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Pottery *à la mode* in the Late Punic world: Production of red-slip 'Kuass ware' in Málaga, Spain (2nd-1st c. BC)

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A R T I C L E I N F O

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A B S T R A C T

Recent archaeological excavations in Málaga city, in southern Spain, uncovered a Late Punic pottery workshop (2nd-1st c. BC) in association with a large assemblage of red-slip tablewares ascribed to the so-called 'Kuass ware'. These wares, which were very widespread in the Western Punic world, are known to have been produced mainly in the area of Cádiz. However, the macroscopic features of the examples found in Málaga together with their association with a probable kiln site suggests the existence of a local production, not reported before. This hypothesis is examined in the present paper through a science-based approach, which involved the analysis of 20 samples of 'Kuass ware' from Málaga through a combination of thin section petrography and elemental analysis by WD-XRF. Results were compared to those of reference samples of 'Kuass ware' from the Bay of Cádiz — their main production area — as well as to geological samples of clays and sands from the surroundings of the site in Málaga, and to previously published data for Punic amphorae from Málaga. The analytical results support the hypothesis of a local production, effectively confirming the first instance of 'Kuass ware' production in the Mediterranean coast of Andalusia, and provide reference data for 'Kuass ware' from the Late Punic city of *Malaka*.

1. Introduction

In the late 4th century BCE, some of the Punic settlements in the western Mediterranean boosted the production of red-slip tablewares influenced by late Classical/Hellenistic Greek prototypes, imitating in particular forms and techniques of Attic black-gloss wares but following local Punic preferences such as the use of a red or brown slip instead of a black-gloss (Niveau de Villedary 2003, 2008, 2014a, 2014b; Sáez Romero, 2014). These products, known as 'Kuass ware', gradually replaced the imports of Attic wares in the western Punic sites, and became very popular during the 3rd and 2nd centuries BC, in the so-called Late Punic period. They were widely distributed over the wider region of the Straits of Gibraltar, including the southern Iberian Peninsula and northern Morocco. Their production ceased during the early 1st century BCE due to the increasing consumption of Italic black gloss wares ('Campanian ware'), which were imported on a large scale and came to gradually dominate the regional markets in the western Mediterranean (Niveau de Villedary and Sáez, 2016).

The forms manufactured included —among others— cups, bowls, and the so-called 'fish plates', replicating or, in some cases, being inspired by Greek types (Niveau de Villedary 2003, 2008, 2014a, 2014b). The Hellenistic influence is also observed in the decoration, which included stamps impressed on to the base of the vessels —such as motifs of rosettes and palmettes— in addition to the slip. At a later stage (2nd-1st centuries BC), the formal repertoire of 'Kuass ware' became increasingly influenced by some of the most popular forms of imported

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black-gloss Campanian ware (Niveau de Villedary 2014a; Niveau de Villedary and Sáez, 2016). Even if most of these 'Kuass ware' ceramics were tableware intended for domestic use, some of them seem to have been used for ritual purposes (Niveau de Villedary 2003, 2008, 2014a, 2014b).

The term 'Kuass ware' refers to the Moroccan site where these red-slip ceramics were first identified and described (Ponsich, 1968,1969), even if subsequent research showed that their main production area was actually the Bay of Cádiz, close to the Punic city of *Gadir*, present-day Cádiz (Niveau de Villedary 1999, 2003, 2008, 2014a, 2014b; Sáez Romero, 2008; Ramon, 2012). The area of *Antipolis* —currently the city of San Fernando—, a few kilometres south of *Gadir*, functioned as an

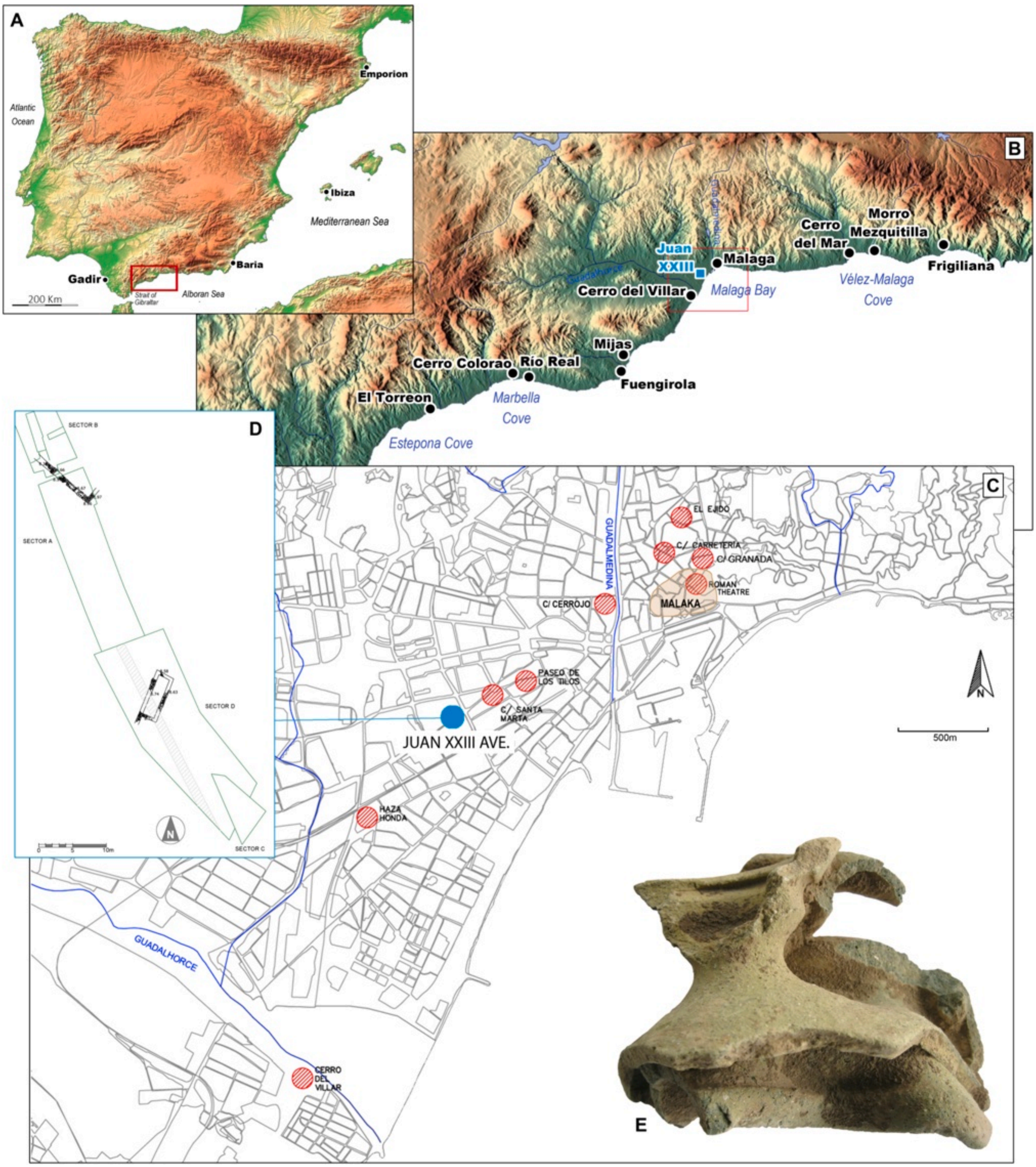

Fig. 1. (A) Location of *Malaka*/Málaga and *Gadir*/Cádiz in the context of the Straits of Gibraltar region. (B) Plan of the coast of present-day Málaga province showing the main Punic and Late Punic coastal sites. (C) Archaeological site of Juan XXIII Avenue in the suburbs of Málaga city. (D) Closeup plan of the main areas excavated in 2009–2010. (E) Misfired jar, strongly deformed and stuck to another one, found at the kiln site of Juan XXIII Avenue.

industrial suburb of this Punic centre, specialising in pottery production. This is attested by a large number of kiln sites which have been excavated, all of which appear to have been used mainly to produce amphorae intended for the trade of salted-fish products (Sáez Romero, 2008). However, other ceramics were also manufactured in the same workshops, including red-slip tablewares (Niveau de Villedary, 2003,2004; Sáez Romero, 2008). *Gadir* appears to have been not only the main producer of 'Kuass ware' but also a major consumer, as suggested by the density of findings in the Bay of Cádiz and the diversity of contexts in which it can be found, among other indicators (Niveau de Villedary 2014b). Despite the dominant role of *Gadir*, other Late Punic cities were also manufacturing local versions of this red-slip ware —like Kuass (Kbiri Alaoui, 2007; Ramon, 2012) and possibly others (*e.g.*, Niveau de Villedary 2003, 2014a; Sousa, 2009)—, as were contemporary Turdetan sites, particularly those in the lower Guadalquivir valley (Escacena and Moreno, 2014; Moreno et al., 2014a,2014b; García-Fernández, 2015; Moreno, 2015,2016).

Recent archaeological fieldwork in Málaga city yielded evidence for yet another potential production centre of 'Kuass ware', this time related to Late Punic *Malaka* (Fig. 1), in an area where the existence of local imitations of this group of pottery had been hypothesised years ago by Niveau de Villedary (2003: 248-254). The aim of this paper is to characterise these materials from *Malaka*, in order to investigate this potentially local production of 'Kuass ware' through a combination of ceramic petrography and elemental analysis. This study thus contributes not only to our understanding of pottery production in Málaga during the latest phase of the Punic societies in the area, but it also broadens our knowledge of the phenomenon of red-slip tableware production in the wider region of the Straits of Gibraltar during the Late Punic period, prior to the Roman occupation.

Notably the red-slip tablewares from Málaga represent the first evidence of 'Kuass ware' production in the Mediterranean coast of Andalusia, as previously confirmed production sites are restricted to the Atlantic coast —mainly in Cádiz— and the lower Guadalquivir valley.

2. The archaeological context

Excavations conducted between 2009 and 2011 at the site of Juan XXIII Avenue in the area of Carranque, present-day Málaga city (Arancibia et al., 2012; Sáez Romero et al., 2022) (Fig. 1) uncovered a diachronic stratigraphic sequence with several phases dated to between the 6th century BCE and the 5th century CE, that is, from Phoenician-Punic to Late Roman times. This site is located about 3 km southwest from the city center of ancient *Malaka* and can be associated with the commercial expansion of this city during the Phoenician-Punic period.

