. Introduction

Neolithisation involves a series of complex changes in human societies, enabling their transition from a way of life based on hunting, fishing and gathering, to other ways which include agriculture and pastoralism and also imply social and symbolic transformation of these societies (*Whittle 2003*). One of the traits traditionally associated with this historical process is the adoption of ceramic vessels, to the extent that their presence has been regarded in many regions as clear archaeological evidence of the transition from the Mesolithic to the Neolithic. However, the appearance of pottery technology and the adoption of farming were

Fig. 1. Location of the sites in the Cantabrian region where earliest pottery assemblages have been recorded.

not coeval processes, and it is now known that pottery appeared at different times in different geographical areas.

The available archaeological information indicates that pottery technology originated simultaneously in three independent locations in Asia (Japan, China and the extreme east of Russia) and displayed different technological and typological characteristics (*Derevianko et al. 2004*; *Hommel et al. 2016*; *Keally et al. 2004*; *Kuzmin 2006*; *2013*). In Europe, the different chronologies for the earliest pottery have allowed to develop a model explaining the origin and the spread of this technology across the continent (*Jordan – Zvelebil 2009*; *Gibbs – Jordan 2016*; *Jordan et al. 2016*). From the original locations in Asia, it is thought to have spread towards northern Europe through the Volga and Ural river basins in central Russia (*Jordan – Zvelebil 2009*), where oldest pottery assemblages, dated between 8300 and 7000 cal BC (*Dolukhanov 2008*), have been found. Within this general model of the adoption of pottery, the expansion of this technology in south-west Europe is related to the spread of the *Linearbandkeramik Kultur* or Linear Band culture (LBK) through central Europe and the impressed pottery tradition in some Mediterranean regions (*Jordan – Zvelebil 2009*). However, the ways in which the technology was adopted are diverse, resulting in multiple situations, including its assimilation by hunter-gatherer groups, as occurred in the north of the continent (*Zvelebil 2008*).

The process was not synchronic either on a European scale or within the Iberian Peninsula and, therefore, regional studies are of vital importance for the understanding the dynamics of introduction of this technology. The first pottery in Iberia, dated in the 6th millennium cal BC, has been documented in Mediterranean regions and is associated with the spread of impressed pottery (*Bernabeu Aubán et al. 2009*; *2011*). However, later dates have been proposed for the North-West (*Prieto-Martínez 2005*) and the Cantabrian region (*Cubas 2013*), showing a delay in the introduction of this technology. For that reason, this last region constitutes an interesting case of study to analyse the transfer mechanisms involve in pottery technology. This paper reappraises the information about the chronology, the archaeological

contexts and the technological and morpho-decorative characteristics of the early pottery evidence in the Cantabrian region and its contribution to our understanding of social dynamics during the first half of the 5th millennium cal BC.

2. Chronology and archaeological context of the earliest ceramics in the Cantabrian region

The introduction of pottery technology in Cantabrian Spain took place in the first half of the 5th millennium cal BC; a crucial time in which the neolithisation process (or processes) occurred. This period is characterised by a complex archaeological scenario with great diversity in the archaeological record, in terms of both the information and the entity of the archaeological sites (*Cubas – Fano 2011*).

The oldest evidence of pottery (see *tab. 1*; *fig. 1*) has been found at the sites of Los Canes (*Arias 2002*), El Mirón (*Straus – González-Morales 2012*), Arenillas (*Bohigas – Muñoz 2002*), Los Gitanos (*Ontañón-Peredo et al. 2013*), Arenaza (*Apellániz – Altuna 1975*) and Kobaederra (*Zapata et al. 1997*).

These are all cave sites, dated in the first half of the 5th millennium cal BC, but the occupations were of different kind. Most of the pottery assemblages attributed to this chronology come from non-funerary sites (El Mirón, Los Gitanos, Arenaza and Kobaederra), although in other cases a dubious association with isolated human remains has been cited (Los Canes, Arenillas).

