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Articles

Late antique African Painted Wares (APW): tracing local production in North Africa

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Abstract

The production and circulation of common wares during the late antique period in North Africa has been largely overlooked by past scholarship, despite their potential to shed light on late antique production, workshop organisation and regional ceramic economies. This paper provides the first detailed study of a distinctive type of late antique, wheelmade common ware, the so-called African 'painted ware' (APW). It first presents a critical overview of the distribution of painted wares and their typology, decoration and chronology based on existing publications. It then develops a typology of vessel shapes, but also decoration patterns based on a large, well-preserved assemblage of painted ceramics recently excavated by the DAI, INP and UCL at the archaeological sites of Bulla Regia and Chimtou in the Medjerda valley, Tunisia. To understand the composition, technology and provenance of the wares, petrographic and chemical analysis was conducted on 57 painted sherds from the two sites. The results suggest the existence of a production centre in the Medjerda Valley, with potters using local calcareous clay tempered with sand, while the decoration was obtained using iron-based pigments. Comparison with published painted wares at other sites contributes to an initial insight into regional distribution patterns of the painted ware.

الفخاريات الأفريقية المطلية في أواخر العصور القديمة: تتبع الإنتاج المحلي في شمال أفريقيا بقلم فيرونيكا أوكاري، هايك مولر، كوريساند فينيويك، باتريك كوين لقد تجاهلت الدراسات السابقة إنتاج وتداول الفخاريات الشائعة خلال فترة العصور القديمة المتأخرة في شمال أفريقيا إلى حد كبير، على الرغم من قدرتها على إلقاء الضوء على إنتاج العصور القديمة المتأخرة و تنظيم الورش واقتصادات الفخار الإقليمية. تقدم هذه الورقة أول دراسة مفصلة لنوع مميز من الفخاريات الشائعة المصنوعة على عجلات الفخار في أواخر العصور القديمة، والتي تسمى عّالفخاريات المطليةْ. حيث تقدم أولاً نظرة عامة و نقدية على توزيع الفخاريات المطلية وتصنيفها وزخارفها وتسلسلها الزمني بناءً على المنشورات الموجودة. ثم تطور تصنيفاً لأشكال الأوعية، بالإضافة إلى أنماط الزخرفة بناءً على مجموعة كبيرة محفوظة جيداً من الفخاريات المطلية، والتي تم التنقيب عنها مؤخراً من قبل المعهد الأثري الألماني و المعهد الوطني للتراث و كلية لندن الجامعية في موقع بولاريجيا الاثري و موقع شيمتو في وادي مجردة، بتونس. لفهم تركيبة، تكنولوجيا، ومصدر هذه الأواني، تم إجراء تحليل صخري وكيميائي على ٥٧ قطعة فخار مطلية من الموقعين. وتشير النتائج إلى وجود مركز إنتاج في وادي مجردة، حيث كان الخزافون يستخدمون الطين الجيري المحلي الممزوج بالرمل، في حين تم الحصول على الزخارف باستخدام أصباغ قائمة على الحديد. تساهم المقارنة مع الأواني المطلية المنشورة عنها من مواقع أخرى في الحصول على نظرة أولية حول أنماط التوزيع الإقليمية للأواني المطلية.

Keywords: archaeometry; ceramics; economy; painted wares; technology

Introduction

North Africa was a major centre of ceramic production in the Roman and late antique Mediterranean, particularly renowned for the manufacture of amphorae and so-called African Red Slip Ware (ARS), fine tableware made with a red fabric and a transparent slip that was widely distributed up to the second half of the seventh century AD (Bonifay 2004; Bonifay and Reynolds 2023; Hayes 1972; Mackensen 2008; Reynolds 2016)[1]. Considerably less attention has been paid to late antique common and handmade wares, despite their importance as markers for the scale and reach of regional economic systems and their potential to provide insights on production, workshop organisation, ceramic distribution patterns and the spread of technologies (Leitch 2013; Reynolds 2016; Wickham 2005, 720–28).

This article aims to address this challenge by presenting the first comprehensive study of the so-called late antique African 'painted ware' (hereafter APW), a type of wheelmade pottery produced from the fifth to at least the mid-seventh centuries, decorated in red and brown with geometric and abstract floral and faunal decoration patterns. These ceramics are characterised macroscopically by relatively fine pastes ranging from a red to a creamy and greenish colour. Though this distinctive pottery group has been recognised for over a century (Bonifay 2004; Carton 1915; Fulford 1984; Février 1965) and is frequently noted in late antique layers in northern Tunisia, little is known about its chronology, production, location, distribution and technology, and the stylistic repertoire of the decoration has yet to be studied. Detailed investigation of painted ware has been complicated by the fact that no kilns have been found, though production centres at *Thuburbo Maius,* Sejnane and *Tiddis* have been tentatively proposed (Berthier 2000; Hayes 1976; Peacock 1984).[2]

Substantial numbers of APW excavated by the DAI, INP and UCL at the neighbouring sites of *Bulla Regia* and Chimtou offer an ideal opportunity to reconsider this ware within the late antique, North African context. This article first presents an overview of the distribution of published late antique APW in North Africa and a critical reassessment of their typology, decoration and chronology based on stratified finds. It proposes a detailed typology of painted ceramic vessel types and decoration patterns based primarily on the material from *Bulla Regia* and Chimtou and other

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published types. It then presents the results of petrographic and chemical analysis on 57 painted sherds from the two sites which provide information on the composition and technology of the wares. Raman spectroscopy was conducted on 23 sherds to identify the pigments used for the decoration. Comparison of the composition of the *Bulla Regia* and Chimtou APW with raw clay samples collected near the sites and ceramics of a likely local provenance (architectural *tubuli* and large storage jars, similar to Bonifay 2013, fig. 1, category 3) identified a 'local signature' for the APW which most likely reflects an unlocated workshop in North-West Tunisia which produced painted wares. The article concludes with an integrated discussion of the results of the archaeological and archaeometric analyses, and identifies possible APW regional production groups and distribution patterns, thus contributing to a better understanding of regional ceramic economies.

Previous research on late antique APW

Louis Carton was the first to identify and describe this distinctive ware in the region of Jendouba (colonial Souk El Arba) and in the later layers in his excavations at *Bulla Regia* (Manigold 1906; Carton 1909, 583; 1911, 601). In 1914, his astonishing discovery of many intact jars of differing sizes filled with foodstuffs in the so-called 'Church of Alexander' at *Bulla Regia* (a building destroyed by fire) allowed him to make some preliminary observations; the jars were wheelmade with a well-fired yellowish fabric and decorated in black and a reddish-brown paint which was applied with a brush before firing (Figure 1). He noted a great diversity of forms, ranging from large pot-bellied jugs with small handles to amphorae with narrower toes: a frustoconical form with an inverted base and a wide cylindrical neck was common. The decoration was also highly variable: many were simply decorated with black and brown alternating zones, as well as more complicated decorations featuring plants, foliage, birds and fish motifs (Carton 1915). A wealth of other finds, including several Byzantine crosses, led him to suggest a date of the late sixth or early seventh centuries (Carton 1915, 123–26; cf. Baratte 2022, 205–16). He saw these ceramics as a crucial transition in the African ceramic tradition between Punic ceramics and contemporary handmade Kabyle ceramics (for an overview of early modern handmade painted ceramics in North Africa, see Guichard and Hamel 2015).

Despite Carton's comprehensive description and the startling preservation of so many intact vessels, there was little further interest in APW until the 1950s and 60s when a series of important late antique excavations took place in Algeria at Sétif, Tébessa and *Tiddis* before independence (Amraoui 2017, 295–98 for overview). In Tunisia, the UNESCO 'Pour Sauver Carthage' campaigns in the 1970s and 1980s prompted a new interest in the wares and provided a tightly dated chronology for their introduction at Carthage. Hayes published several painted sherds from a small jug, and a shallow bowl, and other closed vessels from an ecclesiastical complex and a late antique house found during the University of Michigan excavations at Carthage (Hayes 1976, 89). The Carthage ceramics had a light orangey-brown fabric and brownish-red painted geometric patterns. Large quantities of painted ceramics with similar fabric were noted during work at *Thuburbo Maius* for the *Corpus des Mosaïques de Tunisie*, and Hayes suggested that there may have been a painted ware workshop at the site based on the comparatively large amount of APW compared with the few pieces in Carthage. In the 1980s, Fulford published a more detailed typology of painted ware forms found outside/inside the city walls (Avenue du President Habib Bourguiba site), including two big bowls, several closed forms (closed forms were difficult to define due to poor preservation) and a conical flask. The ceramics uniformly had a fine pale cream or buff fabric (fabric 2.4) and red-brown or purplish black paint (Peacock 1984, 16; Fulford 1984, 225). Peacock identified similarities between thin sections of painted ware and modern handmade painted wares from Sejnane, but also suggested APW could have been produced in Carthage (for Sejnane ceramics, Sekik and Louhichi 2007). Bonifay briefly revisited the ware in his comprehensive work on the late antique pottery of Tunisia and suggested a continuity of production into the seventh century based on stratified finds, but did not revisit the typology (Bonifay 2004, 301–303). The typologies provided by Hayes and Fulford thus remain the main reference point for APW.

Figure 1. African Painted Ware (APW) jar (Carton 1915, Figure 3).

The painted wares from Bulla Regia and Chimtou

The rediscovery of some of Carton's painted jars *in situ* in the 'Church of Alexander', as well as the identification of relatively large numbers of well-preserved painted wares from stratified excavations at two well-documented sites – *Bulla Regia* and Chimtou in the Medjerda Valley, ca 20 km apart – offered an ideal opportunity to address these challenges and establish a new baseline study for African painted wares.

Both *Bulla Regia* and Chimtou were important Numidian and Roman towns which continued to thrive into late antiquity (see Fenwick *et al.* 2022 for an overview of their late antique and medieval phases). *Bulla Regia* is known for its lavishly decorated fourth to fifth-century houses with bathhouses and underground rooms, floored with mosaics (Thébert 1973), at least three churches, fortifications and extensive evidence for late antique activity (Fenwick *et al.* 2022). The painted wares analysed in this article come from the funerary church and cemetery (Chaouali *et al.* 2018; Fenwick *et al.* 2023) and a trench on the other side of the road, the so-called Church of Alexander (Carton 1915), where Carton discovered a large assemblage of intact painted jars in the Church of Alexander (Baratte 2022, 205–16). The presence of similar painted wares has been noted in the Vandal-Byantine occupation phases in the Baths of Julia Memmia (Carton 1909, 583; Broise and Thébert 1993, 95, 387-89), Maison d'Amphitrite (Carton 1911, 601) and the Maison du Trésor (Quoniam 1952, 472, n. 2).

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Unfortunately, French excavations in the 1980s and 1990s in *Bulla Regia* have still to be fully published, but it seems likely that APW were found across the site in late antique layers.