As concerns the Late Punic occupation of the site, large ceramic waste pits dated to the 2nd-1st centuries BC (phase II) were found, which included large quantities of amphorae —including many misfired fragments— but also red-slip tablewares that were identified as 'Kuass ware', based on both typological and technical features (Sáez Romero et al., 2022). These findings suggested the presence of a pottery workshop producing amphorae and, probably, also red-slip tablewares.

The former were related to the maritime trade of salted fish and likely wine, important economic activities of many Phoenician-Punic sites in the wider region of the Straits of Gibraltar. As for the red-slip tablewares, most of the fragments recovered from the ceramic waste pits showed macroscopic fabrics and technical characteristics that pointed to their possible local production; many of them had even technical defects, such as a slight deformation of the body and loss of slip, and were thus potentially products whose poor quality caused them not to be marketed and discarded instead. The forms included bowls (especially the type Lamboglia 31/33), *patera* or plates (types Lamboglia 36 and 6), and small jars (type Niveau XIII), among others, and are similar to those manufactured in the Bay of Cádiz, the main production area of 'Kuass ware' (Sáez Romero et al., 2022).

3. Geological background

The site of Juan XXIII Avenue is located very close to the mouth of the Guadalmedina river to the northeast, as well as to the mouth of the Guadalhorce river to the southwest, lying directly on Quaternary (Holocene) alluvial deposits. The wider area is characterised by a heterogeneous geological background (Fig. 2). The Guadalmedina river basin is mostly associated with the Maláguide Complex, characterised by sedimentary rocks (argillite, mudstone, sandstone, greywacke, conglomerate, and limestone) and low-grade metamorphic rocks (phyllite, metapelite, and metapsammite). On the other hand, the Guadalhorce river basin has a larger extension, and the river receives materials from different geological formations. These include the sedimentary rocks and low-grade metamorphic rocks from the Maláguide Complex which also feed into the Guadalmedina river, but —in addition— also medium- to high-grade metamorphic rocks (gneiss, migmatite, granulite, quartzite, schist, marble, and amphibolite) and peridotite (serpentinite) from the Alpujárride Complex, as well as sedimentary materials derived from other sources in the area, including Paleogene to Miocene sediments from the Campo de Gibraltar Unit (micaceous sandstone flysch), Pliocene sands and marls, and Quaternary conglomerates, sands, and clays (Fontboté et al., 1972; Estévez and Chamon, 1978; Aldaya et al., 1980; Fontboté 1983; Junta de Andalucía, 1998; Martín-Algarra, 2004; Serrano and Guerra, 2004).

4. Materials and methods

With the aim of testing the hypothesis of a local provenance through a science-based approach, 20 ceramic samples of red-slip 'Kuass ware' from the waste pits of the pottery workshop of Juan XXIII Avenue in Málaga city were selected for petrographic and elemental analysis (labelled MAL19/11 to MAL19/30, see Table 1; Fig. 3a). In addition, 5 samples of the same class found at the kiln site of Torre Alta (Sáez Romero, 2008) in San Fernando, Bay of Cádiz, were analysed as reference material (labelled CAD19/1 to CAD19/5, see Table 1; Fig. 3b). This allowed for a comparison between 'Kuass ware' from the main production area (Cádiz/*Gadir*) and similar wares apparently produced in the area of Málaga/*Malaka*. The ceramic samples from Málaga were also compared with seven geological samples of clays and sands, which had been collected from the surroundings of the site in order to examine potential raw materials for pottery production. The results of the analysis of these geological samples —labelled GS18/4 to GS18/10 (Fig. 2) — were already published in Fantuzzi et al. (2020).

In a first step the ceramics were examined macroscopically from a typological and technological point of view. Macroscopically, the fabrics of the samples from Málaga (Fig. 4a-l) are characterised by a yellowish to orange matrix, as well as frequent to few inclusions, poorly sorted, which comprise mostly of reddish-brown to dark grey grains ranging from spherical to tabular, and from subangular to rounded. Also, common/few glossy (quartz-like) inclusions ranging from colourless to white or light grey are observed, in addition to few/rare matt (carbonate-like) inclusions with a white to yellowish colour. To the naked eye, these fabrics are different from the 'Kuass ware' fabrics known so far in Cádiz (Fig. 4m-p) and other production sites. They do, however, resemble the macro-fabrics found in Punic amphorae manufactured in Málaga in the 5th century BCE (Fantuzzi et al., 2020), as well as in Roman and Late Roman amphorae from the same area (Fantuzzi and Cau, 2017; Bernal-Casasola et al., 2020). Therefore, the macroscopic examination clearly supports the hypothesis of a local production of these tablewares in Málaga.

All the ceramic samples were subsequently analysed through a combination of thin section petrography and elemental analysis by means of wavelength dispersive X-ray fluorescence (WD-XRF) spectroscopy. These analyses were conducted at the Fitch Laboratory of the British School at Athens.

Standard thin sections were prepared and examined using a Zeiss

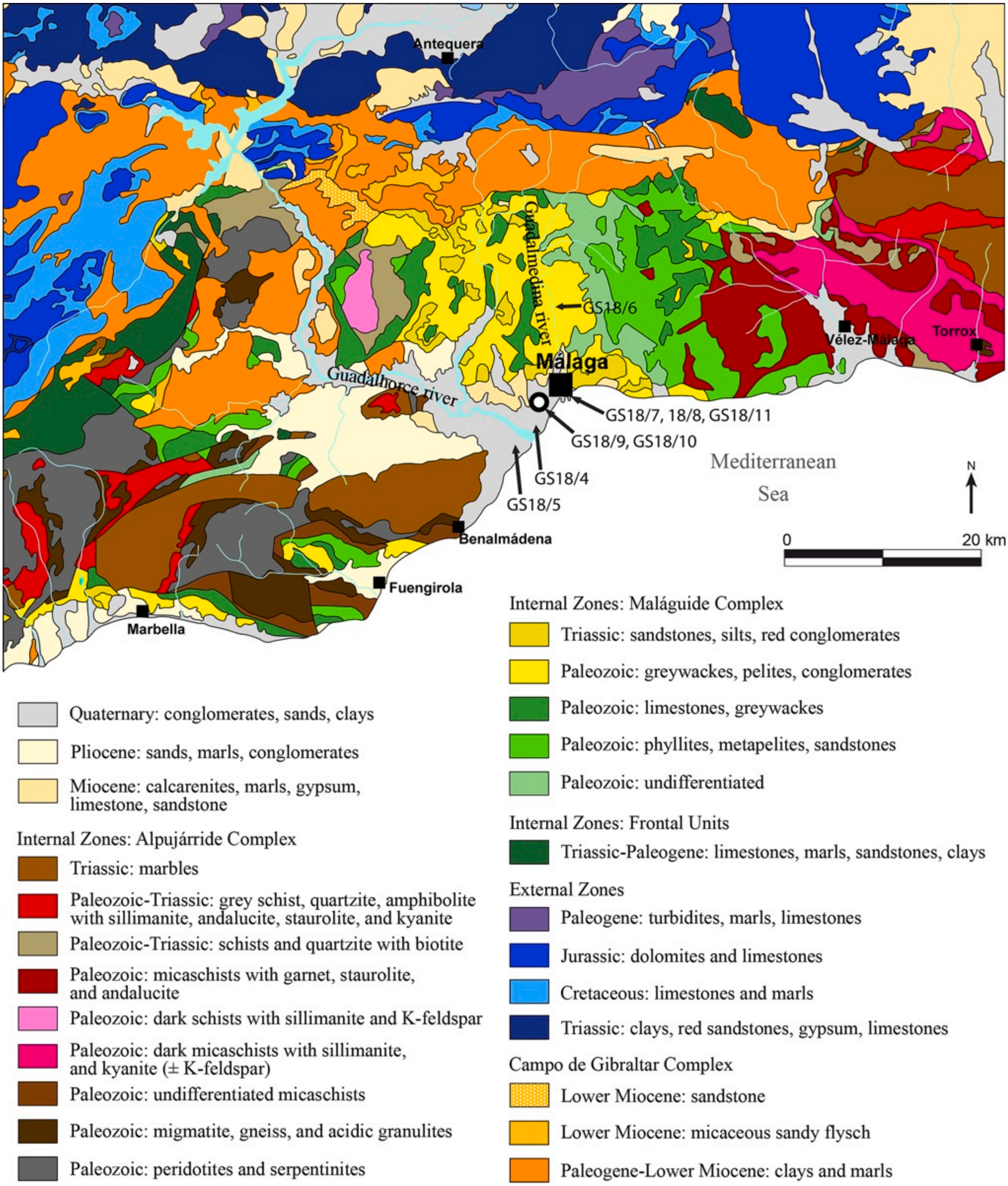

Fig. 2. Geological map of the area of Málaga city and surroundings (based on Junta de Andalucía, 1998). The black and white dot indicates the location of the site of Juan XXIII Avenue. Geological sampling points of clays —GS18/7, GS18/9, and GS18/10— and sands —GS18/4, GS18/5, GS18/6, and GS18/8— from a previous study (Fantuzzi et al., 2020) are also indicated (map by Leandro Fantuzzi).

Table 1
List of the ceramic samples analysed and their main archaeological information.

Sample	Site and context	Ceramic class / form	Type	Part of the vessel
MAL19/11	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Lamb. 31/33	Base
MAL19/12	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Jug	–	Base
MAL19/13	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Lamb. 31/33	Base
MAL19/14	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Plate	–	Rim
MAL19/15	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Plate	GDR-3.2.1	Rim
MAL19/16	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Plate	Fish-plate	Rim
MAL19/17	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Plate	Fish-plate	Rim
MAL19/18	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Plate	Fish-plate	Rim
MAL19/19	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Lamb. 31/33	Rim
MAL19/20	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Plate/lid	–	Rim
MAL19/21	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Echinus bowl	Base
MAL19/22	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Lamb. 31/33	Rim
MAL19/23	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Echinus bowl	Rim
MAL19/24	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Lamb. 31/33	Rim
MAL19/25	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Echinus bowl	Rim
MAL19/26	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Lamb. 31/33	Rim
MAL19/27	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Lamb. 31/33	Rim
MAL19/28	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Lamb. 31/33	Rim
MAL19/29	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Lamb. 31/33	Rim
MAL19/30	Málaga: Juan XXIII Avenue, Trench B – SU 17	Red-slip tableware – Bowl	Lamb. 31/33	Rim
CAD19/1	San Fernando (Cádiz): Torre Alta, Sector 1	Red-slip tableware – Bowl	Outturned rim	Base
CAD19/2	San Fernando (Cádiz): Torre Alta, Sector 1	Red-slip tableware – Bowl	Outturned rim	Base
CAD19/3	San Fernando (Cádiz): Torre Alta, H-I/1997	Red-slip tableware – Plate	Lamboglia 36?	Base
CAD19/4	San Fernando (Cádiz): Torre Alta, Sector 1	Red-slip tableware – Bowl	–	Rim
CAD19/5	San Fernando (Cádiz): Torre Alta, Sector 1	Red-slip tableware – Bowl	Echinus bowl	Rim

Axio Scope A1 polarising microscope, working with magnifications between × 12.5 and × 500. The fabrics observed in the pottery were analysed and described following an adjusted version of the systems proposed by Whitbread (1989, 1995) and Quinn (2013).