In the Province of Asturias, the only archaeological deposit attributed to this moment is in the Cave of Los Canes (Arangas, Cabrales). The pottery found in Stratigraphic Unit 7 comes from a large hollow occupying the central part of the cave; its function could not be determined, although human bones were found in a secondary position (*Arias 2012*).

In the Province of Cantabria, the sites of Los Gitanos (Sámano, Castro Urdiales), Arenillas (Islares, Castro Urdiales) and El Mirón (Ramales de la Victoria) have yielded the earliest pottery assemblages. At the former site, the oldest pottery was found in Sub-levels A4 and A3. Sub-level A4 is thought to be a habitation layer consisting of large numbers of faunal and industrial remains dispersed over a calcite floor (*Ontañón-Peredo et al. 2013*). The more recent Sub-level A3 consists of a greater concentration of occupation waste. In turn, at the small cave of Arenillas, some pottery fragments were found associated with a shell-midden layer (*Bohigas – Muñoz 2002*) but the nature of the deposit does not allow greater precision as regards other aspects. The largest ceramic assemblage attributed to this time was found in El Mirón (*Vega 2012*), where the archaeological Levels 10, 303 and 303.1 are thought to represent a domestic site or animal pen (*Straus – González-Morales 2012*).

In the Basque Country, two early pottery assemblages have been documented in the caves of Arenaza (San Pedro de Galdames) and Kobaederra (Kortezubi), both in the Province of Biscay. According to the few references available about Arenaza, Level 1C2 represents the oldest phase, in which a small number of sherds with impressed decoration were documented (*Apellániz – Altuna 1975*), associated with remains of domestic fauna (*Arias – Altuna 1999*) and a knapped lithic assemblage including geometric microliths. Finally, early pottery was found at the site of Kobaederra in Levels IV and III. Evidence of agriculture was attested in both levels by remains of cereals. In the lower Level IV, the assemblage was associated

with a lithic assemblage containing a high proportion of bladelets and double-bevelled geometrics (segments and triangles), which were also found in Level III, together with abundant backed tools (*Zapata et al. 1997*).

Thanks to the improved understanding of Later Prehistory in the region during the 1990s, we can now state that pottery appeared in Cantabrian Spain in the first half of the 5th millennium cal BC, apparently related to the introduction of cereals and domestic animals, although this association is not attested in the Western area of the region.

3. Summarizing the information: the *"manufacturing sequence"* of Neolithic pottery

3.1. Characterization of the assemblages

The analysis of pottery as the result of a production sequence is a relatively recent approach in studies of prehistoric pottery in Cantabrian Spain. Pottery products are the result of a manufacturing sequence that involves transforming clay into a recipient with different physico-chemical properties from the original raw materials.

The studies currently available about the ceramic assemblages at Los Canes (*Cubas – d. Pedro – Arias 2014*), Los Gitanos (*Cubas et al. 2014*), El Mirón (*Vega 2012*), Arenaza (*Apellániz – Altuna 1975*) and Kobaederra (*Cubas et al. 2012*), in addition to studies bringing together information about Neolithic pottery (*Alday 2003*; *Cubas 2013*), allow a general understanding of the most typical traits of pottery manufactures in this first half of the 5th millennium cal BC. In general, pottery assemblages are characterized by a high fragmentation index, heterogeneity and the absence of complete vessels or profiles.

3.2. Raw materials for pottery manufacturing during the first half of the 5th millennium cal BC

The latest studies of pottery technology have succeeded in determining aspects of the production sequence that were unknown until now. These studies reveal that the first phases of the manufacturing sequence are characterised by the local procurement of raw materials, as great coherence is observed between the mineralogy of the ceramic samples that have been analysed and the surrounding geology (*Cubas et al. 2012*; *2014*; *Vega 2012*; *Cubas – d. Pedro – Arias 2014*). However, the sediment types are diverse and reflect the use of different types of clay in the pottery manufacture (*Cubas et al. 2012*; *2014*; *Cubas – d. Pedro – Arias 2014*).