Chimtou was traditionally thought to have been much reduced after the abandonment of the imperial quarries, but recent archaeological work has complicated the picture considerably. The site seems to have been a thriving late antique centre with at least three churches, including a perhaps martyrial monumental Christian complex with a large basilica, baptistery and probable mausoleum which was built in the late fourth/early fifth century and renovated in the sixth century (Arnold and Scheding in press; Khanoussi *et al.* 2012; von Rummel and Möller 2019). The painted wares studied in this paper come from stratified sequences in two areas: a zone to the north-east of the forum, and a monumental Christian church complex in the so-called 'Kaiserkultbau' area (Arnold and Scheding in press; von Rummel and Möller 2019: Figure 3). The forum contexts post-date the dismantling of the portico and are associated with the conversion of at least some of the monumental buildings into workshops in late antiquity (Ardeleanu *et al.* 2019; von Rummel and Möller 2019, 191). Unfortunately, due to many rebuilding phases, all contexts are chronologically mixed and currently these stratified painted ware finds can only be dated broadly from the fifth to the mid-seventh centuries. At the large Christian Basilica complex the situation is similar. The majority of the painted wares were found in the abandonment phase dated to the first half of the seventh century; however, an earlier date cannot be excluded (Möller in press: K176, K211, K220–K223). In both Forum and Basilica areas, there is a clear abandonment between the late antique layers and a ninth/tenth century medieval re-occupation. Elsewhere, two 'Byzantine' painted sherds were noted in the levelling phase of the Dii Mauri sanctuary (Rakob 1994, 43, and tab. 62.a–b). Rakob notes that they come from the nearby temple of Saturn area, where a small church was built on during the Byzantine period (Rakob 1994, 43). Unfortunately, other late antique buildings, including the small basilica on the Baal-Saturn sanctuary, the forum basilica and the late antique stone cist tombs have not been published or only in limited detail (cf. Mackensen 2008, 354–55).

Painted wares: distribution and chronology

Regional productions of painted wares in calcareous clays, including a buff ware decorated in red/ brown slip with geometric patterns, birds, fish, plants and occasionally crosses painted in red/brown slip, are known across the Mediterranean from the late fifth or sixth centuries, including Egypt ('Coptic Painted Ware': Egloff 1977), the Levant (e.g. Möller 2025; Watson 1991; Vroom 2012), southern and central Anatolia (Jackson 2009: 140–43; Vroom 2004: 297–300), Cyprus (Gabrieli *et al.* 2007), Crete (Vitale 2001) and Greece (Pétridis 1997). Painted ware is also found in Portugal and Spain (Reynolds 2010) and Italy, Sicily and the southern Adriatic, where the earliest examples seem to date to the sixth-seventh centuries, while other broad-brushed variants were made in the ninth–tenth centuries until at least the eleventh century (Arcifa and Ardizzone 2004; Arthur 1998: 495–98; Arthur and Patterson 1998; Whitehouse 1966;).

The neglect of this ware in North Africa until now is understandable. Painted wares are only identified in small quantities in comparison with other common wares in both survey and excavation contexts. Identified sherds are often very poorly preserved and impossible to classify typologically (Fulford 1984, 225). Misclassification probably contributes to the underrepresentation of painted ware in assemblages: the distinctive painted decoration is usually limited to the neck and shoulder area and the unpainted rim and base fragments are therefore likely to be misclassified as an undecorated type (cf. BR P4; Chi P21). Conversely, the painted body sherds can often not be assigned to any type except open and closed forms. As a result, the amount of material to study is very limited. Further challenges arise from the uneven history of research. Very few excavations have taken place in southern Tunisia or Algeria in the past decades, and many sites which have been excavated in detail remain unpublished. In the past, research questions often concentrated on settlement history with a focus on churches for late antiquity: ceramics are rarely mentioned except occasionally when whole vessels were uncovered (e.g. Haïdra, *Belalis Maior*). In these instances, photographs are sometimes provided, but profiles of the vessels are rarely included and many of the publications of late antique churches entirely lack ceramic catalogues, particularly outside Carthage. Where projects have published the ceramics (including the commonwares), yet more challenges are presented by the limited and variable detail on painted wares provided. Frequently, no illustration is provided for identified types (e.g. Hayes 1976, 52.IV.3; 58.VII.56) and often no details are given on the decoration. Petrographic analyses have focused on ARS and amphorae, and commonwares have received far less attention (Capelli and Bonifay 2014). The use of chemical analyses has been even rarer and has focused on ARS and medieval glazed ceramics (e.g. Baklouti *et al.* 2015; Capelli *et al.* 2011; Fermo *et al.* 2008; Mackensen and Schneider 2002; Occari *et al.* 2024), meaning that a precise classification and provenance of late antique commonwares in North Africa is still in its infancy.

Despite these challenges, our systematic analysis of published finds suggests some preliminary patterns. Figure 2 shows the distribution of sites with published painted ware finds (for details, see Table 1). Painted wares seem to be regionally limited to northern and central Tunisia, particularly inland in the Tell region as well as along the coast. Three inland sites with painted ware are also located in Algeria. However, there are multiple challenges in making a comprehensive evaluation of the distribution of ware, and the picture is likely to change with further research, particularly in southern Tunisia and Algeria where very little archaeological fieldwork has taken place in recent decades.

At Carthage, painted wares appear particularly in rubbish deposits of the late fifth and first half of the sixth centuries (Fulford 1984, 228; Hayes 1976, 89). Painted wares of 'local' fabric were found in a late fifth-century deposit in the northern sector of the Theodosian wall (Neuru *et al.* 1980, 203, pl.8E) and in a drain fill deposit dated 425–60 nearby (site 90; Lund 2020). Closed vessels with a similar fabric have been identified in various church contexts, including the 'ecclesiastical complex' (Hayes 1976, 89), Bir el Knissia (Kalinowski 1993, 173–74), the large extra-mural pilgrimage complex Bir Ftouha (Kalinowski 2005, 157.32; 161.13. and 14), and Damous el Karita (Schmidt and Kunze 2001, 107–114). At Bir Ftouha, one sherd is made of buff orange coarse fabric and differs in fabric and decoration from other APW in Carthage (Kalinowski 2005, 161.14). In the cisterns, a well-preserved sherd was found at one of the cisterns in the lower levels (Riley 1981, 97, figure 3.56). However, there are also later examples, including a shallow bowl post-dating the mid-sixth century which was found in a fill overlying latest floor levels in a house (Humphrey 1978, 157.P006, P015), and a closed vessel with ribbed handle which was found in a late sixth- to early seventh-century context near the city walls (Fulford 1984, 227.5).

APW is also found at major coastal and inland towns in northeastern Tunisia, including Nabeul, Sidi Jdidi and *Pupput*. The ceramics from Sidi Jdidi were found in a destruction/abandonment layer in Basilica 2 ('Groupe Épiscopale') dated to the second half of the fifth century (Bonifay 2004, 303; Mukai 2016, 122, context, 81, fig. 79.25). Inland, painted wares were found during the excavations of the Laberii thermal baths in Oudhna (Bonifay 2004, 302.7), which are presumably contemporary with sixth to seventh-century kilns producing ARS and commonwares in the baths. At

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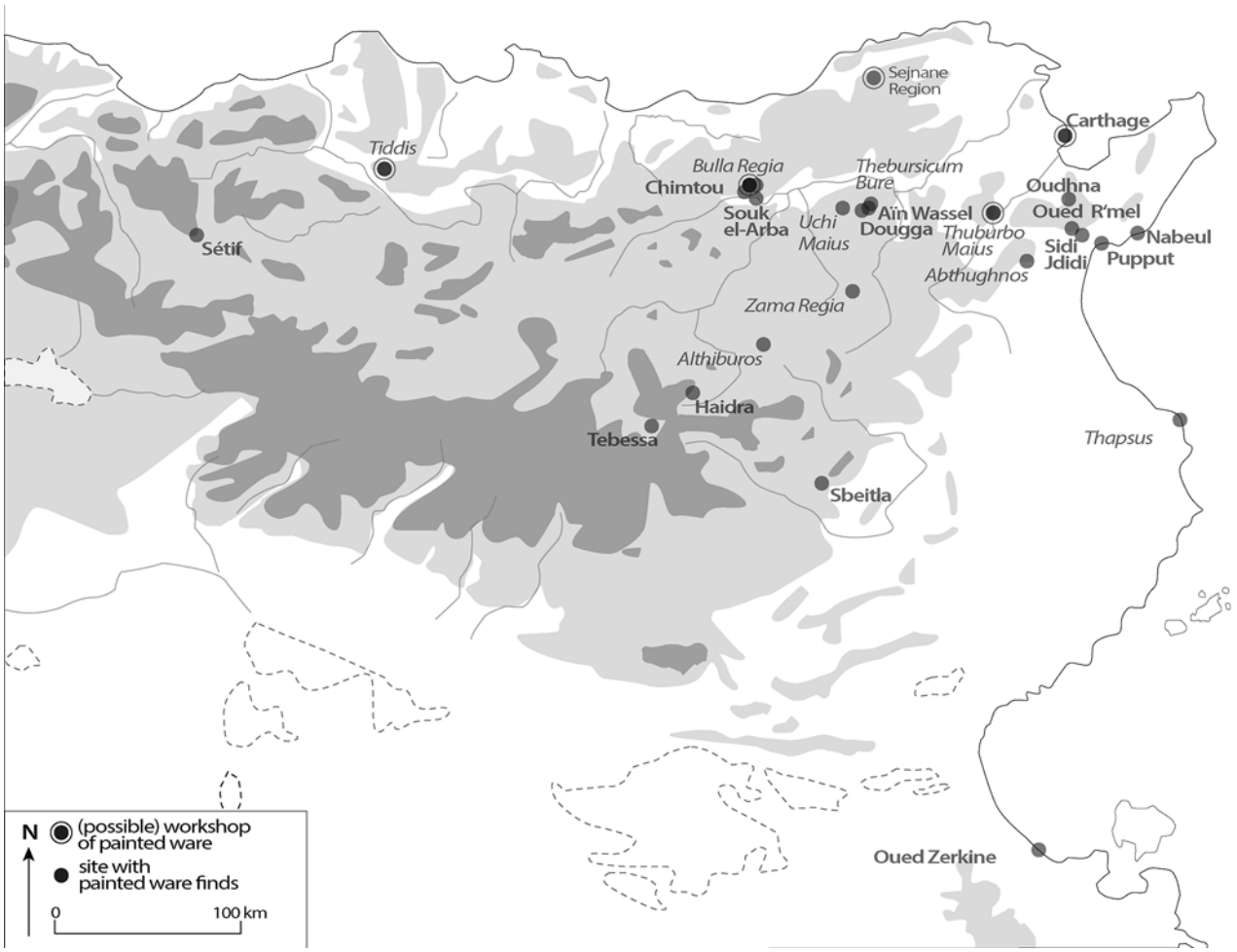

Figure 2. Distribution map with published Late Antique African Painted Ware (APW) sites and possible workshops (HM).

Table 1. Sites with published APW (CF, HM)

Site	Findspot	Painted wares	Dating (stratigraphic)	Bibliography
Abthugnos	church (abandonment layers)	large dish and a small hemispherical bowl with a spiral	seventh c. or later	Ben Nejma *et al.* 2023, 425–26, fig.15, fig. 16
Aïn Wassel	farm	small jugs (mainly body sherds)	mid sixth–mid seventh c.	Andreoli and Polla 2019, 234–36; Ciotola 2000, 40, 45; Ciotola 2004, 90
Althiburos	sixth–seventh layers in theatre	closed (probable pitcher)	sixth–seventh c.	Giuliodori 2012, 303, 307, fig. 10
Althiburos	late antique contexts in Capitol		fifth and early sixth c. contexts	Ben Moussa *et al.* 2011, 293.89; 300.21; 326.19; Ben Moussa and Revialla Calvo 2016, 175, fig. 4.41, pl. 4.2
Henchir el-Faouar/ *Belalis Maior*	large basilica (tomb 4) and late tomb to the south of 'small church'	small jugs	late antique	Mahjoubi 1978, 303–304, n..741, fig. 116b
Bulla Regia	Baths of Julia Memmia	jugs, dishes, bowls	late antique (sixth–seventh c.)	Carton 1911, 601; Broise and Thébert 1983, 95, 387–89
Bulla Regia	Maison d'Amphitrite	sherds	late antique	Carton 1911, 601
Bulla Regia	Church of Alexander	jugs, dishes, bowls	late sixth or early seventh c.	Carton 1915
Bulla Regia	extra-mural funerary church	jugs, dishes, bowls	fifth–seventh c. or later	Fenwick *et al.* 2023, 129–30, fig. 13.