In order to determine the elemental composition of the ceramics, all samples were analysed through WD-XRF using a BRUKER S8 TIGER 4KW spectrometer with Rh excitation source. Each sample was first carefully cleaned to remove any slip and surface incrustations, and subsequently ground to a fine powder. Fused glass beads were prepared from 1 g of ignited sample and 6 g of a mixture of lithium metaborate/lithium tetraborate with lithium bromide added as non-wetting agent. Twenty-six major, minor and trace elements were determined: Na, Mg, Al, Si, P, K, Ca, Ti, Fe, V, Cr, Mn, Co, Ni, Cu, Zn, Rb, Sr, Y, Zr, Ba, La, Ce, Nd, Pb, and Th; a custom calibration based on 43 certified reference materials was used (Georgakopoulou et al., 2017). The WD-XRF data were examined using a variety of bivariate and multivariate statistical procedures, the latter including cluster analysis and principal component analysis (PCA) based on the log transformed elemental data.

The results obtained from the analysis of red-slip tablewares were also compared with published data from Málaga and other Punic production sites in the wider region of the Straits of Gibraltar. Many studies on petrographic and/or elemental analysis of Phoenician-Punic pottery from this region have been carried out to date, including some on ceramics from production sites (*e.g.* Docter, 1997; Amadori and Fabbri, 1998; Pringle, 1998; Cardell et al., 1999; Domínguez Bella et al., 2004; Cau, 2007; De Francesco et al., 2010; Behrendt and Mielke, 2011; Behrendt et al., 2012; Johnston, 2015). However, only very few studies have analysed ceramics from the area of Málaga city, and those that did were focusing on Phoenician pottery from the site of Cerro del Villar, on the mouth of the Guadalhorce river (Cardell, 1999; Cardell et al., 1999; Behrendt and Mielke, 2011; Behrendt et al., 2012). An exception is the recent petrographic and elemental analysis on Punic amphorae found in Corinth and in various production sites (Fantuzzi et al., 2020), which included amphorae from kiln sites in Málaga city. As for Late Punic 'Kuass ware', the only published science-based studies focusing on their compositional characterisation are those by Stambouli et al. (2004) for Kuass and Cádiz, and by Moreno et al., (2014a) and Moreno (2016) for the lower Guadalquivir valley.

5. Results and discussion

5.1. Petrographic analysis

The results of thin section petrography indicate that all the ceramic samples analysed from the workshop of Juan XXIII Avenue in Málaga city can be included into the same general petrofabric group, although two fabrics can be clearly differentiated based on textural parameters.

The first fabric, observed in 9 of these 20 samples (Table 2), is coarse textured and shows a bimodal distribution of the inclusions (Fig. 5a-c). The inclusions in this fabric are characterised by a coarse fraction formed by medium-coarse sand (0.25–1.00 mm) and, in minor amounts, very coarse sand (1–2 mm). The composition of this coarse fraction is somewhat heterogeneous, the most frequent inclusions being fragments of low-grade to very low-grade metamorphic rocks —including metapelites and metapsammites, mostly phyllite— and of terrigenous clastic sedimentary rocks —from claystone to quartz sandstone—, in addition to monocrystalline and polycrystalline quartz. The coarse fraction also contains common-few lumps of calcite (micrite and, in some cases, sparite) and serpentinite, which in some cases show relicts of orthopyroxene or olivine (Fig. 5b); rare fragments of igneous rocks (with phenocrysts of plagioclase, biotite, and rarely amphibole), feldspars, and chert can also be found. On the other hand, the fine fraction of the inclusions (0.01–0.25 mm, mostly <0.12 mm) is mainly composed of quartz, micas —including muscovite, biotite, and minor amounts of chlorite—, calcite —mostly micrite—, calcareous microfossils —foraminifera, ostracods, and very rare echinoids—, and iron oxides/opaques. The clay matrix in this fabric is variable, from samples with a light brown or orange matrix in plane polarised light -PPL- and showing optical activity under crossed polars -XP- (MAL19/12, MAL19/14, MAL19/15, MAL19/21, and MAL19/25), to other samples with a greenish brown matrix in PPL and displaying no optical activity in XP (MAL19/16, MAL19/17, MAL19/20, and MAL19/23). These latter may correspond to samples that were fired at higher temperatures, as suggested also by the higher degree of decomposition of carbonate inclusions that can be inferred from some features —like carbonate reaction rims and ghosts of microfossils— observed in thin section (Cau et al. 2002; Fabbri et al. 2014).

The second fabric, found in 11 of the samples analysed (Table 2), is much finer than the previous one (Fig. 5d-f). Here, inclusions coarser

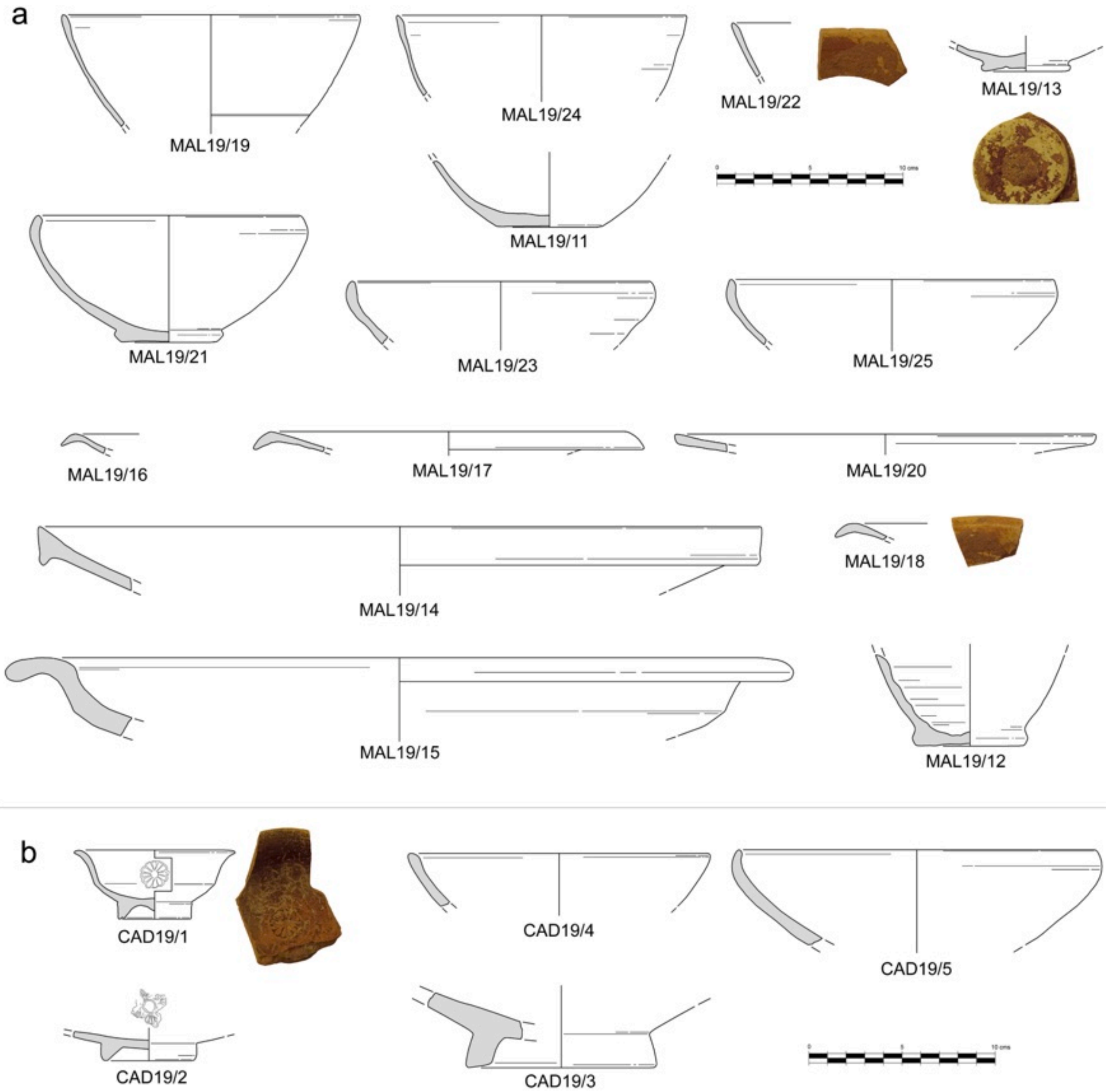

Fig. 3. Representative illustrations of 'Kuass ware' samples analysed in this study from the site of Juan XXIII Avenue in Málaga (a), and from the site of Torre Alta in San Fernando, Cádiz (b) (drawings by A. M. Sáez Romero).

than 0.25 mm are absent or rare; if present, they are of the same nature as those found —in higher quantities— in the first fabric, that is, low-grade to very low-grade metamorphic rocks, sedimentary rocks, quartz, lumps of calcite, and/or serpentinite. Moreover, the characteristics of the fine fraction and the clay matrix are the same as those described for the first fabric, which suggests a clear link between both fabrics. Again, the matrix varies from brown to orange, optically active in XP (MAL19/11, MAL19/29, and MAL19/30), to greenish brown and showing no optical activity in XP (MAL19/13, MAL19/18, MAL19/19, MAL19/22, MAL19/24, MAL19/26, MAL19/27, and MAL19/28).