The distances from the procurement areas for the raw materials used in pottery manufacture is an aspect that has been widely discussed in ethno-archaeological literature (e.g. *Arnold 1985*; *2006*; *Mercader et al. 2000*; *Stark et al. 2000*). These models are based on three basic factors: identification of the exact procurement areas, functionality of the settlement and manufacturing context. The determination of the distances from the potential procurement areas is clearly dependent on the establishment of the production site, the place where the pottery was manufactured (*Gosselain 2002*). However, the archaeological evidence in Cantabrian Spain displays certain limitations for the application of interpretative models proposed in the field of ethno-archaeology. The functionality of the sites is one

Site	Level	Sample	Dating method	Laboratory ref.	Date BP	Calibration cal BC 2σ	Reference
Arenaza	IC2	*Bos taurus*. Bone	14C AMS	OxA-7157	6040±75	5210–4780	*Arias – Altuna 1999*
Los Canes	UE 7	Human bone	14C AMS	TO-11219	5980±80	5200–4680	*Arias 2005/2006*
Los Gitanos	A3	Bone. Fauna	14C AMS	AA-29113	5945±55	4980–4710	*Arias et al. 1999*
Los Gitanos	A4	Calcite	TL	MAD-860	5834±566	4970–2710	*Arias et al. 1999*
Los Canes	UE 7	Charcoal. Pottery	14C AMS	AA-5788	5865±70	4910–4550	*Arias 2002*
Kobaederra	III	Charcoal	14C	UBAR-471	5820±240	5310–4230	*Zapata et al. 1997*
El Mirón	303.3	Charcoal	14C AMS	GX-25856	5790±90	4880–4460	*Straus – González-Morales 2012*
Los Gitanos	A3	Pottery	14C AMS	MAD-656	5771±499	4770–2780	*Arias et al. 1999*
Arenaza	IC2	Bone. *Bos taurus*	14C AMS	OxA-7156	5755±65	4770–4460	*Arias – Altuna 1999*
El Mirón	10	Charcoal	14C AMS	GX-23413	5690±50	4690–4400	*Straus – González-Morales 2012*
Los Gitanos	A2	Pottery	TL	MAD-654	5669±541	4760–2591	*Arias et al. 1999*
Kobaederra	IV	Charcoal	14C	UBAR-470	5630±100	4710–4270	*Zapata et al. 1997*
Covacho de Arenillas	Conchero	Charcoal	14C AMS	GrN-19596	5580±80	4610–4260	*Bohigas – Muñoz 2002*
El Mirón	10	Charcoal	14C AMS	GX-23414	5570±50	4500–4340	*Straus – González-Morales 2012*
El Mirón	303.3	Cereal	14C AMS	GX-30910	5550±40	4490–4330	*Straus – González-Morales 2012*
El Mirón	303.1	Charcoal	14C AMS	GX-25855	5520±70	4500–4240	*Straus – González-Morales 2012*
El Mirón	303	Charcoal	14C AMS	GX-25854	5500±90	4540–4070	*Straus – González-Morales 2012*

Tab. 1. Absolute dates of archaeological levels containing the first evidence of pottery in the Cantabrian region. Radiocarbon determinations have been calibrated with IntCal13 calibration curve (*Reimer et al. 2013*), using the program OxCal 4.2 (*Ramsey 2001; 2009*).

of the main issues in Late Prehistory studies in the region. The known sites of this chronology are mainly caves, which mean it is difficult to determine the place where certain everyday activities, such as pottery manufacturing, took place. The archaeological record does not allow the interpretation of production places and site functionality. At the three sites that have been analysed directly, Los Canes, Los Gitanos and Kobaederra, the mineralogy of the samples is coherent with the geology in the surroundings of the sites, which suggest that the pottery was manufactured with local raw materials. However, it cannot be stated that the manufacture took place at the archaeological site itself and therefore, *a priori* we do not know exactly where the pottery was made, which is an aspect closely related to site functionality. The raw materials used to make the pottery at Los Canes and Los Gitanos and the nature of the occupations at the sites, particularly in the latter case, seems to suggest that the pottery was made somewhere near the sites, as no direct evidence of pottery manufacturing has been found in their deposits. In contrast, at Kobaederra (Level IV and III) the pottery may have been made in the cave, as the lithic assemblage includes tools with use-wear associated with scraping a semi-humid mineral substance, possibly clay (*Ibáñez 2001*).