(*Continued*)

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Table 1. (*Continued.*)

Site	Findspot	Painted wares	Dating (stratigraphic)	Bibliography
Bulla Regia	Maison du Trésor	jug	an early-mid-seventh c. hoard (post 613)	Quoniam, 1952: 472 and n. 2
Carthage	Juno hill (east flank)	sherds	late antique	Lantier 1921, 92
Carthage	ecclesiastical complex, late house	1 small jug and other closed vessels of unknown type, 1 shallow bowl	late fifth–sixth c.	Hayes 1976, 89 P006 and P015; Hayes 1978, 50–52, no. 22, fig. 121
Carthage	northern sector of Theodosian wall	jug	late fifth c.	Neuru *et al*. 1980: 203, pl.8E
Carthage	ditches and dumps associated with city wall	2 big bowls, several closed forms and a rim fragment of a conical flask	primarily late fifth and first half of sixth c. but some in late sixth to early seventh c. contexts	Fulford 1984, 25; Peacock 1984, 16
Carthage	Bir Ftouah	jugs, body sherds	first half sixth c.	Kalinowski 2005, 137.39; 143.7; 157.32; 161.13.14
Carthage	Damous El Karita	'rare'	fifth and sixth c. contexts	Schmidt and Kunze 2001, 107–14
Carthage	surface in late activity Circus	sherd and painted base	sixth c. on ceramics and coins, but seventh c. on stratigraphy	Tomber 1988, 518–19, no. 486, 487
Carthage	Vandalic cemetery – rubbish dump in ditch	1 painted commonware jug with carinated vertical rim (context 2010) (Hayes 1976, 89 MC1, Fulford 1884dm BC Form 4.1); 1 x closed form probable jug 4011	late fifth–early sixth c.	Freed 2009, 116–17, fig. 3.2, 21–22.
Carthage	Bir el-Knissia	1 rim and body: small shallow bowl with thickened rim	sixth c. (Justinianic)	Kalinowski 1993, 174.33
Carthage	Cistern, Deposit XXVII, Cistern 1977.1 Lower Level	1 painted pot, complete profile	mid fifth c.	Riley 1981
Chimtou/ *Simitthus*	abandonment phase of the large basilica	jugs, dishes, bowls	sixth–seventh c.	Möller in press, K176, K211, K220–K223, Schicht 15, SE 439
Chimtou/ *Simitthus*	Dii Mauri sanctuary (backfill of room E)	2 sherds	post-sanctuary phase – sixth–seventh c.?	Rakob 1994: 43 and tab. 62.a–b
Chimtou/ *Simitthus*	workshops and dwellings in late antique forum	jugs, dishes, bowls	fifth–seventh c.	Möller in press
Dougga/ *Thugga*	?	sherds with grid	late antique	Poinssot and Lantier 1925, LXXIX, n. 2
Haïdra/ *Ammaedara*	Basilica VII (cemetery between tombs 2 and 6)	jug with globular body	late antique	Baratte and Jaquest 2009, 71, figs 77, 78; Baratte *et al*. 2009 189–90, no. 39, fig. 39
Haïdra/ *Ammaedara*	Basilica I (pre-basilica? 2 second phase of occupation/destruction above earlier mosaic (under level 2)	jug	fifth–sixth c.	Duval 1981, 36 (cat. 102), p. 161, fig. 173.
Nabeul/ *Neapolis*	?houses/vats excavated in 1960s	bowl (bol), jar	seventh c.	Bonifay 2004, 302–303, fig. 169.1, 3
Oudhna/ *Uthina*	Thermes des Laberii (presumably in relation with sixth–seventh century ARS kilns)	jug	late antique	Bonifay 2004, 302–303, fig. 169.7
Oued Rʿmel	late Roman villa	bowl (jatte), small jug, jar	seventh c.	Bonifay 2004, 302–303, figs 169.2, 4, 9; Bonifay 2006, 80, fig. 38
Oued Zerkine (site 35)	site 35	sherd	late antique	Bonifay 2004, 302-3, 8; Bonifay *et al*. 2002a, fig. 11.134

(*Continued*)

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Table 1. (*Continued.*)

Site	Findspot	Painted wares	Dating (stratigraphic)	Bibliography
Hammamet/ *Pupput*	baths in centre (abandonment layer inroom XV)	small jug	seventh c.	Bonifay 2004, 302–303, fig. 169.10; Ben Abed Ben Khader 2005, 517 on seventh c. activity (we presume this to be the findspot).
Sbeitla/ *Sufetula*	Church 1 (associated with foundations of eastern apse)	sherds	late fifth to first half of sixth c.	Duval 1971, 97 (not illustrated)
Sétif/*Sitifis*	churches	jugs	fourth? fifth/sixth c.	Février 1965, 142; Février *et al*. 1970, 116–22; 130–32; Guéry 1970, figs 30, 35
Sidi Jdidi/*Aradi*	basilica 2, destruction level II	jug	second half of fifth c. for Mukai	Bonifay 2004, 302–303, fig. 169.6; Mukai 2016, fig. 79.25.
Souk el-Arba	cemetery, on site of 'ancient Souk el Arba'	many sherds reported	late antique	Manigold 1906, 201–202 (for site, Carton 1891, 227)
Tébessa/ *Theveste*	abandonment layer of Byzantine building (1) in ampitheatre	2 jugs and body fragments	fifth–sixth c.?	Lequément 1968, 209–19, pl. 29, 181–87
Thapsus	surface finds across site	many sherds reportedly observed – unpublished	late antique	Fulford 1984, 225
Thuburbo Maius	late houses and across site	many sherds observed	late antique (seventh c. hoard in association with some)	Merlin and Lantier 1922, 199, no. 1055, 1056; Poinssot and Lantier 1925, LXXIX, Hayes 1976, 89
Teboursouk/ *Thubursicu Bure*	surface finds around site	sherds	late antique	Andreoli and Polla 2019, 234
Tiddis	House P and elsewhere	cups, jugs, bowls, jars	fifth–sixth c.	Berthier 2000, 334; Amraoui 2017, 295–98
Henchir ed-Douaâmés/*Uchi Maius*	late-antique oil press in forum	jugs (closed forms only)	fifth–sixth c.	Biagini 2007, 390–91
Zama Regia	thermal baths	numerous sherds of closed vessels	fifth–seventh c.	Bartoloni *et al*. 2010, 2035–2036, fig. 14

Thuburbo Maius, painted jugs and a bowl were noted in 'late houses' below the Capitol (Poinssot and Lantier 1925, LXXIX – a late antique ceramic kiln has been identified (Ben Abed and Bonifay 1998, 231, n. 1). The discovery of painted wares in the late antique villa of Oued R'mel suggests a wide diffusion in rural sites (Bonifay 2006, 80, fig. 38); it is unclear whether the Segermes survey found any painted wares as only the finewares were published. At Nabeul, *Pupput* and Oued R'mel, the ceramics seem to continue into the seventh century.

In the Medjerda Valley, large assemblages of painted wares have been found at both *Bulla Regia* and Chimtou, where painted wares have been noted extensively in sixth- and seventh-century layers (see above). Carton also identified many painted sherds at a cemetery on the site of a settlement he identified as 'ancient Souk-el-Arba' (i.e. a small Roman settlement on the site of modern Jendouba), (Manigold 1906, 201–202). At *Belalis Maior*, painted jugs were found in a tomb in the large church as well as a late tomb near the 'small' church (Mahjoubi 1978, 303–304, n. 741, fig. 116b).

In the High Tell, painted wares have been found at multiple urban sites. In the hinterland of Dougga, a variety of small jugs (mainly bodysherds) were found in the Byzantine farm of Aïn Wassel (Ciotola 2000, 45, 49; Andreoli and Polla 2019, 234–236). The jugs had a hard, well-purified fabric with small, white, beige-brownish inclusions, which is distinct from the local fabrics of other common-wares and coarse-wares. In nearby *Uchi Maius,* painted ware jugs were found with other finds from the fifth and sixth centuries associated with late antique oil presses in the forum (Biagini 2007, 390–391). The clay paste is described as light beige or orange in colour with white and less commonly red inclusions, similar to that of nearby Aïn Wassel. Limited surface finds of painted ware (no typology given) were also noted around *Thubursicu Bure* (Andreoli and Polla 2019: 234). Numerous sherds of closed vessels were found in the thermal baths in *Zama Regia* (Bartoloni *et al.* 2010, 2035–2036, fig. 14) and a Byzantine church in *Abthugnos*, where a large dish and a small hemispherical bowl with a spiral decoration were found in abandonment layers dated to the late seventh century or a little later (Ben Nejma *et al.* 2023, 425–26). At *Althiburos*, closed vessel fragments were found in sixth to seventh-century contexts in the Theatre (Giuliodori 2012, 303, 307, Figure 10) and the Capitol area where a date of the early sixth century is postulated (Ben Moussa *et al.* 2011, 293.89; 300.21; 326.19, 178.US26015/26050; 179.US26054).

The High Steppes are more obscure, despite extensive excavations of late-antique churches in this area. Painted 'Christian' sherds (red on a beige background) were found at Sbeïtla in Church

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1 (Bellator) in association with the foundations of the earliest eastern apse which is dated to the late fifth/early sixth century (Duval 1971, 97). At Haïdra, two complete jugs have been published, one in the cemetery associated with Basilica VII and a second in a destruction layer which may predate the construction of Basilica I. Across the border in modern Algeria, painted wares with orange-red to ochre fabrics were noted at *Tébessa* in Vandal-Byzantine accumulation layers covering an abandoned house (Habitat 1) built in the amphitheatre and associated with late fifth- and early sixth-century coins (Lequément 1968).

In central and southern coastal Tunisia, the picture is very different. There are almost no recorded painted wares, even in those coastal sites which have been comprehensively studied and published. Painted ware was apparently noted at *Thapsus* on a visit by Fulford in the 1980s (Fulford 1984, 225), but no sherds have been identified in subsequent surveys or publications of the ceramics (Slim *et al.* 2004, 152–53; Younes 1999; Sghaïer *et al.* 2023). No painted wares have been identified in the comprehensive survey in and round nearby port-city Salakta (Nacef 2015, 61–76) or at the comprehensive studies of late antique commonwares from excavations at *Leptiminus* (Ben Lazreg and Mattingly 1992; Stone *et al.* 2011), Rougga (Guéry and Bonifay 2020, 97–106) or further south in the excavations of *Meninx* on Jerba (Ritter and Ben Tahar 2022; Fentress *et al.* 2009). The most southerly find is a body sherd of a closed vessel at a rural agglomeration in the Oued Zerkine (Site 35), the only painted ware noted in the Tunisian Coastal Survey (Slim *et al.* 2004, 109–110; Bonifay *et al.* 2002a, 152, no. 134).