It seems, therefore, that the first fabric is a coarse version of the second one, and various alternative interpretations may be proposed to account for this variation. One possibility is that different clayey raw materials were used in each case: a clay source with naturally occurring coarse inclusions for the first fabric, and a finer clayey sediment for the second fabric. Given the overall strong compositional similarities of the two pastes, and their apparent use in the same workshop for different types of vessels, this may well reflect the selective use of sediment layers of varying coarseness derived from the same extraction site. Another explanation could be that both fabrics were made from the same base clay but following different paste processing recipes; either by adding temper to a fine-grained clayey sediment to produce the coarse fabric, or by refining a base clay with naturally occurring coarse inclusions through sieving or levigation to produce the fine fabric. In this case the latter seems to be more likely, as there are strong similarities in matrix and fine fraction between both fabrics, and the rare coarse inclusions (>0.25 mm) observed in the fine fabric —which are very similar in nature to the coarse inclusions found in higher amounts in the coarse fabric— are likely to be naturally occurring, rather than intentionally added.

Comparison with geological clay samples from Málaga (GS18/7, GS18/9, and GS18/10), analysed by Fantuzzi et al. (2020), provides additional support for this interpretation. These raw clayey sediments are generally coarse grained as they naturally contain particles of coarse to very coarse sand, and some granules. For instance, experimental briquettes made from sample GS 18/7 (see analytical details in Fantuzzi

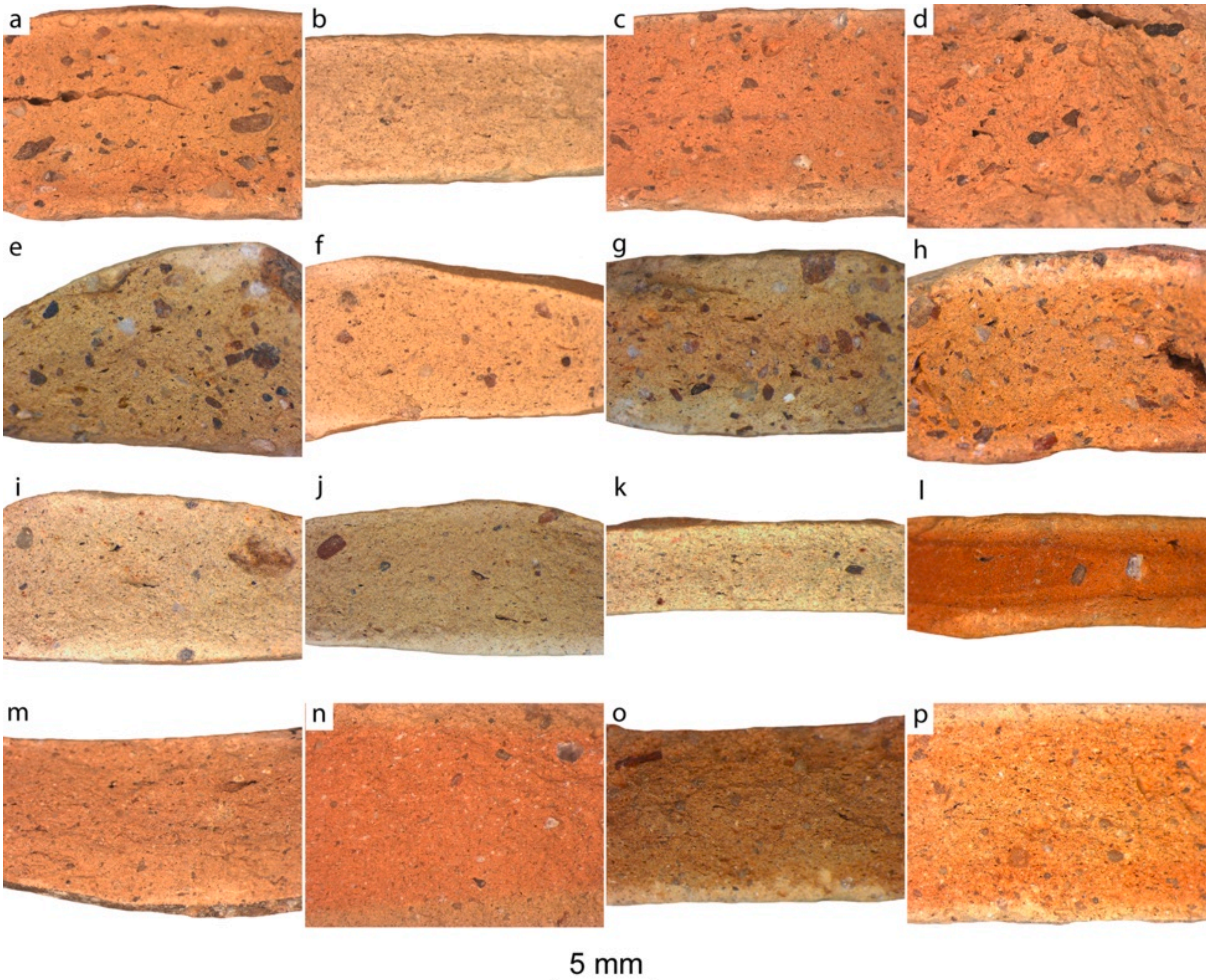

Fig. 4. Photographs of fresh breaks (12.5x) representing the macroscopic fabrics observed in the 'Kuass ware' samples from Málaga (a-l) and Cádiz (m-p).

Table 2
Summary of the results obtained from the thin section petrographic analysis.

Petrofabric group	Samples
Low-grade metamorphic and sedimentary rocks, quartz, calcite, and serpentinite	
Coarse fabric (n = 9)	MAL19/12, MAL19/14, MAL19/15, MAL19/16, MAL19/17, MAL19/20, MAL19/21, MAL19/25, MAL19/23
Fine fabric (n = 11)	MAL19/11, MAL19/13, MAL19/18, MAL19/19, MAL19/22, MAL19/24, MAL19/26 to MAL19/30
Quartz, microfossils and calcite (n = 5)	CAD19/1 to CAD19/5

et al., 2020) (Fig. 6a) showed similarities with the ceramic samples of the coarse fabric in terms of texture and the nature of coarse inclusions, although with some differences in the matrix and fine fraction (*e.g.* lower frequency of microfossils). Even if it was not possible to find an exact match between the clay samples so far analysed and the ceramic samples examined in this study, the nature of the inclusions observed in the former (Fig. 6a-b) strongly supports the hypothesis of a local provenance for the latter. Similarly, comparison with geological samples of sands collected in the area (samples GS18/4 to GS18/6, and GS18/8: see Fantuzzi et al., 2020) also revealed the presence of rock fragments and minerals similar to those found in the ceramic fabrics described above (Fig. 6c). There is a general predominance of fragments derived from sedimentary rocks —from claystone to sandstone— and low-grade metamorphic rocks —metapelites and metapsammites—, in addition to quartz, carbonates, and variable amounts of serpentinite, among others. This is clearly in agreement with the geological background of the area (Fig. 2), mostly in relation to outcrops of the Maláguide Complex, but also with contribution of other sources, like the serpentinites derived from the Ronda ultramafic complex (Fontboté et al., 1972; Aldaya et al., 1980; Fontboté 1983; Junta de Andalucía, 1998; Martín-Algarra, 2004; Serrano and Guerra, 2004). The latter suggests that the raw clay for the tablewares analysed may have been obtained from a source close to the mouth of the Guadalhorce river or, most likely, in the interfluve between the latter and the Guadalmedina rivers, where the workshop of Juan XXIII Avenue is located.

It should be noted that the coarse fabric described above shows similarities to petrographic fabrics identified in fifth-century BC Punic amphorae manufactured in the area of Málaga, published by Fantuzzi et al. (2020), providing additional support for a local provenance for the 'Kuass ware' samples analysed in this study. Compared with the two petrofabric groups of Punic amphorae from Málaga (FG 2 and FG 3) defined in that study, the coarse fabric of the tablewares analysed in the present research shows intermediate characteristics: the abundance of sedimentary and low-grade metamorphic rock fragments, as well as the

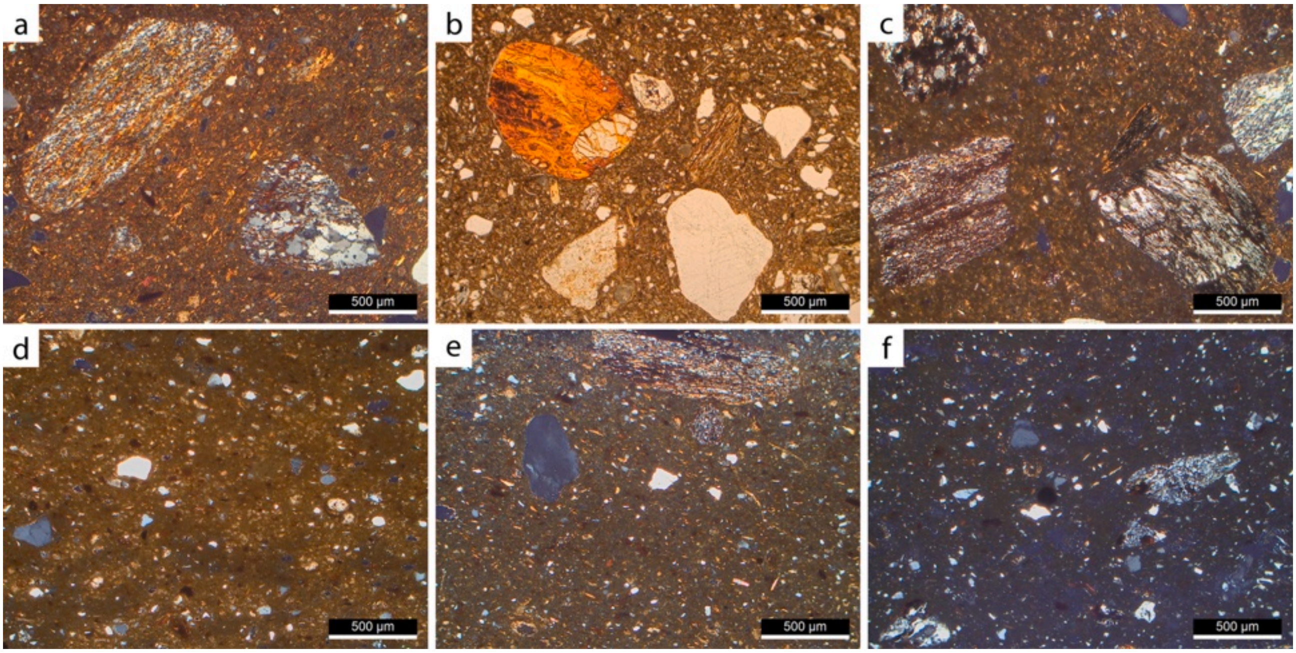

Fig. 5. Petrographic fabrics found in 'Kuass ware' samples from the site of Juan XXIII Avenue in Málaga: coarse fabric (a-c) and fine fabric (d-f). Photomicrographs of thin sections taken at 50x, under XP (a, c-f) or PPL (b). Samples: a- MAL19/12; b- MAL19/15; c- MAL19/17; d- MAL19/19; e- MAL19/22; f- MAL19/28.

fine fraction, remind more of FG 2, however, the abundance of coarse quartz and serpentinite is higher than in FG 2, but not as high as in FG 3. These minor variations in fabric might be the result of exploiting slightly distinct clays available in the area.