3.3. The modification of the raw material and the manufacturing process

Clay preparation

Illite-group clays were used most both in their natural state and modified by the addition of different types of temper (*Cubas 2013*; *Cubas et al. 2012*; *2014*; *Cubas – d. Pedro – Arias 2014*). Although the most representative are the non-tempered products, it can be highlighted the identification of some tempers.

Calcite is the most common inclusion, although in varying proportions depending on the site and stratigraphic unit where the pottery was found (*fig. 2A*). Indeed, it was in frequent use in Iberia from the beginning of the Neolithic (*Clop-García 2000*; *2011*; *Martín et al. 2010*) and has been documented across the whole of the western Mediterranean basin (*Convertini 2010*). Flint temper has also been identified (*fig. 2B*) but is less common as in the Cantabrian region it only appears at the site of Kobaederra (*Cubas et al. 2012*). However, it has been recognised at other Iberian (La Carigüela: *Navarrete et al. 1991*) and European sites (Lagnano da Poiede and Ripa Tetta in Italy: *Eygun 2001*). The possible addition of fragments of other rock varieties has also been regarded as intentional in some recipients. The possible use of the sandstone in the site of Kobaederra (*fig. 2C*), the limestone in Los Gitanos (*fig. 2E*), and the presence of rocks with an ophitic texture was documented in pottery from both Los Gitanos (*Cubas et al. 2014*) and Kobaederra (*fig. 2D*; *Cubas et al. 2012*). This latter temper is also found at other sites in Iberia, such as Los Murciélagos in Zuheros (*Barrios et al. 1999*) and Papa Uvas (*Barrios et al. 2005*) with slightly more recent chronologies. Finally, it should be noted that grog was identified at the site of Kobaederra (*fig. 2F*). This temper is relatively frequent at Iberian and some authors suggest the hypothesis that in the western Mediterranean was the first temper (*Clop 2012*).

In general, the most common temper is calcite, which has been documented at all the sites with a representative number of samples whereas the other kinds reflect a sporadic and clearly minor use in comparison with it. The intentional addition of other rock fragments, such as sandstones or ophitic-texture rocks, is difficult to argue due to their scarce abundance in the samples. Indeed, in some cases the detritical fraction is composed by minerals related to the weathering of these rocks, impeding differentiate two different resources in the mineralogical composition.

Manufacturing techniques, the firing process and the ceramic products

The high fragmentation index does not allow an analysis of the central processes in the manufacturing sequence: the modelling. Certain uniformity is apparently seen in these phases of the sequence, but this apparent *homogeneity* is a consequence of the low representativeness of the assemblage.

No technological evidence has been observed in connection with the shaping although, *grosso modo*, certain complexity may be supposed, with the use and combination of several techniques, as attested by the available ethno-archaeological evidence for hand-made pottery (see, among others *García-Roselló – Calvo 2013*; *Gelbert 2001*; *Gosselain 2002*; *Livingstone Smith 2007*; *Neupert 2000*; *Stark et al. 2000*).