Further west in modern Algeria, painted ware has been identified at two inland sites. A large assemblage of painted wares (including jugs, jars and small bowls) was found at *Tiddis,* particularly in a mosaic-floored room of the so-called 'House P' (Berthier 2000). The sherds have a fine, dense reddish-brown to yellowish paste with white, irregularly applied slip and red painted decoration. The concentration of painted ware sherds and wasters in the same fabric in the vicinity of the pottery kilns suggests that the vessels were produced locally, though no painted wasters were found (Berthier 2000, 334). Painted wares with a fine, hard, brick-red and reddish fabric with white inclusions were noted in the excavations of churches at Sétif (Février 1965; Février *et al.* 1970; Guéry 1970). The painted wares of Sétif (basilica) and Tébessa (amphitheatre) are dated broadly to the fifth–sixth century; the ceramics from *Tiddis* are assumed to be contemporary, based on typological features (Amraoui 2017, 295–98).

Three conclusions may be drawn from this overview of the data. First, though there are significant gaps in our knowledge particularly in eastern Algeria and central Tunisia, the distribution of painted wares seems to focus on northern Tunisia and the inland regions of Algeria. It is striking, however, that APW has not yet been identified in published assemblages of fifth to seventh-century commonwares from major coastal towns (Leptiminus, *Thapsus*, Meninx) and it seems that painted wares may not have diffused far south.

Second, APW are found in a wide diversity of fifth–seventh-century contexts. Closed forms (jugs and jars) are more commonly noted in the literature than open forms. Reflecting the urban bias of scholarship, most of our finds come from urban sites that were thriving in late antiquity. These urban sites, however, range significantly in size and importance from the metropolis of Carthage to substantial large coastal and inland cities, as well as much smaller towns (e.g. *Zama Regia, Althiburos, Abthugnos*). Significantly, the two farms that have been excavated (as well as the rural 'bourg' on the site of modern Jendouba) show that this ware was widely dispersed into the countryside. APW is found primarily in residential/workshop contexts and churches (including occasionally in association with graves). At Carthage, the presence of painted ware in dumps in the ditches in and around the Theodosian wall, mixed in with household refuse, shows that these ceramics were being consumed and dumped regularly.

Finally, the chronology of APW still requires refinement. Scholars broadly agree that they date to the fifth–seventh centuries, but due to a lack of well-stratified published contexts, their introduction and end date remain to be determined. Our earliest examples come from Carthage and the coast. At Carthage, APW appears mainly in the levels of the late fifth and early sixth century (Hayes 1976: 89; Fulford 1984, 228; Kalinowski 1993), with its first appearance in several mid–late fifth-century deposits (Neuru *et al.* 1980; Lund 2020). The second half of the fifth century is also proposed for Sidi Jdidi where APW were found in the second destruction level of Basilica 2 (Bonifay 2004: 303). A mid to late fifth-century introduction in, and around, Carthage is given further weight by the complete absence of APW at Utica, which seems to be abandoned in the early fifth century (Fentress pers. comm). Fulford (1984, 228) suggested that the main period of painted wares at Carthage was 475–550, with the majority being produced between ca. 500–535, and proposed that later examples are residual. He also suggested that those with 'confused' patterns are later than those with distinct motifs of birds, lattice and leaves. To Bonifay, APW in seventh-century contexts at Carthage, Nabeul, *Pupput* and Oued R'mel seemed to be too numerous to be residual (Bonifay 2004, 303).

Continuity of production beyond the sixth century can now be confirmed, especially outside Carthage. A later dating is also suggested by the farmhouse of Aïn Wassel where APW was found together with ARS produced in the mid-sixth–mid-seventh century in both the occupation and abandonment layers of two rooms (Andreoli and Polla 2019). At Chimtou, a few fragments of painted wares in the abandonment phase of the large basilica are associated with late ARS Hayes 99B of probably regional production and ARS D Hayes 109, which could possibly indicate a production into the seventh century (Möller in press, Schicht 15, SE 439). In Bulla Regia, the early seventh-century hoard (post-613) of 70 gold solidi in a small painted jar in the Maison du Tresor confirms that the ceramics were still in use in the seventh century (Quoniam, 1952, 472 and n. 2). The painted wares of the 'Church of Alexander' associated with amphorae of type Hammamet III might also suggest a later date (Baratte 2022). Unfortunately, the painted vessels in both Chimtou and Bulla Regia, with the exception of the jar with the hoard, are all found in contexts together with pottery from the late sixth century. Our poor understanding of early medieval ceramics before the introduction of glazed ceramics in the late ninth century hinders consideration of the 'end-date' of these wares, but the frequent presence of APW in very late abandonment/destruction contexts (e.g. church at *Abthugnos*, funerary church at *Bulla Regia,* baths at *Pupput*) suggests that there is a strong likelihood that the wares continued to be produced even into the late seventh and probably eighth centuries.

Painted wares: typology and decoration

Earlier attempts to classify the typology of painted wares were stymied by the poor preservation of painted wares, in particular, the challenge of identifying rims, bases and handles which were usually undecorated. The excellent state of preservation and comparatively large assemblages of APW at *Bulla Regia* and Chimtou, particularly the well-preserved jars in the reserves of *Bulla Regia* which are presumably those from Carton's (1915) excavations, have permitted a typology to be created. Table 2 provides a summary of all known APW types, integrating other published examples for comparison. The ceramics are buff in colour and have a very thin lighter surface layer, probably a so-called 'self-slip' layer obtained by wetting the surface of the formed ceramic object while the clay

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Table 2. Summary of APW typology and identified examples (HM)

Type	Description	Decoration	Occurence	Reference
APW 1	One-handled jug. Rim slightly outbent, rounded and thickened; neck, tubular, medium high and 2–3 cm in diam.; body rounded/globular; foot slightly stemmed, base flat, 3–4 cm in diam.; handle attached to shoulder and neck.	Out.: Vessel Part: B and C, decoration pattern (1)	*Bulla Regia*; Chimtou	Chimtou: von Rummel and Möller 2019, fig. 14.34
APW 2	One-handled jug. Clover-leaf mouth; rounded rim, 3 cm in diam.; handle attachment underneath the rim.	Out.: Vessel Part: B, decoration pattern (1)	*Bulla Regia*	
APW 3	Table Amphora. Flat base; looped handles attached on both sides to neck and shoulder.	Out.: Vessel Part: C, decoration pattern (1)	*Bulla Regia*	
APW 4	One-handled jug; tubular-shaped neck of medium heigth; handle attachment just below the rim. Variant A: Rim, almost squared, flattened on upper surface, with shallow groove around outside; Variant B: rounded, triangular rim, three shallow grooves around outside; Rim diam. of all variants 6–8 cm; two almost complete one-handled vessels with almost straight body; flat base and handle attachment on the shoulder and neck from *Belalis Maior* and one from *Tiddis* might belong to the same type APW 4a/b; Variant C: has a globular body; a slightly outbent rim, rounded and thickened, 8 cm in diam. and a tubular neck; the ring-base is flat; handle attached to shoulder and neck and was found in Haidra; Variant D: has a slightly rounded body and handle attachment just on the shoulder (BR P2).	Out.: APW 4a–c: Vessel Part: B and C (complete vessels *Belalis, Tiddis)* decoration pattern (1); APW 4d: Part B and C, decoration pattern (1) and (3)	*Bulla Regia*; Chimtou; *Belalis; Tiddis*, Aïn Wassel; APW 4a: *Uchi Maius*, Aïn Wassel; APW 4c: Haïdra; APW 4d: Aïn Wassel; BR P2	*Belalis Maior*: Mahjoubi 1978, fig. 116b; *Tiddis*: Berthier 2000, fig. 147. *Uchi Maius*: Biagini 2007, 425.237; Haidra: Baratte *et al*. 2009, 190, fig. 145.39; Aïn Wassel: Andreoli and Polla 2019, 235, fig. 3.59.4
APW 5	One-handled jug; rounded rim, 5 cm in diam; neck widens towards vessels body; handle attachment just below the rim.	Out.: Vessel Part B; decoration pattern (1)	*Bulla Regia*; Chimtou	Chimtou: von Rummel and Möller 2019, fig. 14.36
APW 6	Jug; rectangular, thickened rim, 8–10 cm in diam.; funnel-shaped neck.	Out.: Vessel Part B; decoration pattern (1)	*Bulla Regia*; Chimtou	*Bulla Regia*: Fenwick *et al*. 2023, fig. 15.6
APW 7	One-handled jug; rounded rim, 8–10 cm in diam.; funnel-shaped neck; handle attachement at neck/shoulder, horizontal ledge?	Out.: Vessel Part C decoration pattern (1)	*Bulla Regia*; Chimtou	Chimtou: von Rummel and Möller 2019, fig. 14.32
APW 8	Jug; rounded rim, slightly thickened towards inside and outside; 6 cm in diam.; funnel-shaped neck.	Out.: Vessel Part B; decoration pattern (1)	*Bulla Regia*; Chimtou	
APW 9	Jug; tubular neck, 5–6 cm in diam.; two horizontal ledges outside, one along neck/shoulder, second one below the rim.	Out.: Vessel Part C; decoration pattern (3)	*Bulla Regia*; Chimtou	
APW 10	One-handled jug; sharply bent body. Almost complete profile in *Uchi Maius* has a squared rim, 6(?) cm in diam.; horizontal ledge inside just below the rim and outside on the neck; where the handle is attached. Slightly looped handle ends on the vessel's shoulder.	Out.: Vessel Part B(?) and C, decoration pattern (2)	*Bulla Regia*; Chimtou; *Uchi Maius*	*Uchi Maius*: Biagini 2007, 425.236
APW 6-7	Jug; funnel-shape neck, horizontal ledge outside, neck/shoulder, handle attachment on neck and vessels shoulder; ring base, concave 10–13 cm in diam. One variant with almost straight body, the other one with slightly rounded body – might belong to APW 6 and/or APW 7, similar rounded body, cf. Chi P33 (fig. 5.2), the jug published by Carton (fig. 2) and finds in Aïn Wassel.	Out.: Vessel Part C and D and along the ledge; decoration pattern (3) and (2)	*Bulla Regia*; Chimtou; Aïn Wassel	*Bulla Regia*: Carton 1915, fig. 3; Aïn Wassel: Andreoli and Polla 2019, 235.1 and 6
APW 11	Jug/Table amphora; rim horizontally bent towards outside, 13–4 cm in diam.; horizontal rilling on neck's inside.	Out.: Vessel Part B; decoration pattern (1)	Chimtou	
APW 12	Bowl; rim straight, slightly pointed, 8–10cm in diam.; base almost flat, slightly concave towards the middle.	In.: Vessel Part A to D; decoration pattern (1); (2) and (4)	*Bulla Regia*; Chimtou; Nabeul; Carthage; *Abthugnos; Tiddis*	*Bulla Regia*: Fenwick *et al.* 2023, fig.15.7; Carthage: Kalinowski 1993, 174.33; Nabeul: Bonifay 2004, 302.1; *Tiddis*: Amraoui 2017, 297, fig. 310.4–5; *Abthugnos*: Ben Nejma *et al*. 2023, 426, fig. 16 2023

(*Continued*)

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Table 2. (*Continued.*)