Further support for a local production of the 'Kuass ware' samples from the site of Juan XXIII Avenue in Málaga city, is provided by the comparative analysis of samples from the Bay of Cádiz, the main production area of these wares. The analysis of five ceramic samples of 'Kuass ware' from the kiln site of Torre Alta in San Fernando (CAD19/1 to CAD19/5), revealed a very different fabric in thin section (Fig. 6d-f), with no metamorphic components, and inclusions which consist mainly of quartz, calcareous microfossils, and calcite (micrite mainly), in addition to common-few alkali feldspars, and rare micas. These inclusions show a bimodal grain size distribution, with a sandy coarse

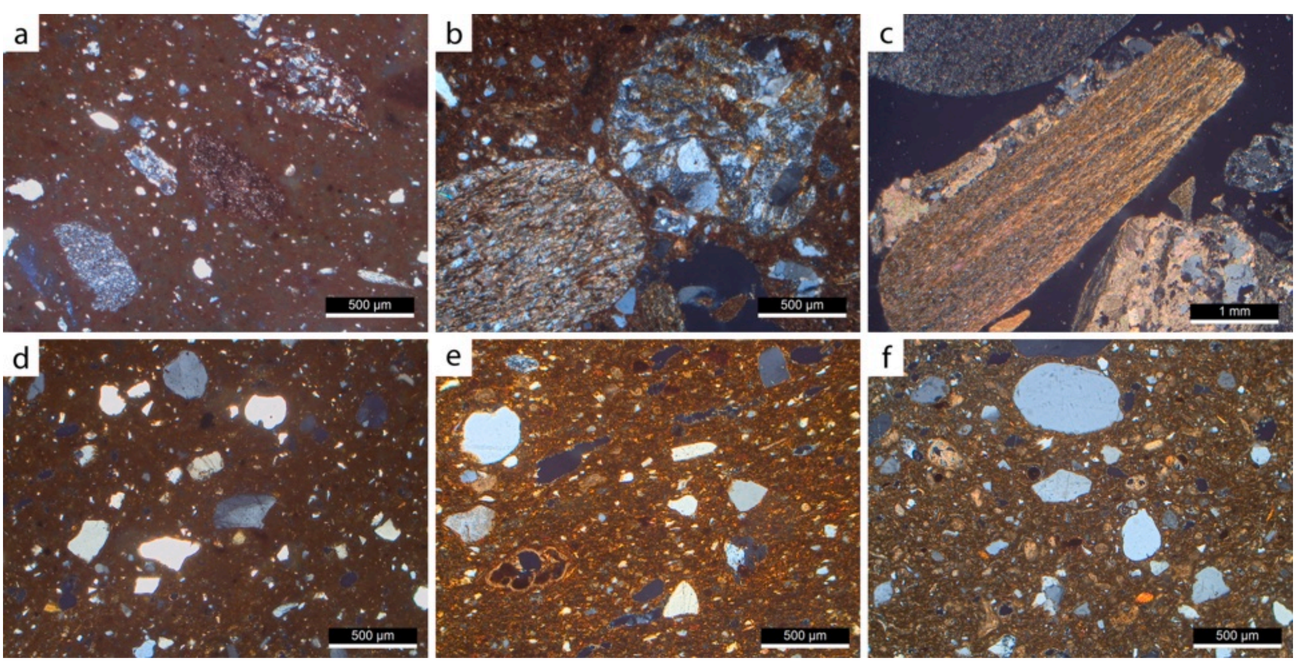

Fig. 6. Photomicrographs of thin sections —taken at 50x under XP— of reference samples used for comparison with the 'Kuass ware' samples from Málaga. (a) Experimental briquette of a clay sample, GS18/7, from the site of metro Málaga-14/Albert Camus in Málaga city —close to the mouth of Guadalmedina river— fired at 1050 °C. (b) Experimental briquette of clay sample GS18/10, collected in the same site of Juan XXIII Avenue in Málaga, fired at 700 °C. (c) Geological sample of sand, GS18/6, from the lower Guadalmedina river basin, in Málaga city. (d-f) Ceramic samples of 'Kuass ware' from the kiln site of Torre Alta in San Fernando, Bay of Cádiz: samples CAD19/1 (d), CAD19/2 (e), and CAD19/5 (f).

fraction (mode 0.25–0.50 mm) differentiated from a fine fraction (0.20–0.01 mm); quartz is frequent in both fractions, while carbonate inclusions are more frequent in the latter. Sample CAD19/1 showed some particularities in thin section: it has a more reddish clay matrix, and amphibole and tourmaline are very rarely found amongst the coarse mineral inclusions. Apart from this, however, the fabric is very similar to that in the other samples. The fabric of 'Kuass ware' from the kiln site of Torre Alta in San Fernando is virtually indistinguishable to the fabric identified in previous studies (Fantuzzi et al., 2020) in amphorae produced in Torre Alta and other Punic kiln sites located in San Fernando.

5.2. Elemental analysis

The dataset with the elemental compositions of the 20 'Kuass ware' samples from Málaga analysed (Table 3) was first explored statistically by calculating the compositional variation matrix or CVM (Aitchison, 1986,2005; Buxeda, 1999), which yielded a relatively low total variation value (vt = 0.44). According to the CVM, most of the elemental variability among these pottery samples from Málaga is related to variations in Na_2O ($\tau i = 3.55$), Pb ($\tau i = 1.78$), and K_2O ($\tau i = 1.76$). In the case of Pb, the high variability should be taken with caution since this element is often associated with contamination problems. The same can be stated for Na_2O, but in this case it can also be observed that the high τi values both for this element and for K_2O are caused by five samples (MAL19/16, MAL19/19, MAL19/20, MAL19/24, and MAL19/28) with higher percentages of Na_2O and lower of K_2O (Table 3; Fig. 7), as well as lower concentrations of Rb. This pattern is likely associated with the high firing of these samples. The high firing of calcareous clay pastes results in a glassy matrix from which potassium can leach and which is known to favour the formation of analcime, a zeolite that can fix sodium during burial (Buxeda et al., 2002; Schwedt et al., 2006). The particular five samples are all high-fired (>1000 °C), as is suggested by the appearance of the fabric in thin section and the optically inactive matrix under XP, and have a CaO content in the range of 13.3–14.7 wt%. When Na, K, Rb, and Pb are excluded, the total variation value for the Málaga samples is significantly lower (vt = 0.19) and clearly indicative of a monogenic population (Buxeda and Kilikoglou, 2003).

Multivariate analysis of the elemental data showed that the 'Kuass ware' samples tend to cluster into two different groups, one including the Málaga samples and the other one comprising samples from a kiln site in San Fernando, Cádiz (Fig. 8). This is consistent with the results of petrographic analysis, where the main fabric group from Málaga can be differentiated from the smaller group of Cádiz samples. The latter are characterised by a lower content in MgO, Mn, Co, and Ni than in the samples from Málaga, and in most cases also a higher content in SiO_2 and Zr, and lower Fe_2O_3 (Table 3); these trends can best be visualised through principal component analysis (PCA), in which Cádiz samples clearly plot apart from Málaga samples (Fig. 8). As concerns the clayey raw materials, the experimental briquettes made from three clay samples from Málaga (Fantuzzi et al., 2020) do not cluster together with the ceramic samples; only GS18/7 is relatively close to the tableware samples from Málaga in the PCA (Fig. 8), but it is still different from the latter in both major (Fe_2O_3, Al_2O_3, and K_2O) and trace (V, Mn, Rb, and La) elemental composition (Table 3). This discrepancy was expected, based on the results of thin section petrography; generally, a perfect match in elemental terms between ceramic samples and raw clays is rarely found. However, this finding does not negate local production, especially since the qualitative similarities observed in thin section are strongly indicating local production, as discussed above.

No comparative elemental data is currently available for 'Kuass ware' or, more generally, Punic or Late Punic tablewares from the wider region of the Straits of Gibraltar (except for local imitations of 'Kuass ware' in the lower Guadalquivir valley, which are clearly different in fabric and composition from the ceramics analysed in the present study: see Moreno, 2016). The WD-XRF elemental data obtained in this work were compared with those published by Fantuzzi et al. (2020) for fifth-century BC Punic amphorae found in Corinth and in production sites from the Straits of Gibraltar region (Fantuzzi et al., 2020), which included amphorae from kiln sites in Málaga city. This previous research provides reference data for 39 amphora samples produced in the area of Málaga city (including 12 samples from three pottery workshops), as well as 77 amphora samples manufactured in the Bay of Cádiz (25 of them from kiln sites), in addition to 76 samples from other production sites in the Punic West. The amphorae produced in Málaga were divided in that study into two distinctive compositional reference groups, one (FG 3) related to the use of raw material sources from the mouth of the Guadalhorce river, and one (FG 2) likely associated with a source in the lower Guadalmedina basin (Fantuzzi et al., 2020). Multivariate statistical analysis over an extended dataset including those earlier data shows a clear relation between Late Punic 'Kuass ware' and the earlier, Punic amphorae samples of FG 2 from Málaga (Fig. 9). Both cluster together, although forming two separate groups in the same cluster, thus suggesting the presence of slight compositional differences between these two ceramic classes, in agreement with the evidence obtained from thin section petrography, as discussed above. This is also observed through PCA, where the 'Kuass ware' samples and the amphorae samples of FG 2 from Málaga slightly pull apart from each other (Fig. 10), due to somewhat lower concentrations of K, Rb, Co and V, and usually higher CaO wt%, in the former (Table 3).

In summary, these results provide further support to the hypothesis of a local provenance of the 'Kuass ware' samples found in Málaga while, at the same time, they indicate minor differences in elemental composition between the fifth-century BC Punic amphorae and the second-century BC Late Punic tablewares. This points to the use of slightly different raw materials and/or paste recipes for the manufacture of the two ceramic classes, although it is not possible —at present— to ascertain whether these differences are due to distinct technological choices according to the type of vessel manufactured (amphora or tableware) or to the chronology of the ceramic contexts, or both.