The only trait that can be noted in reference to the shaping of the vessels is the identification of different surface treatments (scraping, smoothing, burnishing), which are of greater or lesser importance at each site and in each stratigraphic unit. These forms of treatment,

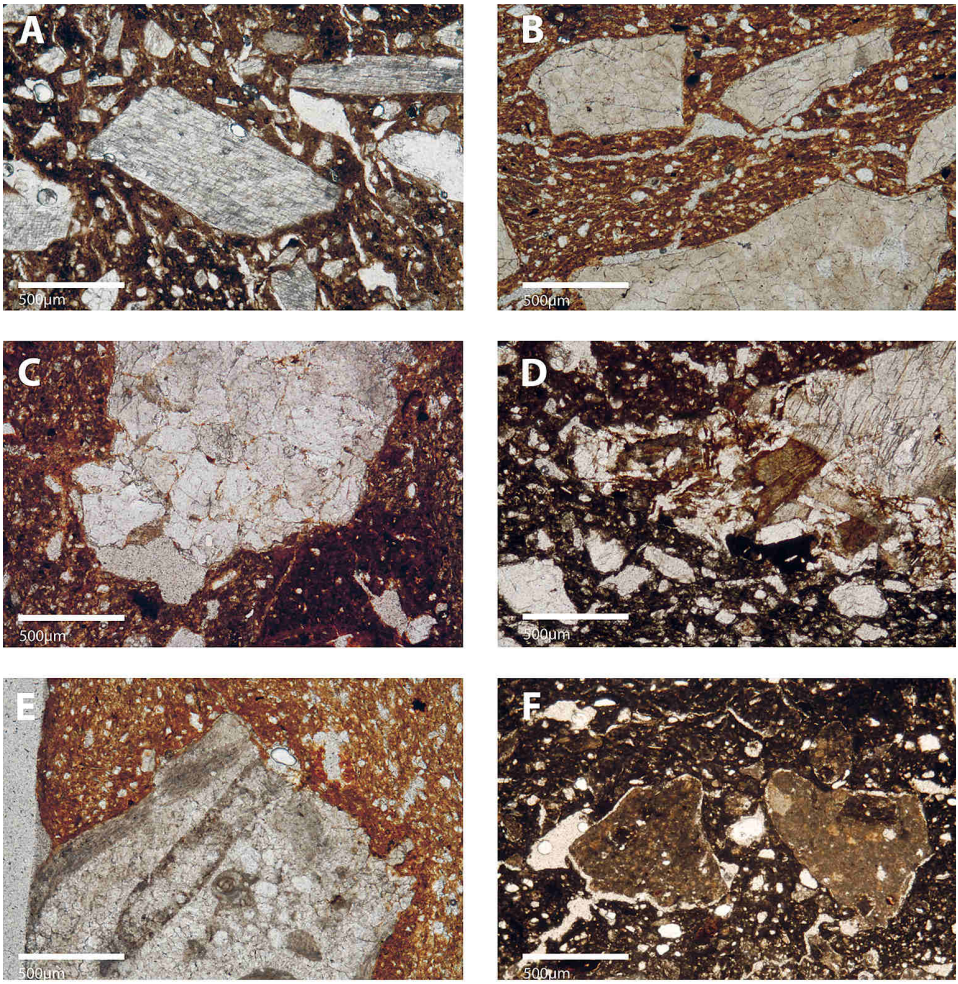

Fig 2. Main temper identified in the Cantabrian region. Microphotograph images with plane-polarized light. A. Calcite (Los Gitanos, sample 735). B. Flint (Kobaederra, sample 1246). C. Sandstone (Kobaederra, sample 1241). D. Ophitic texture rock (Los Gitanos, sample 726). E. Limestone (Los Gitanos, sample 729). F. Grog (Kobaederra, sample 1238).

which are identified by technological macro-traces (*fig. 3*), are seen on the inner and outer surfaces of the sherds and appear individually or in combination with one another.