Type	Description	Decoration	Occurence	Reference
APW 13	Large bowl, rim thickened, rounded, slightly flanged, ca. 30 cm in diam.; horizontal (?) handle attached to the rim.	In.: Vessel Part A to D; decoration pattern (3) and (4)	Chimtou	Chimtou: von Rummel and Möller 2019, fig. 14.38
APW 14	Large bowl. Variant a: rim nearly rectangular, profiled at the outside, flattened on top, ca. 30 cm in diam.; Variant b: rim nearly rectangular, slightly rounded on top, ca. 26–30 cm in diam.; Variant c: rim nearly rectangular, profiled, slightly thickened towards the inside, 26–30 cm in diam.	In.: APW 14a–c: Vessel Part B and C, decoration pattern (2) and (4); APW 14b also decorated on top of the rim, Part A	*Bulla Regia*; Chimtou	
APW 15	Large bowl, rim nearly rectangular, slightly overhanging on the outside, flattened on top, but slighly profiled, ca. 28 cm in diam.	In.: Vessel Part A and B, decoration pattern (3) and (4)?	Chimtou	
APW 16	Large convex bowl, rim flattened/cut on top, ca. 30 cm in diam.	In.: Vessel Part A and B, decoration pattern (3) and (4)	*Bulla Regia*; Chimtou	
APW 17	Shallow bowl, rim vertical, cut on top, ca. 30 cm in diam.	In.: Vessel Part A and B, decoration pattern (1)?, (3) and (4)?	*Bulla Regia*; Chimtou	*Bulla Regia*: Fenwick *et al.* 2023, fig. 15.8
APW 18	Large bowl, rim rounded, triangular, slightly overhanging outside, ca. 30 cm in diam.	In.: Vessel Part A to D, decoration pattern (3) and (4)	Chimtou	Chimtou: von Rummel and Möller 2019, fig. 14.39
APW 19	Large bowl, rim everted, concave, ca. 32 cm in diam.; strap-handles attached to upper surface of rim; ring base.	In.: Vessel Part A to D; decoration pattern (2), (3) and (4)	Carthage	Fulford 1984, fig. 88.1
APW 20	Pot with two vertical handles, rim rounded, convex, 6.5 cm in diam.; base slightly concave; vertical handles attached to rim and body.	Out.: Vessel Part A to C, decoration pattern (3) and (4)	Carthage	Riley 1981, 96, fig. 3.56

is still moist to produce a smoother finish (Quinn 2022, 255). Brownish-black and reddish-brown paint is used for details (see below on its composition). The typological variability of painted wares in Chimtou and *Bulla Regia* is very limited. The forms are restricted to small and large closed vessels (one-handled jugs and table amphorae) and a few open vessel forms (small bowls and plates/bowls of large diameter). In general, all types occur on both sites. A few exceptions such as APW 2 and 3 which only appear at *Bulla Regia* may reflect the better state of preservation of vessels at the site.

Closed vessels (Figure 3)

Smaller examples of one-handled jugs (APW 1 and APW 2), can occur with round or cloverleaf mouths and have an average rim diameter of 2–3 cm. A table amphora (APW 3) is similarly small. Larger vessels are more common and vary typologically. Particularly common are variants of one-handled jugs with a tubular neck and thickened rim (APW 4a–d). The rim diameter is usually between 6–8 cm. Two completely preserved vessels from *Tiddis* (Berthier 2000, fig. 147) and *Belalis Maior* (Mahjoubi 1978, fig. 116b) with an almost straight body, flat (?) base and one handle attached to neck and shoulder have a similar rim as seen in type APW 4a/b. Another almost completely preserved vessel with the same rim shape, but with a round rather than a straight body was found in Haïdra (APW 4c, Baratte *et al.* 2009, 90, fig. 145.39, not shown in Figure 3). A further variant APW 4d has a slightly rounded body. It is possible that some rim fragments summarised under APW 4a and b might also end in body types APW 4c and d. One example of a one-handled jug, APW 5, has a neck that widens towards the vessel's body.

Funnel-shaped samples (APW 6–8) are just as common as those with a tubular neck (APW 4) and are differentiated into three main types by their rims. The funnel-shaped neck of an almost complete vessel (BR P4) probably shows the complete shape of one of types APW 6–7, as does Chi P21 (both Figure 3) and the jug published by Carton (1915, fig. 3), as well as the vessels found in Aïn Wassel (Table 2). They all have in common a horizontal ledge on the outside; however, the transition from shoulder to body can also be smoothed/rounded (APW 6–7). A similar ledge can be seen by a jug (APW 9) without a preserved rim. A one-handled jar with northern Tunisian fabric from the Musée des beaux-arts de Montréal, thought to have been purchased in Carthage (Caron 2021), is similar to APW 6–7, but has to be treated with care as its origin is uncertain. An almost complete one-handled jug published from *Uchi Maius* (APW 10, Table 2) has the same sharp, bent body visible on the body sherds from Chimtou. The rim of APW 11 is folded horizontally outwards. The vessel is thicker-walled than the other types and traces of the production process (wheel-turning lines) are clearly visible (CHI22-073, not sampled).

Open vessels (Figure 4)

Bowls with a small diameter (APW 12) are widely known and found at several sites (Figure 15). The large bowls are more variable in their typology. Unique is an example of a large bowl with the handle attached to the rim (APW 13, cf. Table 2.) which may be related to type APW 18 with triangular, slightly overhanging rim. APW 19, a large bowl with everted, concave rim that has strap-handles to the upper surface of the rim, found in Carthage with

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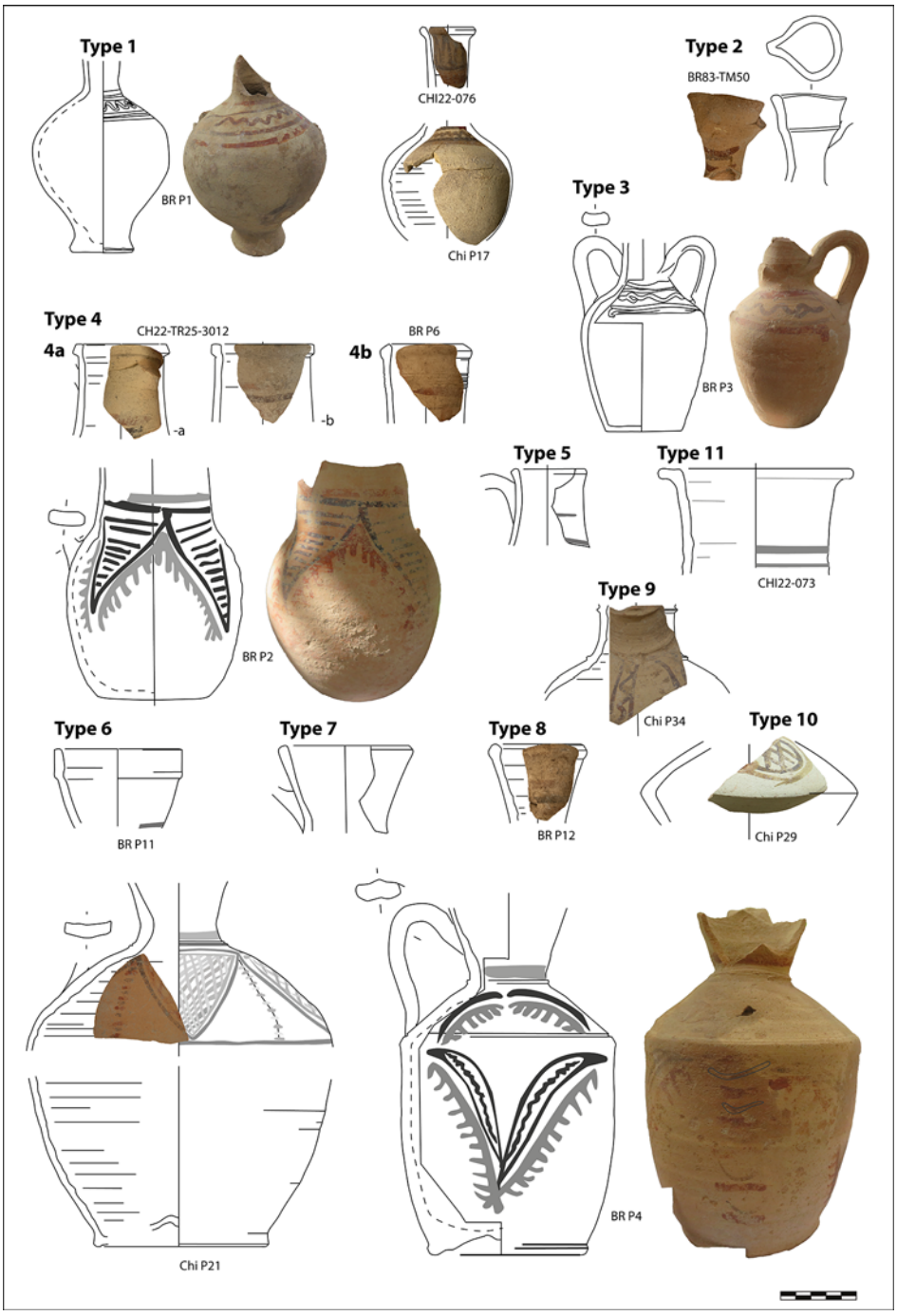

Figure 3. Typology of APW - closed forms (APW 4c see: Baratte et al 2009, 190, figure 145.39 (HM)).

at least one more piece of the same type, does not currently have any parallel in the *Bulla Regia* or Chimtou wares. More common are bowls APW 14a–c with a compact, nearly rectangular rim that occurs in three different variations. Bowl APW 15 is closely related. A bigger group of large bowls are summarised under AWP 16. The group itself is not as homogeneous as the other open vessel types (e.g. APW 12, APW 14). APW 17 is slightly different but also related to APW 16 because of a similar rim-treatment. Up to now only one type of base can be attributed to the large bowls. It has a ring base and is typically 12cm in diameter (Chi P7, Figure 6a).

The complete profile of a pot found in Carthage is summarised under APW 20. Similar pots have not been identified in Chimtou nor in *Bulla Regia* – these may be a coastal production as similar pots are also mentioned in Nabeul and Oued Rʿmel (Bonifay 2004, fig. 169.3–4).