6. Archaeological implications

The scientific analysis of red-slip tablewares —'Kuass ware'— found at the pottery workshop of Juan XXIII Avenue in Málaga showed the presence of two different but related fabrics, with coarse and fine-grained texture. Integration of the results of the petrographic analysis (Table 2) with the typological information for each pottery sample (Table 1) revealed that the fine-grained petrographic fabrics correspond in 10 of 11 cases (with the only exception of the fish-plate MAL19/8) to bowls of type Lamboglia 31/33, which were imitating similar forms of Campanian black-gloss ware that were widely distributed in the western Punic markets (Niveau de Villedary 2014a; Niveau de Villedary and Sáez, 2016). These bowls had thinner walls compared to the rest of the tableware samples analysed —other forms of bowls, plates, and jugs— (Fig. 3; Table 1), so that differences in the coarseness of clay pastes are likely associated with different technological choices depending on these formal variations. It is worth mentioning, however, that the results of WD-XRF analysis confirmed that all these samples are characterised by similar elemental compositions, forming a quite homogeneous compositional group, suggesting that similar clayey raw materials were used in the manufacture of all these tablewares, but with either targeted selection of finer and coarser layers of a deposit, or differences in processing and paste preparation, as discussed above.

Apart from variability in the textural characteristics of the fabrics,

Table 3
Elemental composition of the ceramic samples from Málaga and Cádiz that were analysed through WD-XRF. Concentrations of oxides (and LOI) are given in wt%, trace elements in ppm. Mean (m) and relative standard deviation (rsd) values of each element are given for each group of ceramics. The elemental composition of three clay samples from Málaga and the mean composition of Punic amphora groups produced in Málaga (published by Fantuzzi et al., 2020) are given for comparison.

Sample	*Na_2O*	*MgO*	*Al_2O_3*	*SiO_2*	*P_2O_5*	*K_2O*	*CaO*	*TiO_2*	*Fe_2O_3*	*V*	*Cr*	*Mn*	*Co*	*Ni*	*Cu*	*Zn*	*Rb*	*Sr*	*Y*	*Zr*	*Ba*	*La*	*Ce*	*Nd*	*Pb*	*Th*	*LOI*	*Sum (%)*
Kuass ware from Málaga																												
MAL19/11	0,53	2,69	13,59	51,04	0,18	2,27	14,81	0,69	5,46	78	93	532	15	50	46	81	87	281	27	182	344	27	71	36	22	10	9,77	101,22
MAL19/12	0,65	2,39	12,00	53,11	0,15	2,07	13,73	0,60	5,05	79	110	519	15	51	46	83	80	265	23	156	378	29	50	30	24	8	10,53	100,48
MAL19/13	0,57	2,64	13,85	51,40	0,19	2,20	14,97	0,69	5,49	92	119	542	14	96	43	80	80	298	25	180	361	28	77	34	19	10	8,75	100,96
MAL19/14	0,64	2,33	12,53	54,82	0,21	2,27	14,40	0,64	5,41	87	90	544	14	47	42	76	95	345	25	179	407	27	61	33	25	9	7,36	100,82
MAL19/15	0,69	2,41	11,92	56,50	0,16	2,09	12,30	0,62	5,47	78	123	532	15	52	42	75	78	240	24	166	371	32	60	30	25	7	8,30	100,64
MAL19/16	1,39	2,98	15,21	53,18	0,21	1,40	14,33	0,75	6,24	106	114	631	17	55	42	79	71	324	27	180	312	39	78	39	23	10	5,18	101,08
MAL19/17	0,90	2,54	13,62	58,14	0,20	2,23	11,86	0,70	5,75	95	116	565	14	51	39	75	97	293	26	181	345	32	71	30	21	9	4,91	101,06
MAL19/18	0,72	2,79	14,52	52,45	0,20	2,53	14,12	0,72	5,76	89	93	571	18	53	48	84	109	363	27	179	409	32	72	32	24	11	7,00	101,03
MAL19/19	1,07	2,58	14,19	52,25	0,20	1,83	14,68	0,72	5,73	93	101	542	17	54	39	69	70	310	26	188	343	33	74	33	18	9	7,33	100,78
MAL19/20	1,00	2,52	12,39	55,45	0,17	1,62	13,86	0,61	5,49	65	92	544	13	49	42	72	68	292	22	153	327	24	63	27	24	8	7,06	100,35
MAL19/21	0,61	2,51	11,65	56,11	0,15	1,95	12,79	0,60	4,93	75	79	475	13	44	37	73	77	238	23	160	328	27	59	27	21	9	9,49	100,96
MAL19/22	0,68	2,95	14,60	54,28	0,19	2,46	12,07	0,75	5,96	94	96	540	15	52	39	83	100	349	29	192	598	33	74	35	24	10	6,94	101,12
MAL19/23	0,63	2,33	12,35	59,19	0,17	1,90	10,61	0,64	5,31	80	79	550	15	48	35	76	69	227	25	171	357	26	57	28	25	8	7,89	101,20
MAL19/24	1,65	2,71	15,19	53,71	0,20	1,22	13,35	0,77	6,12	102	135	538	16	55	38	66	58	318	27	200	322	31	79	35	15	11	5,81	100,94
MAL19/25	0,63	2,29	12,04	58,62	0,15	1,94	11,27	0,63	5,20	80	87	508	15	50	38	71	73	241	25	163	328	26	58	29	23	9	7,84	100,79
MAL19/26	0,63	2,57	14,60	54,09	0,20	2,48	12,67	0,74	5,83	97	94	561	17	51	40	81	98	310	27	189	353	30	77	35	22	10	6,97	100,99
MAL19/27	0,63	2,56	14,66	54,71	0,20	2,30	12,25	0,76	5,94	87	98	559	16	53	44	76	87	305	28	192	371	35	75	39	20	10	6,70	100,92
MAL19/28	1,65	2,74	14,80	52,71	0,19	1,22	14,36	0,75	5,92	105	97	564	14	54	40	70	64	321	26	190	306	36	70	31	11	8	6,61	101,16
MAL19/29	0,65	2,52	12,48	46,99	0,21	2,41	15,20	0,63	4,91	74	67	479	15	44	45	88	95	405	25	165	532	29	70	31	22	9	14,85	101,08
MAL19/30	0,52	2,36	12,32	47,78	0,18	2,30	15,34	0,63	5,06	78	74	532	14	45	52	88	90	308	23	172	373	25	67	27	28	9	13,96	100,64
m	*0,82*	*2,57*	*13,43*	*53,83*	*0,18*	*2,03*	*13,45*	*0,68*	*5,55*	*87*	*98*	*541*	*15*	*53*	*42*	*77*	*82*	*302*	*26*	*177*	*373*	*30*	*68*	*32*	*22*	*9*		
rsd	*42*	*7*	*9*	*5*	*11*	*19*	*10*	*8*	*7*	*12*	*17*	*6*	*9*	*20*	*9*	*8*	*16*	*15*	*7*	*7*	*19*	*13*	*12*	*11*	*17*	*11*		
Kuass ware from San Fernando, Cádiz																												
CAD19/1	0,97	1,90	13,31	61,69	0,29	1,92	9,52	0,78	5,24	115	107	324	9	35	22	80	85	298	24	319	315	32	67	31	23	9	4,78	100,60
CAD19/2	0,72	1,89	12,21	61,35	0,16	2,21	10,30	0,69	4,64	75	79	295	12	33	27	67	92	270	23	233	394	29	58	32	21	9	6,89	101,25
CAD19/3	0,62	1,96	11,48	58,85	0,15	1,93	12,16	0,64	4,59	76	82	302	10	30	27	65	80	326	22	219	460	27	56	31	21	8	7,85	100,41
CAD19/4	0,69	1,86	10,70	66,51	0,21	1,94	8,48	0,61	4,38	71	70	310	7	27	22	63	79	229	23	239	281	29	58	27	20	9	5,70	101,24
CAD19/5	0,63	1,72	9,85	57,49	0,22	1,46	14,21	0,54	3,80	58	60	242	8	30	22	56	55	245	19	168	330	27	49	21	19	6	10,86	100,93

(*continued on next page*)

Table 3 (*continued*)

Sample	*Na₂O*	*MgO*	*Al₂O₃*	*SiO₂*	*P₂O₅*	*K₂O*	*CaO*	*TiO₂*	*Fe₂O₃*	*V*	*Cr*	*Mn*	*Co*	*Ni*	*Cu*	*Zn*	*Rb*	*Sr*	*Y*	*Zr*	*Ba*	*La*	*Ce*	*Nd*	*Pb*	*Th*	*LOI*	*Sum (%)*
m	*0,73*	*1,87*	*11,51*	*61,18*	*0,21*	*1,89*	*10,93*	*0,65*	*4,53*	*79*	*80*	*295*	*9*	*31*	*24*	*66*	*78*	*274*	*22*	*236*	*356*	*29*	*58*	*28*	*21*	*8*		
rsd	*19*	*4*	*11*	*5*	*27*	*14*	*20*	*13*	*11*	*27*	*22*	*10*	*20*	*9*	*11*	*13*	*17*	*14*	*8*	*23*	*19*	*7*	*11*	*16*	*7*	*15*		
Geological clays from Málaga: experimental briquettes fired at 900 °C (Fantuzzi et al., 2020)																												
GS 18/7	0,79	2,91	16,04	58,53	0,23	3,15	11,07	0,78	6,49	131	90	811	19	46	54	98	134	221	27	181	464	42	76	36	38	11	0,66	100,89
GS 18/9	0,54	2,70	11,77	52,20	0,10	2,01	25,09	0,61	5,00	92	73	334	10	33	38	67	79	391	22	161	367	25	52	25	16	7	0,97	101,16
GS 18/10	0,80	2,26	15,14	68,95	0,16	2,87	3,07	0,79	6,33	116	90	749	16	48	70	85	115	118	27	179	471	35	76	34	33	10	0,34	100,94
Punic amphorae produced in Málaga: FG 2 (Fantuzzi et al., 2020), n = 24 (including 23 samples found in Corinth and 1 from a kiln site)																												
m	0,64	2,52	15,04	58,31	0,26	3,04	10,71	0,74	5,77	111	101	573	27	54	52	80	118	330	27	187	396	35	72	33	29	11		
rsd	19	6	4	2	33	9	9	4	3	8	7	10	5	15	14	6	7	9	4	4	21	10	7	10	31	9		
Punic amphorae produced in Málaga: FG 3 (Fantuzzi et al., 2020), n = 15 (including 4 samples found in Corinth and 11 from kiln sites)																												
m	0,84	2,82	14,22	59,88	0,32	2,00	8,08	0,80	6,05	105	198	1075	32	115	101	94	75	236	30	223	545	38	78	36	31	11		
rsd	12	6	5	3	56	19	13	6	6	10	17	6	5	6	121	5	17	8	7	7	18	8	7	8	15	14		