In the firing processes, these recipients were subjected to low firing temperatures, with maximum temperatures between 700 and 800 °C. The lower limit may be established as 300–350 °C because at this temperature the clay is physically transformed as it loses its superficial and compositional water (*Rice 1987*). The higher limit is determined by the mineralogy that can be observed. In the samples from Los Canes, Los Gitanos and Kobaederra, no refractory minerals, such as gehlenite or spinel, which can indicate temperatures above 800 °C, have been recorded (*Cubas 2013*; *Cubas et al. 2012*; *2014*; *Cubas – d. Pedro – Arias*

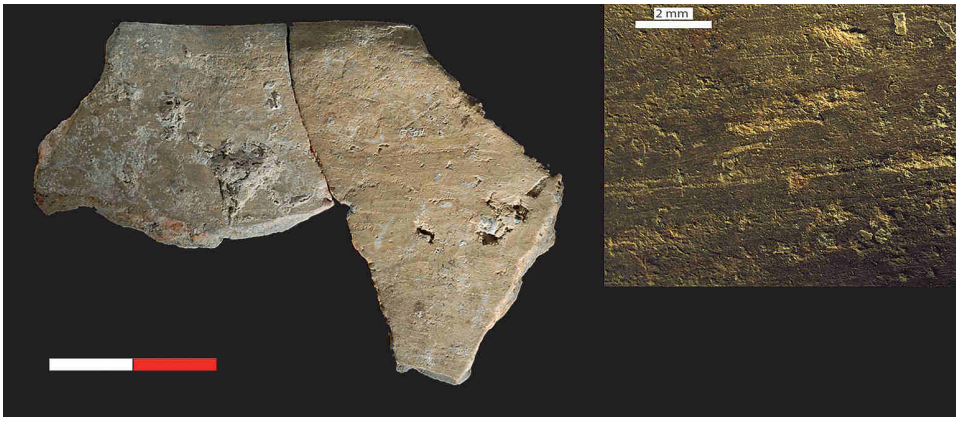

Fig. 3. Technological traces related to the superficial treatment. Los Gitanos.

2014). The colouration observed in the sherds suggests alternating or reducing atmospheres, and colouring related with oxidising firing conditions is less common.

The final products of the manufacturing sequences are difficult to classify. The impossibility of obtaining complete profiles does not allow any appreciation of the possible forms of the recipients (*fig. 4*). No macroscopic features have been observed susceptible of characterising the pottery forms attributed to these chronologies, as the morphological and decorative traits are inconclusive. Finally, the decorative techniques identified include impression, incision and plastic decoration, although smooth, undecorated sherds predominate (*fig. 4*). These techniques are found irregularly across the region, and no regional patterns have been recognised.

4. Discussion: the contribution of pottery to our understanding of social dynamics

The variability of archaeological assemblages allows certain inferences about production modalities to be drawn. It is generally accepted that low variability is indicative of standardised production (*Rice 1981*; *1984*; *1996*) and this is the result of a process associated with specialisation, intensification in the production system and an increase in political and social complexity (*Morrison 1994*; *Rice 1981*).

The problem lies, therefore, in determining the correspondence between the variability observed in the pottery assemblages and the different production processes, and in how to measure the degree of standardisation or uniformity of the assemblages. In addition, this aspect can only be observed in certain phases of the manufacturing sequence.

As the main characteristics of the pottery assemblages documented in northern Spain in the first half of the 5th millennium cal BC have been described, it is now necessary to propose a hypothesis enabling an approach to how the pottery production was organised. The archaeological evidence seems to reflect certain continuity in the use of clay types and the choice of temper. A random (or non-selective) use of raw materials would give