Decoration patterns

Four categories of decoration can be identified (Figure 5): **(1)** horizontal lines and wavy bands; **(2)** faunal (birds and fish) and floral patterns; **(3)** grids (criss-cross and parallel lines), often framed by triangular patterns. However, they can also be used as filling pattern for the bird wings (cf. Figure 5: Chi P33); **(4)** irregularly placed strokes and dots. Vertical lines partially interrupted by horizontal strokes or wavy bands abutted by lines are used as dividing lines/filling motifs (e.g. Figure 5: BR P4; Chi P21) for different

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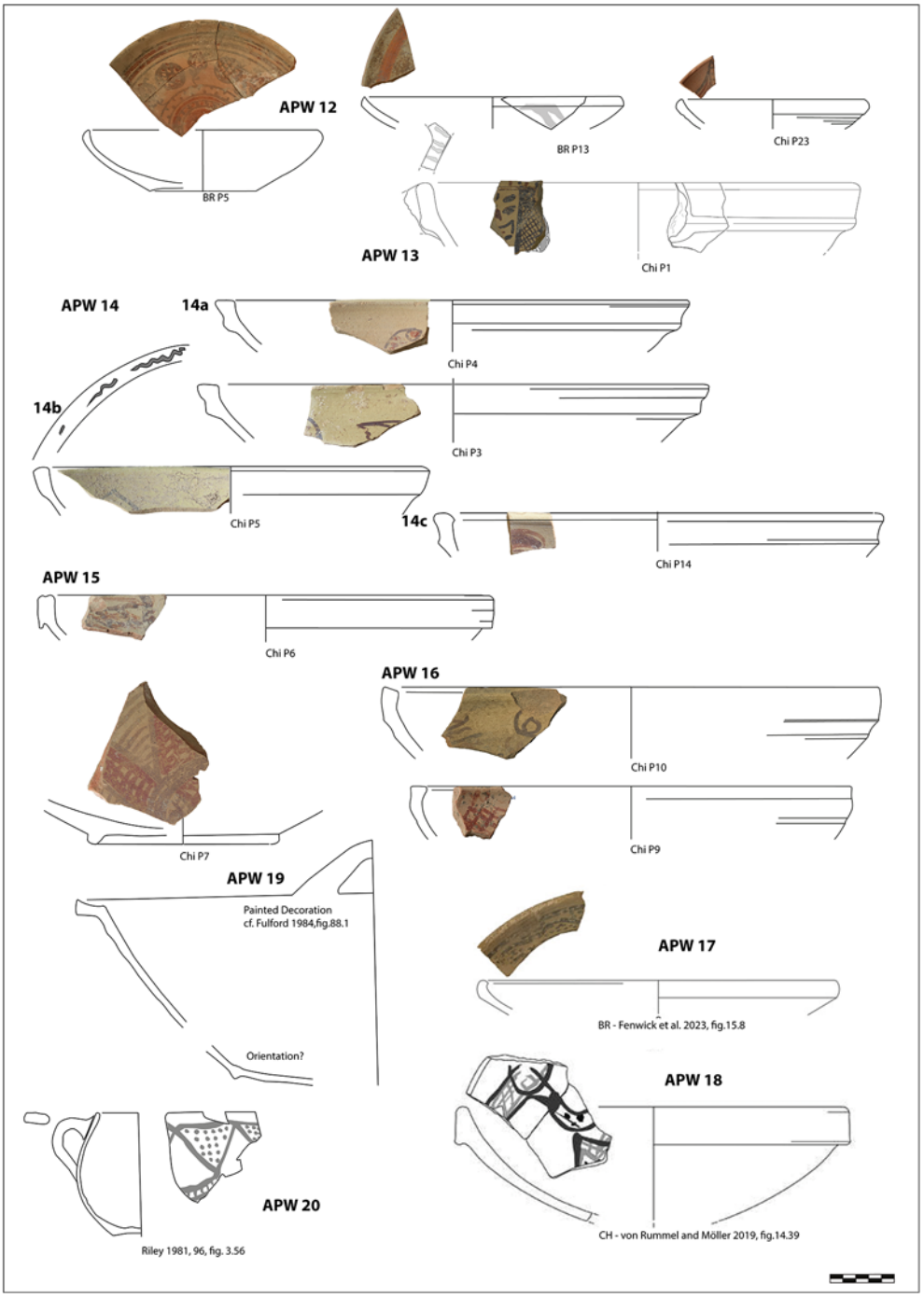

Figure 4. Typology of APW - open forms (HM).

zones. Vertical lines from which short, diagonal strokes emanate can also be selected as dividing lines or filling motifs (Figure 5: BR P4; BR P2).

The jug showing a Chi-Rho, two cockerels and possible architecture (a basilica) from the Musée des beaux-arts de Montréal has not been considered here (Caron 2021, fig. 4). The painted decoration has no parallels in published APW; in our opinion the jug's Tunisian provenance is uncertain.

The nature of decoration on the open and closed vessels differs significantly. On closed vessels (jugs and juglets), there is usually a strict order for the zones of decoration. The closed vessels found in Chimtou and *Bulla Regia* are divided into **zones (A–D)**; each zone is separated by horizontal lines (zone A: rim; zone B: neck/shoulder; zone C: body; zone D: body/bottom) (see Table 2). If there is a handle, the decoration runs out in the area of that zone (Figure 5: BR P1). In rare cases, the zones are orientated along the vessel profile (along ridges, edges, see Figure 5: Chi P21; BR P4). On closed vessels, painted decoration is always present in zone B, frequently present in zone C and sometimes present in zone A. Zone D is always left blank (but can be painted on the open vessels).

The most common decorative patterns on closed vessels are horizontal lines alternating in colour or monochrome lines and wavy bands **(1),** whereby a wavy band is framed by a horizontal line in the same colour (Figure 5: BR P1; Chi P34; BR P19). The height and density of the waves can vary greatly. These patterns occur mainly in Zone B, but they exist also in Zone A (Figure 3: BR P12; BR P6; CHI22-073) - a wavy band alone without a

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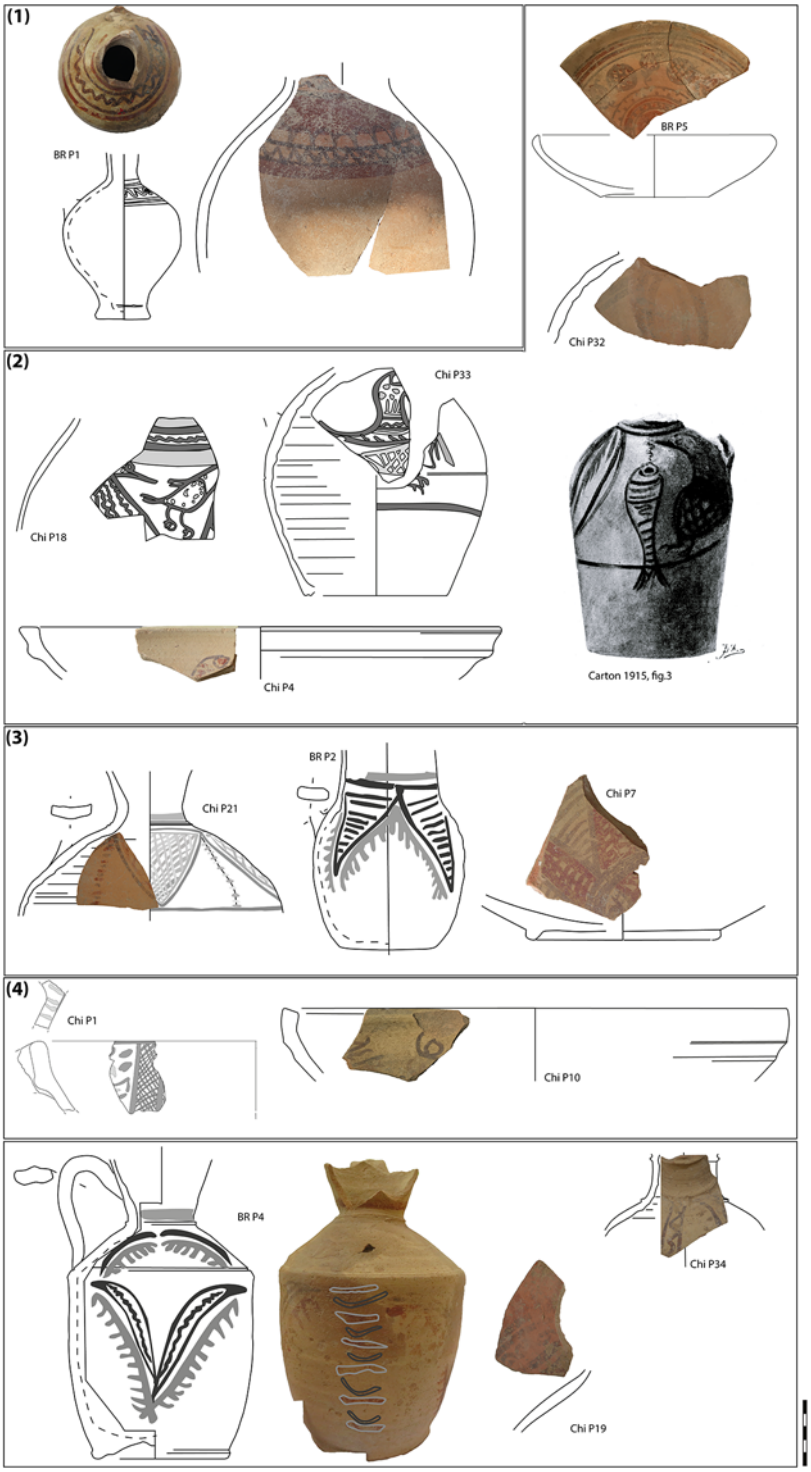

Figure 5. Decoration patterns (DP) of APW (HM).

border of lines can occur in Zone A, but so far this has only been observed on the open vessels on top of the rim (Figure 4: Chi P5). Floral and fauna motifs **(2)** are found only in Zone C of the closed vessels, delimited by a horizontal line above and below (Figure 5: Carton 1915, Figure 3; Chi P33). The most common motif is abstract birds in profile: wavy bands, dots, grids, lines and short strokes are used to define their figure. There are often dividing lines between the birds (Figure 5: Chi P18; Carton 1915, Figure 3). Leaf motifs drawn with thick strokes are also characteristic. The leaves are 'hung' in a row on the horizontal line that introduces the zone (Figure 5: Chi P32, Carton 1915, Figure 3). Roses can also be noted on some examples (Figure 5: BR P5). The grid patterns **(3)** are usually arranged in the same style. They are found in Zones B and C, often integrated into triangles that point downwards framed by lines with short vertical strokes (Figure 4: Chi P21; BR P2).

In contrast to the closed vessels, large plates/bowls are filled with decoration in all zones. However, the decoration can be set selectively, so that many blank spaces are created (Figure 4: Chi P5; Figure 5: Chi P10). Geometric patterns (lines, wavy bands, grid lines) dominate. Floral or faunal decorations have only occasionally been identified (Figure 5: Chi P4 (bird); Figure 4: APW 18 (animal?), but this may reflect poor preservation. The selection of motifs/decoration patterns seems less ordered except for decoration pattern 3: grids are organised around the centre of some open vessels in a similar manner to closed vessels (Figure 5:

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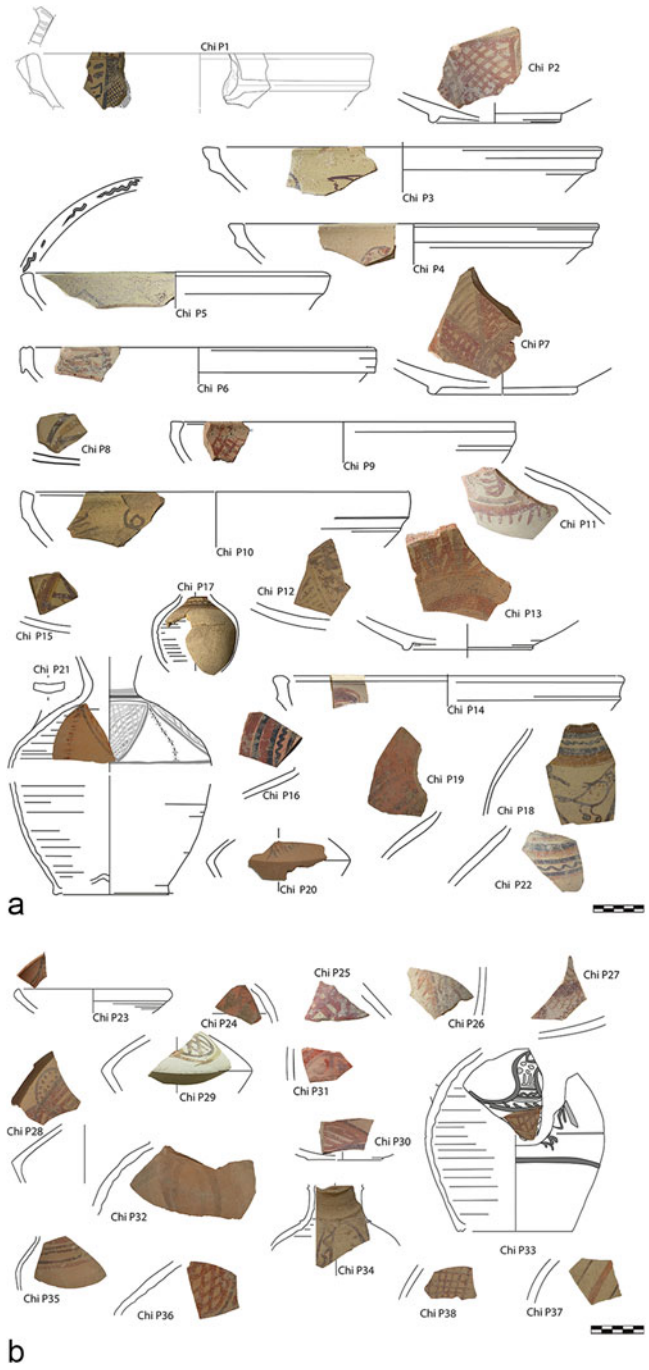

Figure 6. a and b: Chimtou - all analysed samples (Chi P) (HM; VO).