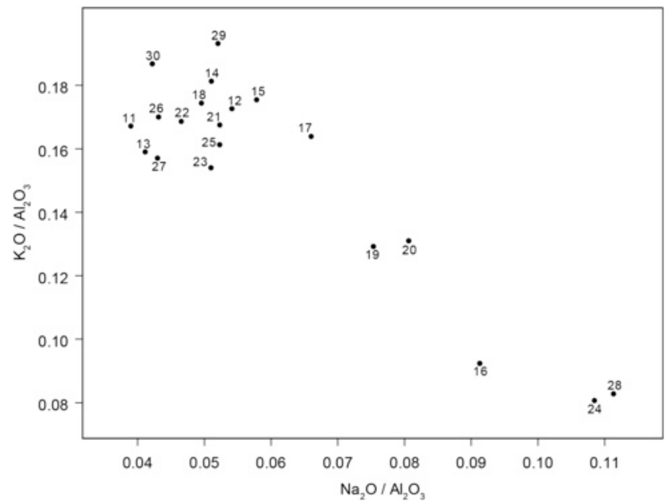

Fig. 7. Binary variation diagram of Na_2O/Al_2O_3 vs K_2O/Al_2O_3 for the 'Kuass ware' samples analysed from Málaga, showing the presence of five samples with higher Na_2O and lower K_2O than the rest of the data set. For each sample the MAL19/- prefix was removed to simplify the reading.

other variations —easily observable to the naked eye— are related to the colour of the matrix, which ranges from buff-orange to yellow, and more rarely reddish. The results of the analysis suggest that differences in the firing conditions may account for these chromatic variations, as samples fired at lower temperatures —as suggested by the optical activity of the matrix in thin section, as well as the lower degree of decomposition of carbonate inclusions— tend to show buff-orange or reddish colours, whereas in higher-fired samples the matrix becomes more yellowish-greenish (Fig. 4). The strong similarities observed in elemental composition between all the samples suggests that the differences in colour are not related to the use of different clays for potting.

The comparison with the regional geology —including the analysis of geological samples of clays and sands— and with other ceramics produced in the area of Málaga city provide clear evidence for a local production of 'Kuass ware' in Málaga. Clear similarities in petrographic fabric and elemental composition can be observed between the Late Punic 'Kuass ware' and some of the Punic amphorae produced in the area of present-day Málaga city published by Fantuzzi et al., (2020: see group FG 2). Nevertheless, slight differences in fabric exist between these amphorae and the red-slip tablewares (*e.g.* higher frequency of serpentinite inclusions in the latter), as well as in the concentrations of some major and trace elements (particularly CaO, K_2O, Rb, V, and Co). It is worth mentioning that other Punic amphorae from the same area (group FG 3 by Fantuzzi et al., 2020) were manufactured using more distinct clay pastes, with much higher frequencies of coarse quartz and serpentinite inclusions, which was reflected in their elemental compositions (*e.g.* higher Ni and Cr). The provenance of the latter was related to a source close to the mouth of the Guadalhorce river, whereas for FG 2 the source of raw materials was located more likely in the lower Guadalmedina valley (Fantuzzi et al., 2020). In the case of the 'Kuass ware' samples analysed in this study, the minor variations compared with the amphorae of FG 2 might be the result of exploiting different sources of raw materials in the surroundings of Punic *Malaka*. The slightly higher frequency of serpentinite inclusions in the fabrics of these tablewares would point to a source area closer to the mouth of the Guadalhorce river, most likely in the interfluvial zone between the latter and the Guadalmedina rivers, where the workshop of Juan XXIII Avenue is located. This comparison between the Late Punic 'Kuass ware' and the Punic amphorae produced in Málaga is helpful not only for providing further evidence on the local provenance of the former, but also for examining any possible technological changes and/or continuities in the ceramic production of the ancient city of *Malaka*. The observed

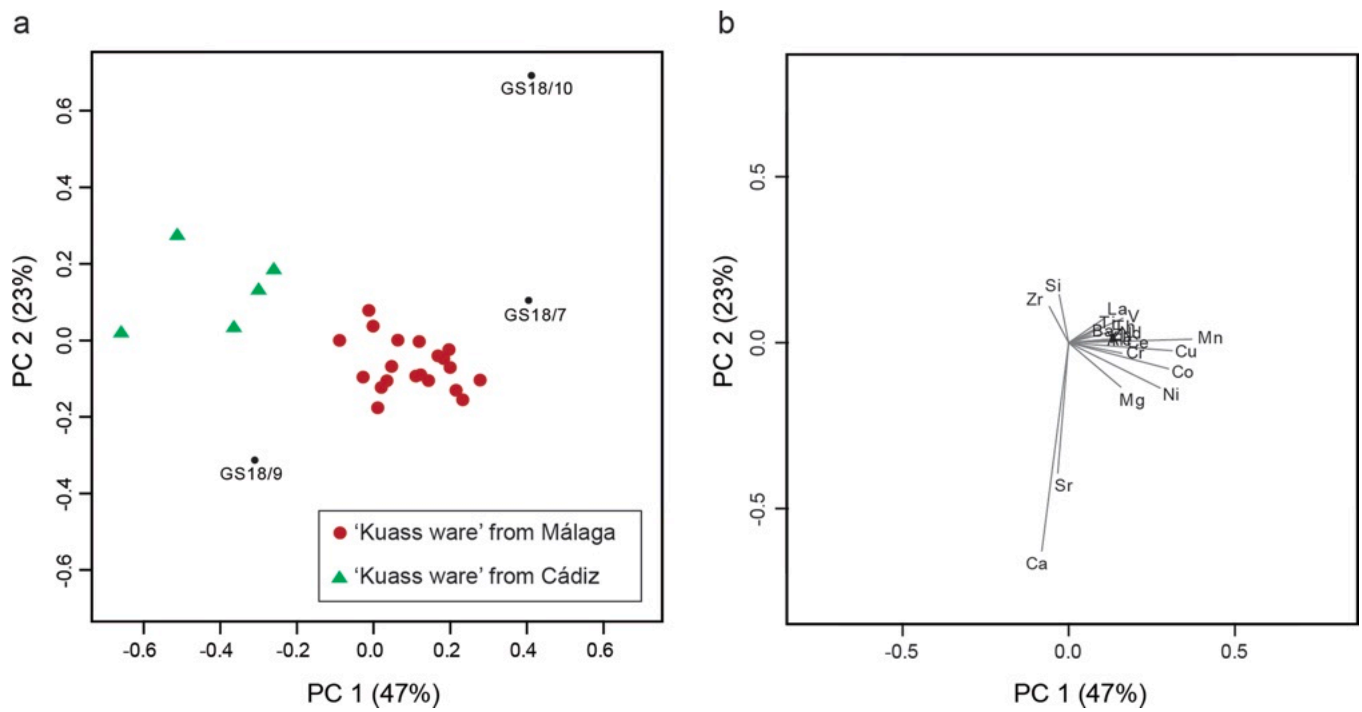

Fig. 8. PCA of the log transformed elemental data (WD-XRF) for the 25 'Kuass ware' samples analysed, including also data for three clay samples —labelled GS18— from a previous study (Fantuzzi et al., 2020) for comparison. The elements Na_2O, K_2O, P_2O_5, Rb, and Pb were excluded from the statistical treatment. (a) Biplot PC1 vs PC 2. (b) Projections of elemental loadings.

differences between amphorae and tablewares in terms of raw materials and potentially, in some cases, paste recipes (*e.g.* fine-grained fabrics in some of the tablewares) are of interest, however further research is needed —particularly through analyses of local Late Punic amphorae— in order to understand if these variations may be related to the class of ceramic manufactured in each case and/or to diachronic changes between the Punic and Late Punic periods.

7. Conclusions

In summary, the results of this study provide clear evidence for the existence of a local production of Late Punic 'Kuass ware' in *Malaka* during the 2nd-1st centuries BC, as first hypothesised by Niveau de Villedary (2003: 248-254), who suggested the existence of a secondary production of these red-slip tablewares in the Mediterranean coast of Andalusia (including both *Malaka* and the area of Vélez-Malaga, Cerro del Mar and Morro de Mezquitilla). This is the first confirmed evidence of 'Kuass ware' production in this region, since the existing evidence so far has been restricted to the Atlantic coast —mainly in Cádiz— and the lower Guadalquivir valley. The scientific investigation of 20 samples of these wares from the pottery workshop of Juan XXIII Avenue in Málaga city, through a combination of thin section petrography and WD-XRF elemental analysis, provided new data for a first compositional and technological characterisation of this local production, as well as for differentiating local 'Kuass ware' samples from those manufactured in the main production area located in the Bay of Cádiz, in relation to the Punic city of *Gadir* (Sáez Romero et al., 2022).

The 2nd-1st centuries BC were the latest phase of 'Kuass ware' production in the wider region of the Straits of Gibraltar and it was undoubtedly influenced by similar red-slip tablewares from the Gadiritan area. The scarcity of published data on 4th-2nd centuries BC contexts in Málaga and Vélez-Málaga does not —at the moment— allow determining if the production attested at Juan XXIII Avenue was the last link in a long production chain of 'Kuass ware' on the coast of Malaga. The lack of evidence from burial areas in the bay of Málaga, along with the absence of these wares in the necropolises of the area of Vélez (at Jardin, significantly), suggest that we should be cautious. Also, the remains reported so far for the area of the Roman Theater of Málaga (Gran Aymerich 1991) and the preliminary information provided for Cerro del Mar and Morro de Mezquitilla (Niveau de Villedary 2003: 248-254) do not allow us to identify if the production of wares that imitated the Greek items of the 4th century BCE took place in this part of the Iberian coast following similar patterns to the Bay of Cadiz, or if it could have been a later phenomenon with different characteristics and phases. More recent findings dating to the same stage of Juan XXIII, such as evidence for ceramic production found at Calle Granada 57–61 (Pérez-Malumbres, 2012), very close to the Roman Theater, have not provided conclusive proof of a local manufacture of 'Kuass ware' in this area close to the Late Punic and Republican city.