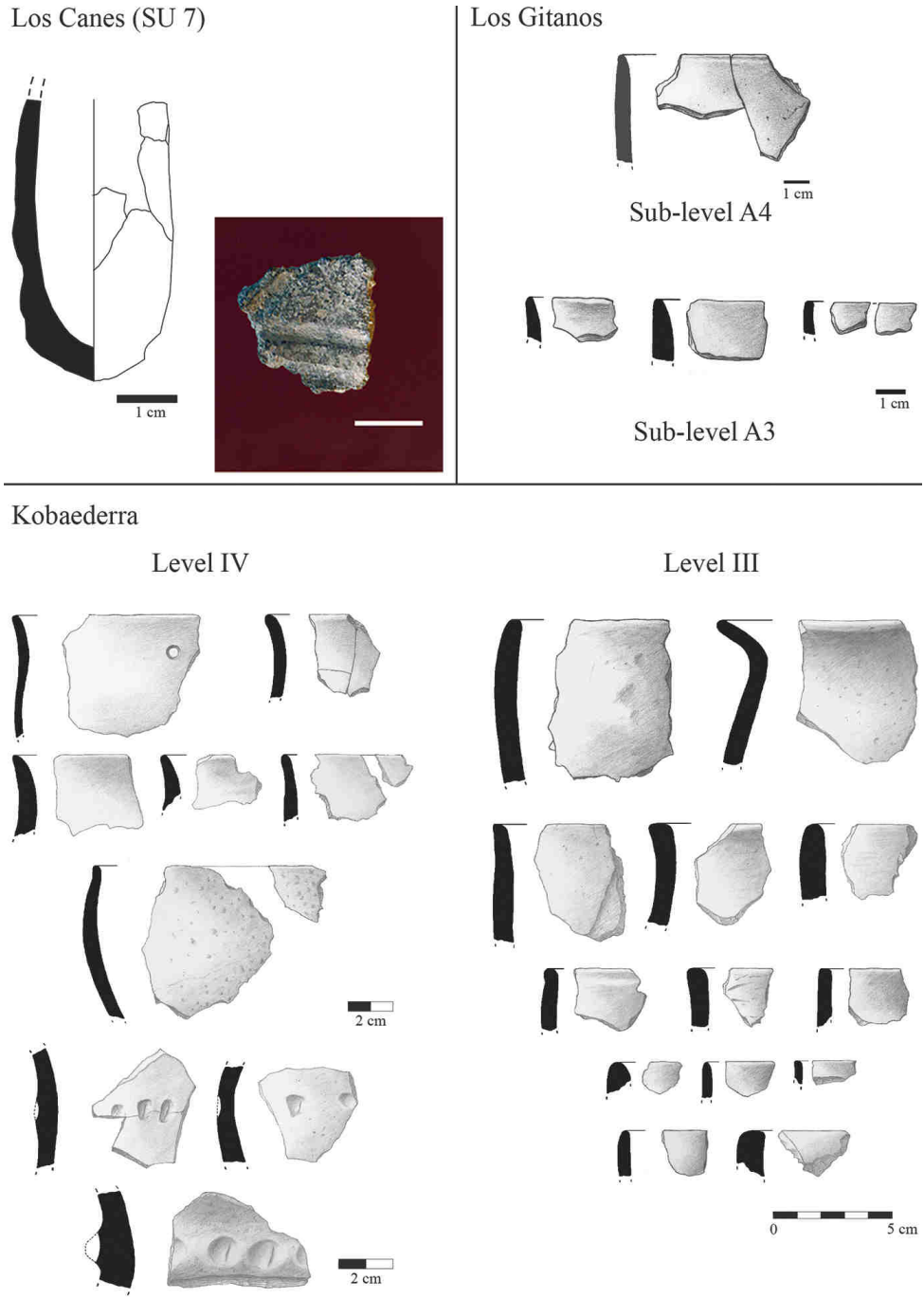

Fig. 4. Main morphological and decorative characteristics of the assemblages recorded at Los Canes (SU 7), Los Gitanos (sublevel A4 and A3) and Kobaederra (levels IV and III).

rise to greater mineralogical heterogeneity both in general and within each assemblage. However, most of the samples that have been analysed display great mineralogical coherence, especially in the reiterative use of types of temper. Therefore, it is thought that the use of certain raw materials is not accidental or fortuitous, but denotes a deliberate choice of temper.

At the same time, both the character of the manufactures and the contexts in which they are documented seem to indicate that pottery production was a daily activity forming part of the group's subsistence tasks. It is seen, therefore, that the procurement of raw materials was selective and carried out in the immediate (physical and functional) surroundings of the site with the objective of making products to be used within the group to satisfy its own needs.