BR P2; Chi P21 and Chi P7). For small bowls/plates, it is sometimes possible to identify different zones of decoration. Zone A is filled by one broad line just underneath the rim part of the vessel (Figure 4: BR P13) or concentrical lines alternating in colour. The latter is followed by a broad band, showing alternating circles and faunal motifs, which are filled with dots and grid patterns (Zone B). The vessel's centre is marked by a large dot, which is encircled by lines filled with dots of different colours (Zone C) (Figure 5: BR P5). It remains unclear whether this is a typical decoration of these small bowls (Figure 4: APW 12) in the region, as we have found no further examples in *Bulla Regia* or Chimtou. Similar APW 12 found in Nabeul and Oued R ʿ mel shows different decoration , including a spiral painted on the interior of the vessel (cf. Figure 16).

Archaeometric analyses

The samples and sampling strategy

Fifty-seven ceramic artefacts representing the different types and decoration designs identified in the painted ceramics excavated at Chimtou and *Bulla Regia* were selected for analysis (Table S2 in supplementary material; Figures 6, 7). Since the 'local fingerprint' for ceramic production in *Bulla Regia* or Chimtou has yet to be established in the absence of kilns, 16 architectural *tubuli* and five large storage jars from the same stratigraphic phases as the painted wares were also analysed on the assumption that they were produced locally due to the high quantity/mass production (*tubuli*) and the size and weight (storage jars, cf. Bonifay 2013, 539) (Figure 8). One modern sherd manufactured by a local potter in *Bulla Regia* has also been included in the analysis for comparison. They are intended to serve as an additional parameter for determining origin.

Methods

Methods employed for compositional analyses are summarised below; see supplementary material for further details.[3] The samples were first analysed using thin-section petrography to examine the composition and the textural characteristics of the body pastes. The storage jars and the modern sample were not analysed in thin section, as the samples were very small.

The sherds were also characterised geochemically by LA-ICP-MS using an Applied Spectra J200 Tandem LA/LIBS system coupled to an Agilent 7900 quadrupole ICP-MS (See Table S1 in supplementary material for information on the instrument parameters and Table S2 in supplementary material for LA-ICP-MS results). Four samples (BR P1–4) were too small after thin sectioning to be analysed by LA-ICP-MS. Three SRMs were used for calibration: NIST 610, 614 and NIST 679. Accuracy and precision were measured on NIST 612 and are reported in supplementary information (Table S3 in supplementary material). A sub-sample of 23 sherds was analysed by Raman spectroscopy to identify the pigments used for the painted decoration. Samples were selected to include all decorative patterns and their different hues. Samples were analysed using a Renishaw inVia Qontor confocal Raman microscope. The accuracy and stability of the wavenumber were checked by recording the Raman spectra of a silicon standard (520 cm-1). The dark-brown decoration of a sub-selection of three samples was analysed by portable X-ray fluorescence spectrometry to confirm the results obtained by Raman for the dark-brown pigment, using an Olympus Innox-X Delta Premium hand-held portable X-ray fluorescence spectrometer ('UCL IoA pXRF4') with a Rhodium source and a 2 mm aluminium filter. Compositional groups have been established using multivariate statistical methods including principal component analysis (PCA) and hierarchical cluster analysis (HCA), the latter using the average linkage method. Prior to statistical analysis, data were transformed to log-ratio values as a resolution of the constant-sum constraint (Aitchison 1986).

Geological prospection

In order to test whether the painted wares from Chimtou and *Bulla Regia* were manufactured locally, raw clay samples were collected at locations near the sites and investigated both chemically and petrographically. The Central Medjerda Valley is a tectonic depression that is delimited by the Kroumir Mountains in the north and the Dorsal Mountains in the south. The geology of the area around Chimtou is dominated by alluvial deposits and bounded by Pontian to Quaternary sediments to the north and

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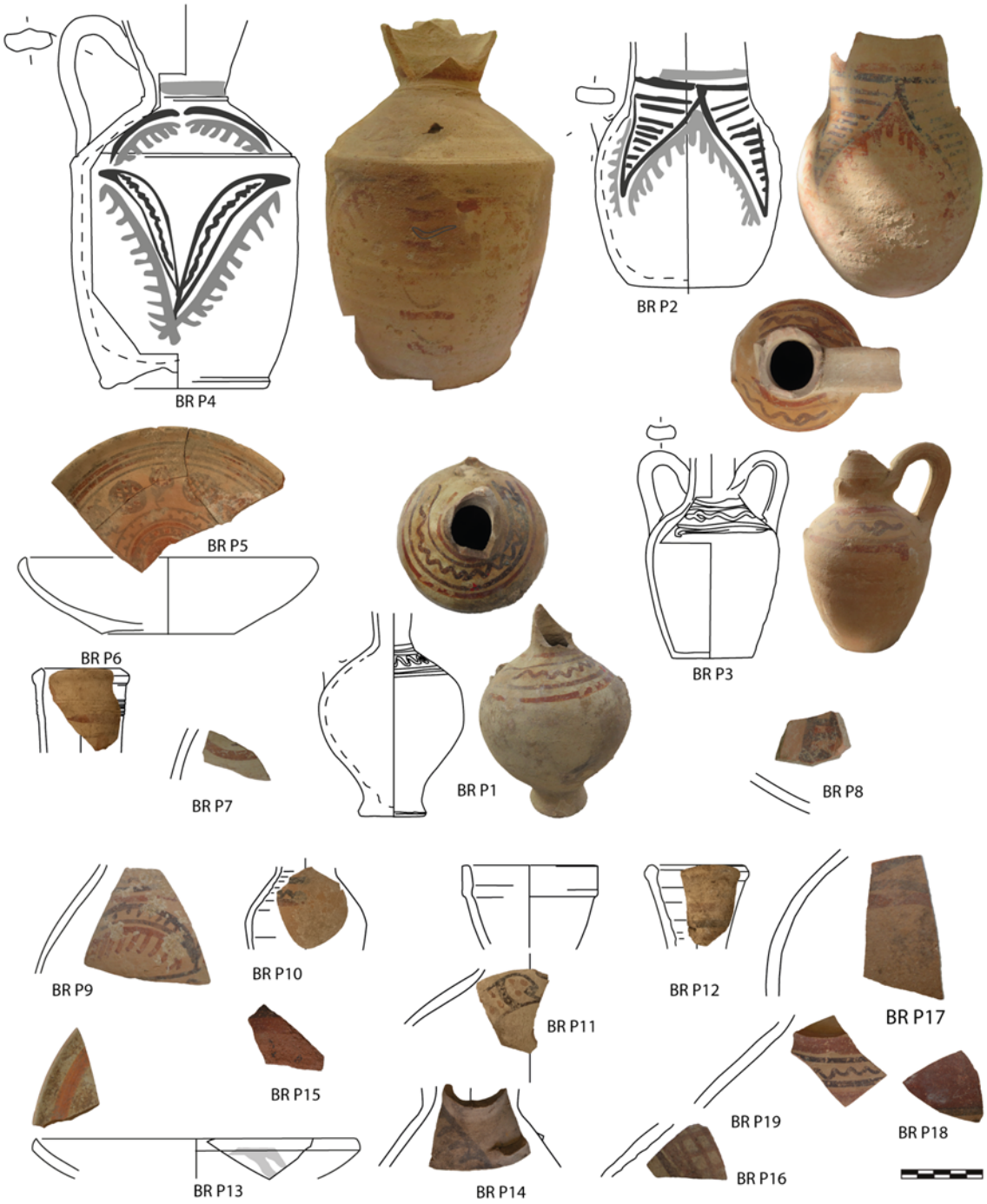

Figure 7. Bulla Regia - all analysed samples (BR P) (HM; VO).

south, composed predominantly by mudstone, marl, sandstones and conglomerates, while Triassic formations composed of shale and sandstone have been reported north-east of the site. The geological formations around *Bulla Regia* are similarly characterised by alluvium deposits constituted of silt, sand and marl, as well as by Eocene limestone (Ayed-Khaled *et al.* 2015).

Using geological maps and information provided by local potters, attempts were made to sample naturally occurring raw materials which might have been used as clay sources in antiquity. The suitability of the clay for the manufacture of ceramics was tested by handling and manipulating a clay deposit when moist (Quinn 2022,187). Five clay samples were collected around the site of Chimtou and nine around the site of *Bulla Regia* (Figure 9). These clays formed in different geological formations and are exploited today by local potters for the manufacture of both cooking and decorative pottery. Additional clay samples were taken from Sejnane as Peacock (1984) suggested that clay from this region might have been used for the manufacture of painted wares excavated in Carthage. The samples were kindly provided by two different families of potters working in the area. All collected clay samples were processed at the Wolfson Laboratories: they were dried, crushed, cleaned of large stones and roots, then hydrated and left to soak. The refined clay was then fashioned into briquettes and fired at 800°C in an electric kiln. One sample (Chi 6) was found not to have sufficient plasticity due to its high sand content, so was discarded. The fired clay briquettes were then prepared as thin sections for their examination and analysed under the polarising light microscope, as well as being ground and pressed as pellets for LA-ICP-MS analysis, in the same way as archaeological ceramics.

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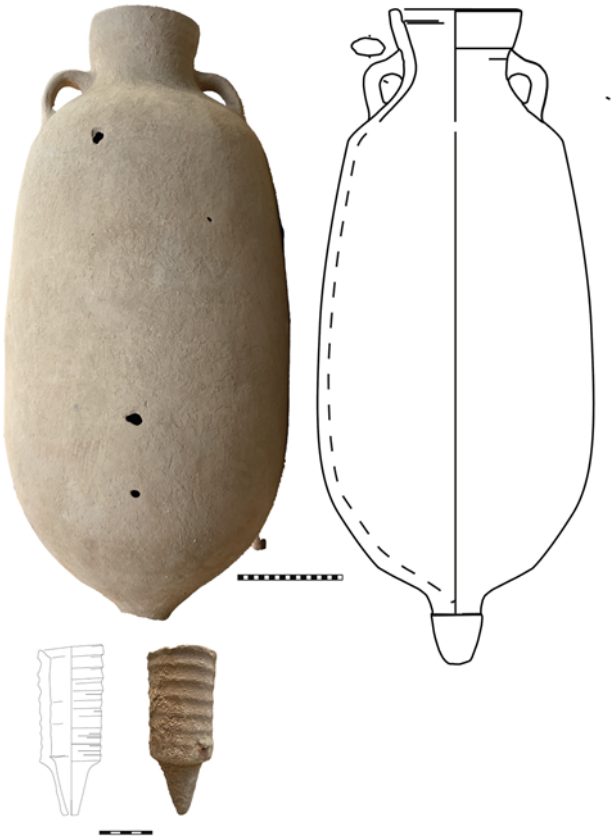

Figure 8. One of the storage jars and *tubuli* sampled (HM).