Either way, it seems that the 'Kuass ware' produced in Cádiz during the 4th-3rd centuries BC might have been consumed in the area of *Malaka* and could have triggered not only the demand, but also a first phase of local production, in an area where Greek pottery types had already been imitated since the Archaic period (see for example Gran-Aymerich, 1991; Niveau de Villedary, 1999,2003; López Castro and Mora Serrano, 2002; Muñoz, 2009). Evidence from Juan XXIII Avenue and the Roman Theater (Gran Aymerich 1991: 80–85, fig. 66) indicates that, at least during the 2nd century BCE, potters from *Malaka* manufactured local versions of 'Kuass ware' imitating some of the forms and technical features that characterised the products from *Gadir* and that were in fashion throughout the Late Punic world. Therefore, *Malaka* should be considered as a secondary production site of 'Kuass ware', although the nature of its relation with the Gaditan workshops still remains to be defined. It seems very likely that the red-slip tablewares produced in *Malaka* were oriented towards local or limited regional markets —likely to the hinterland of the city or, at the most, within the Alboran Sea—, since no other examples of 'Kuass ware' with these macroscopic fabrics have been published so far in Late Punic archaeological contexts.

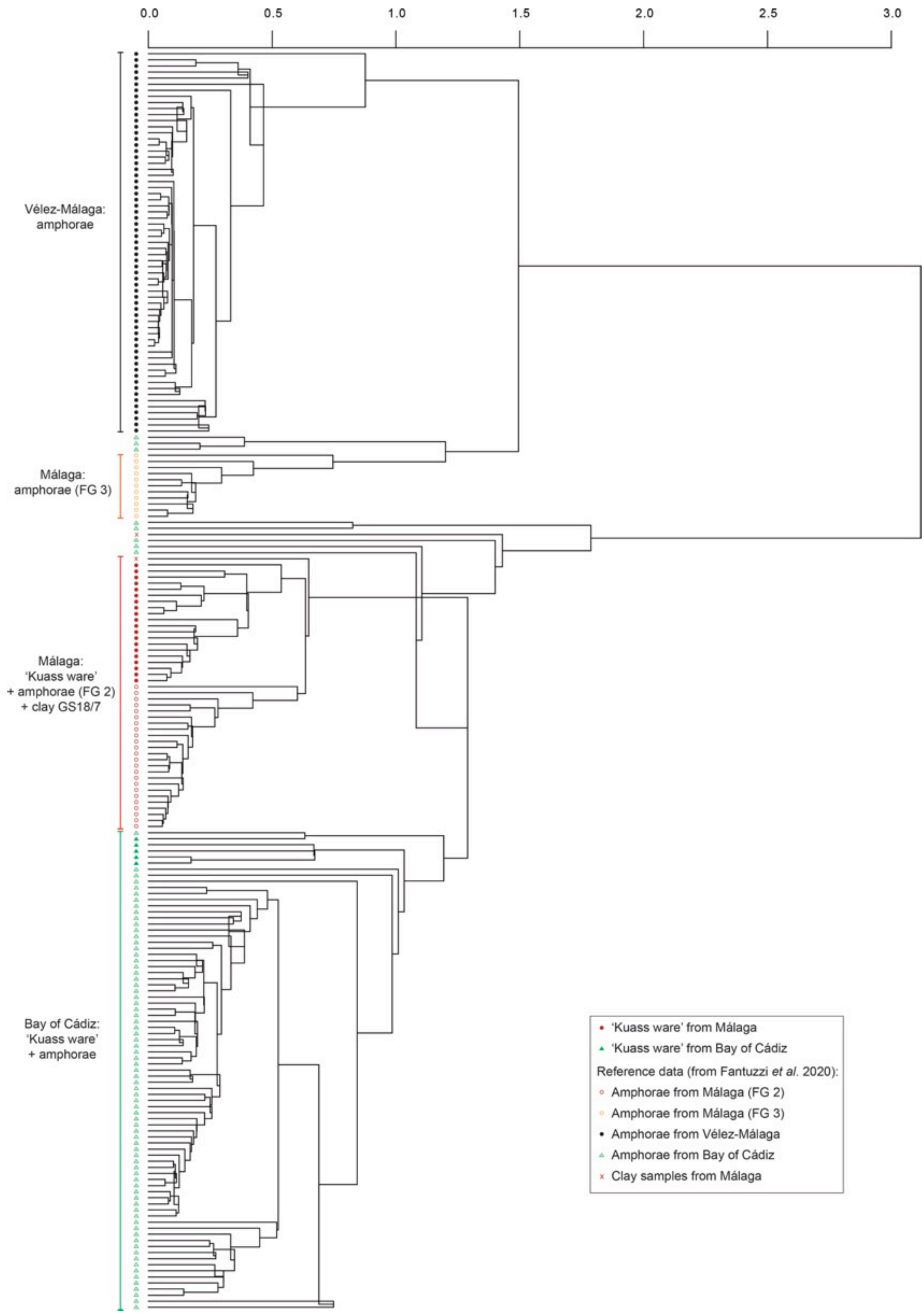

Fig. 9. Cluster analysis comparing the elemental composition (WD-XRF) of 'Kuass ware' samples from Málaga and the Bay of Cádiz with previously published data by Fantuzzi et al. (2020), which include Punic amphorae found in Corinth and in production sites from the Straits of Gibraltar region, as well as experimental briquettes of geological clays from the area of Málaga. The analysis was performed on the log transformed subcomposition Mg, Al, Si, Ca, Ti, Fe, V, Cr, Mn, Co, Ni, Zn, Sr, Y, Zr, Ba, La, Ce, Nd, and Th, using the centroid agglomerative method and the squared Euclidean distance. Some elements were excluded for the reasons mentioned in the text (Na, K, Rb, and Pb), in addition to others (P and Cu) that were also left out to avoid possible contamination problems.

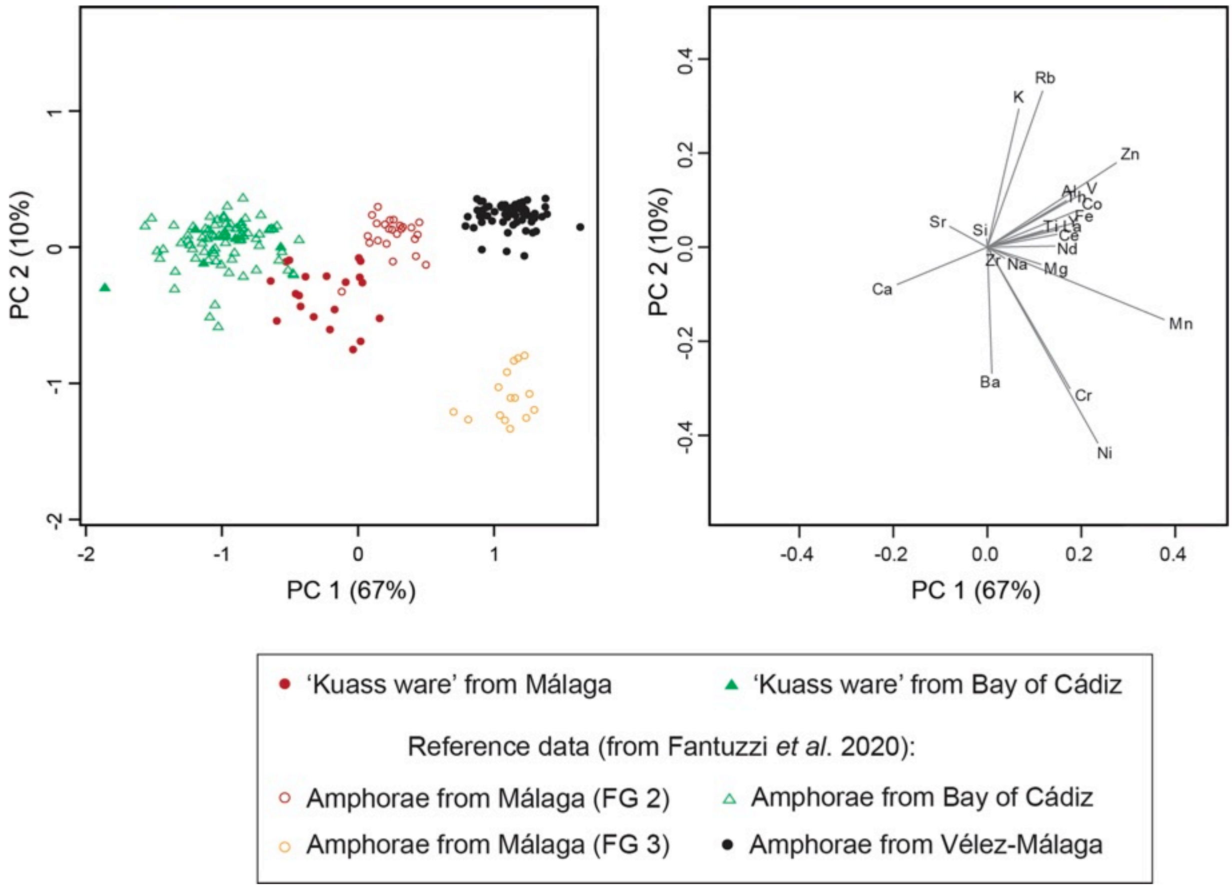

Fig. 10. PCA of the log transformed elemental data (WD-XRF) for the 25 'Kuass ware' samples compared to previously published data by Fantuzzi et al. (2020) for Punic amphorae and clay samples. The PCA was performed on the log transformed subcomposition Na, Mg, Al, Si, K, Ca, Ti, Fe, V, Cr, Mn, Co, Ni, Zn, Rb, Sr, Y, Zr, Ba, La, Ce, Nd, and Th (P, Pb, and Cu were excluded to avoid possible contamination problems). (a) Biplot PC1 vs PC 2. (b) Projections of elemental loadings.

CRediT authorship contribution statement

Leandro Fantuzzi: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Antonio M. Sáez Romero:** Writing – review & editing, Visualization, Supervision, Resources, Methodology, Investigation, Funding acquisition, Conceptualization. **Noémi S. Müller:** Writing – review & editing, Validation, Methodology, Investigation, Formal analysis. **Evangelia Kiriatzi:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Formal analysis. **Bartolomé Mora Serrano:** Writing – review & editing, Resources, Investigation, Funding acquisition. **Ana Arancibia Román:** Writing – review & editing, Resources, Investigation.

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.

Data availability

Data are contained in the manuscript.

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