The appearance of this new technology in northern Spain brings with it major implications in the study of the neolithisation processes, as its introduction in the first half of the 5th millennium cal BC is simultaneous with the first unmistakable signs of socio-economic change. This prompts questions about the role pottery played in these processes and whether it was added to material culture as a result of the dissemination of technology or by the arrival in the area of groups bringing pottery with them. The present study supports the explanation that the appearance of pottery in northern Spain was not the result of an exchange of products, but was due to technological dissemination, as the recipients were made in the area with raw materials available in the surroundings. However, this dissemination could be the result of the transfer of knowledge through several mechanisms (*Dietler – Herbich 1994*) or of the arrival from other geographical areas of human groups who possessed ceramic technology. Sufficient evidence is not currently available to choose between one or other hypothesis.

In general terms, the neolithisation process in Cantabrian Spain has been associated with the expansion of the Mediterranean Neolithic along the Ebro valley (*Arias 2007*). However, if the Ebro valley was the focus of influence for the transmission of pottery technology, a temporal gradient would exist; a spatial articulation of the sites with pottery on each side of the watershed in a diachronic sequence. Equally, certain similarities would be seen between the production in the original focus and those within reach of its technological influence.

The available absolute dates situate the earliest evidence of pottery in the middle-upper Ebro basin (*Alday 2009*) and the Pyrenees in the first half of the 6th millennium cal BC, reflecting certain temporal difference between these areas and Cantabrian Spain. This indicates different rates in the transfer of pottery technology between the two areas, but no diagnostic traits are seen in the characteristics of the pottery assemblages in each one. In both cases, the recipients are characterised by lack of morphological and decorative definition and solely common technological traits can be recognised, such as the use of calcite, whereas the morphological and decorative features are inconclusive in an attempt to determine influences. The available archaeological evidence do not display a high correlation in comparison with other regions in the vicinity (*Cubas et al. 2016*).

Within Cantabrian Spain, the first pottery manufactures are associated with the earliest evidence of domestication in the central-eastern sector of the region. Here, a clear link is seen between the appearance of domestic species and the first evidence of pottery technology (El Mirón, Los Gitanos, Kobaederra and Arenaza), apart from at a few sites, like Herriko Barra, where the absence of this technology might be connected with the function of the site

as a specialised hunting camp (*Iriarte et al. 2005*). However, this association is less clear in the western sector, where the limited archaeological record is insufficient to characterise the subsistence pattern in the first half of the 5th millennium cal BC. This lack of archaeological evidence is only offset by the limited information from Los Canes (SU 7) where its precariousness does not allow an assessment of the subsistence model it was associated with.

In this context, the appearance and development of pottery technology in Cantabrian Spain was integrated as an everyday activity, immersed in the subsistence strategies of the human groups. The everyday nature of pottery-making is supported by the use of local raw materials and its documentation at sites in which other activities were carried out. No evidence has been found allowing it to be considered a prestige item, and therefore it must have been adopted by these human groups as practical technology (following the conceptualisation proposed by *Hayden 1995*; *1998*). The technological, morphological and decorative characteristics of the pottery reflect a limited investment in time and effort, possibly in accordance with the everyday and practical nature of the products. In addition, in the pottery, no sign can be identified suggesting it was an indicator of status or identity, or that it was used as a surface on which to transmit symbolic thought. Therefore, both the contexts in which it is found and its most significant characteristics indicate that pottery did not play a symbolic role within the human groups.

5. Conclusions

To sum up, pottery manufacturing appeared as an activity carried out in the region in the first half of the 5th millennium, when it became part of the daily tasks of the human groups, in a historic moment characterised by changes in their model of subsistence. With the available archaeological data, it is not possible to establish the mechanisms that operated in the transfer of the technology, and it can only be stated that it developed as a local technology using local raw materials, and no exchange of products with neighbouring geographical regions has been identified. Furthermore, no traits have been observed allowing it to be considered a prestige item. Pottery was therefore adopted by the human groups in the region as a practical technology, as the technological, morphological and decorative characteristics of the recipients reflect a limited investment in time and effort probably in accordance with the everyday and practical nature of the products.

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