Ceramic petrography

In general, the samples are petrographically fairly homogeneous, and distinct fabrics were not easy to distinguish. The situation is complicated by the fact that sherds also exhibit different degrees of vitrification and were altered post-depositionally to a varying extent. In addition, the sherds have a fine fabric dominated by quartz and are thus more difficult to split into fabrics. Nevertheless, five classes were defined (Figure 10), mainly in terms of textural characteristics. The fabrics have been numbered following the sequence created for North African ceramics in our previous study published in Occari *et al.* (2024). Petrographic fabrics can be thought of as 'recipes' that reflect the use of specific combinations of raw materials and paste preparation techniques (Quinn 2022, 89–97). In this case, the subtle differences between the fabrics may also reflect natural variation in the raw material sources or intrinsic variability within a single batch of clay.

Petrographic Fabric 4: Dominant quartz and calcite. This fabric is represented by the majority of the thin sections analysed (34/57). It is characterised by the occurrence of medium grained sand temper (mode 0.30 mm) added to a calcareous base clay with variable amounts of medium and course silt-sized inclusions (abundance of silt-size inclusions ca. 5–10%) (Figure 10). It contains ca. 10% rounded to sub-angular sand-sized inclusions of monocrystalline quartz, as well as ca. 5–7% rounded to angular, elongate and rhombic micritic limestone. Rounded iron-rich inclusions and aggregates are also present (ca. 3–5%). Less common inclusions include siltstone, and rare chert (less than 2%). The presence of temper is indicated by the often bimodal grain size distribution of the inclusions in the samples in which there is a gap between the sand and silt grades, or in some cases a lack of silt grains. It appears that loose, relatively rounded sand to silt-sized quartz was added as temper to a finer calcareous base clay. The base clay varies in terms of the proportion of silt-sized inclusions from fairly silt-rich to more 'clean' silt-poor material, which is often iron-rich. The silt-sized inclusions are dominated by angular quartz. Tests of foraminifera microfossils and shell fragments are also occasionally present. The clay matrix (abundance ca. 64–75%) is optically inactive and has a light-brown to a red colour. Many limestone inclusions have decomposed leaving characteristic vesicles or vughs (abundance ca. 2–4%), some with a calcareous rim. Patchy secondary calcite precipitated during burial is also visible in the matrix. The samples contain few thin elongated planar voids, likely due to the shrinkage of the clay paste during drying and restricted by the quartz inclusions. This fabric exhibits variation between samples in terms of the colour of the matrix, the presence of microfossils, the abundance of secondary calcite in the matrix as well as the abundance of sand temper added. Little variation exists in terms of the size of the sandy material, even though samples BR P17, Chi P36 and Chi P38 may contain slightly coarser sand inclusions. Two samples (Chi P12 and Chi P13) have slightly better sorted inclusions compared to the other samples of this group.

The samples in Fabric 4 are related to Fabric 5, described below, and bear similarities with Fabric PR8, published in Sacco (2024, 308), corresponding to an unglazed medieval ceramic found in Sicily and possibly originating from Northern Tunisia.

Petrographic Fabric 5: Fine, silty clay. This fabric includes seven samples. It is characterised by the presence of ca. 15–20% rounded to angular fine-grained sand and silt-size quartz inclusions in an iron-rich clay (Figure 10). Sand-size quartz inclusions are generally smaller than in the other fabric groups (<0.16 mm, mode 0.08 mm). As with Fabric 4, the addition of sand and silt-sized quartz as temper is suggested by the presence of some inclusion-free areas, which perhaps represent areas of the iron-rich base clay where temper was incompletely blended. Small (0.03 mm to 0.06 mm, with rare larger inclusions <0.10 mm) rounded calcareous inclusions and numerous iron-rich spherical inclusions are also common (abundance ca. 10%). Less frequent inclusions include microfossils, mainly foraminifera and shell fragments. The matrix (abundance ca. 67–72%) is red in colour, with no optical activity, and presents sparse lighter patches of a greenish colour caused by the presence of fine micritic calcite, which might be secondary. The samples contain ca. 3% voids, mainly spherical or vughs-shaped, probably left by decomposed calcareous inclusions. The samples of this fabric group exhibit variation in terms of the abundance of secondary micritic calcite and voids. Overall, these seven samples are related to Fabric 4, but have much finer inclusions.

Petrographic Fabric 6: Highly fired calcareous clay. This fabric encompasses nine samples. It is a distinctive fabric composed of ca. 15–20% moderately sorted, rounded to sub-angular medium-grained sand (mode 0.30 mm) to silt-sized quartz inclusions in a clean calcareous clay (Figure 10). The bimodal distribution of the inclusions suggests that quartz inclusions have been added as temper to a fine calcareous base clay with naturally occurring silt. Several calcareous inclusions are also present in the samples; however, these tend to be partially or almost entirely decomposed, often leaving vesicles or vughs which show a calcareous rim (abundance ca. 3–5%). The clay matrix (abundance ca. 75–82%) is optically inactive and has an olive-green colour that is characteristic of vitrified calcareous clay (Molera *et al.* 1998). This is related to the reaction between the calcite present in the clay used and the clay minerals at high temperatures of ca. 1000°C, leading to the formation of pyroxenes and a glassy phase which reduce the total content of iron available to form iron oxides (Maniatis *et al.* 1983; Matson 1971; Molera *et al.* 1998). The samples vary mostly in terms of the abundance of limestone inclusions, with sample BR P1 containing more of this material, while Chi P29 contains the lowest proportion. This fabric does not substantially differ from those discussed

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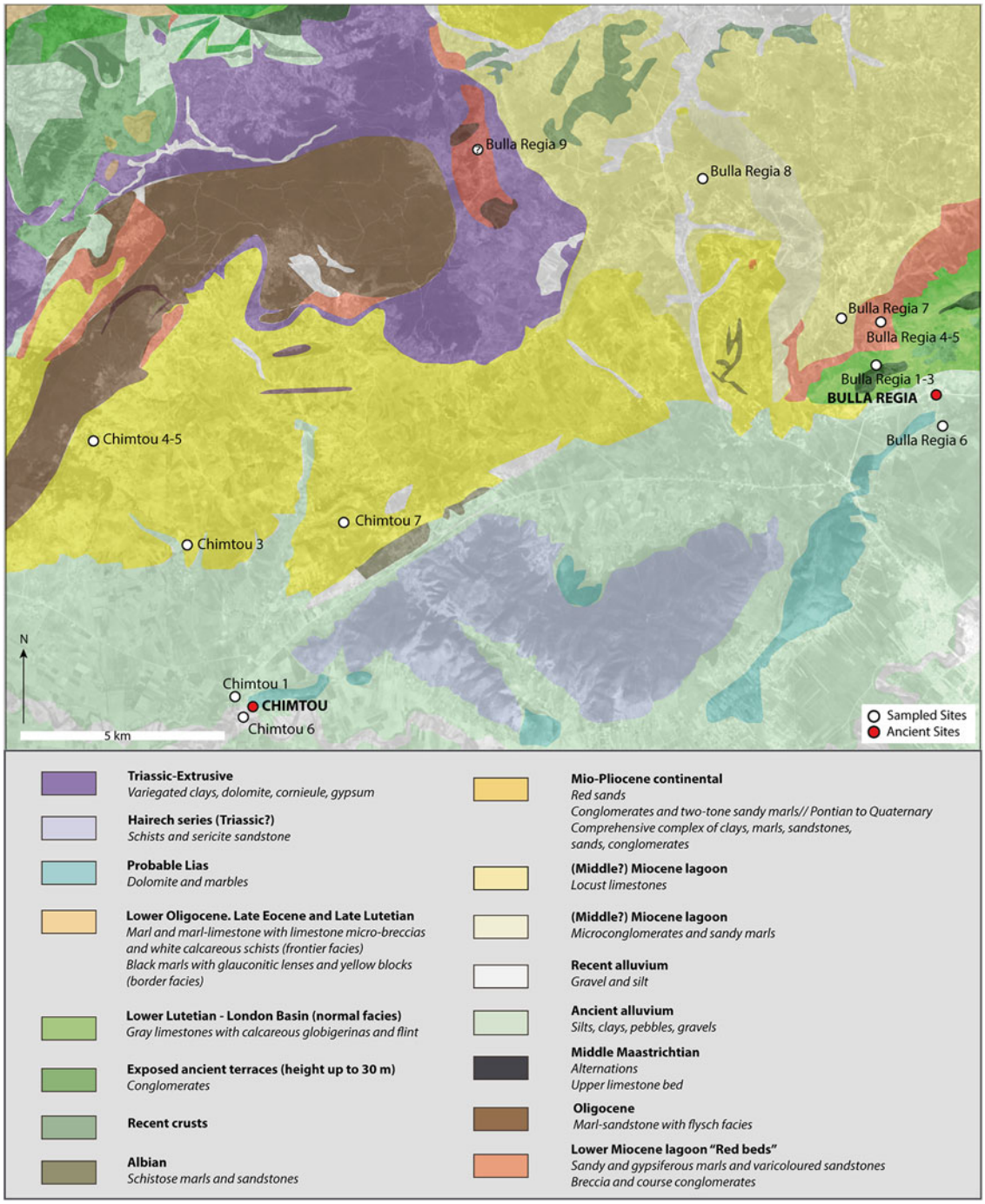

Figure 9. Geological map with surveyed sites – after P. Sainfeld and Ch. Gottis (1948-1949), published by the Geological Service of the Directorate of Public Works of Tunisia (Mines, Industry and Energy Service). (HM).

above, and it may simply represent a higher fired version of Fabrics 4 and 5.

Petrographic Fabric 7: Highly fired calcareous clay, untempered. This fabric includes only one sample in the analysed assemblage (Chi P8, Figures 6a and 10). This homogeneous fabric is composed of the same greenish calcareous clay, characteristic of highly vitrified calcareous clays, as in Fabric 6. The matrix is optically inactive. In contrast to Fabric 6, however, this fabric is almost entirely inclusion free (abundance of inclusions ca. 3%), containing only very few coarse silt-sized quartz (mode 0.04 mm) and rare very fine sand (mode 0.10 mm), suggesting that temper was not added in this case. Therefore, it can be considered as a non-tempered version of Fabric 6, pointing to the use of a different recipe.

Petrographic Fabric 8: Dominant calcite and angular quartz. This fabric includes five samples. It is composed of a calcareous iron-rich base clay with ca. 15–20% of poorly sorted, rounded to angular inclusions of micritic limestone (0.02–0.38 mm (Figure 10). This fabric is not fully homogeneous, showing differences in terms of the amount and proportion of inclusions. Silt and fine sand-sized quartz inclusions (mode 0.12 mm) are predominantly angular to sub-angular in shape and are more abundant than in the other fabric groups (ca. 30–40%). Rounded iron-rich inclusions and microfossils are frequently present. Vesicles and vughs are also present (abundance ca. 7%), probably left by the breakdown of calcareous inclusions during firing. No inclusion-free areas can be observed in the samples. The matrix (abundance ca. 40–50%) has low to no optical activity and presents an

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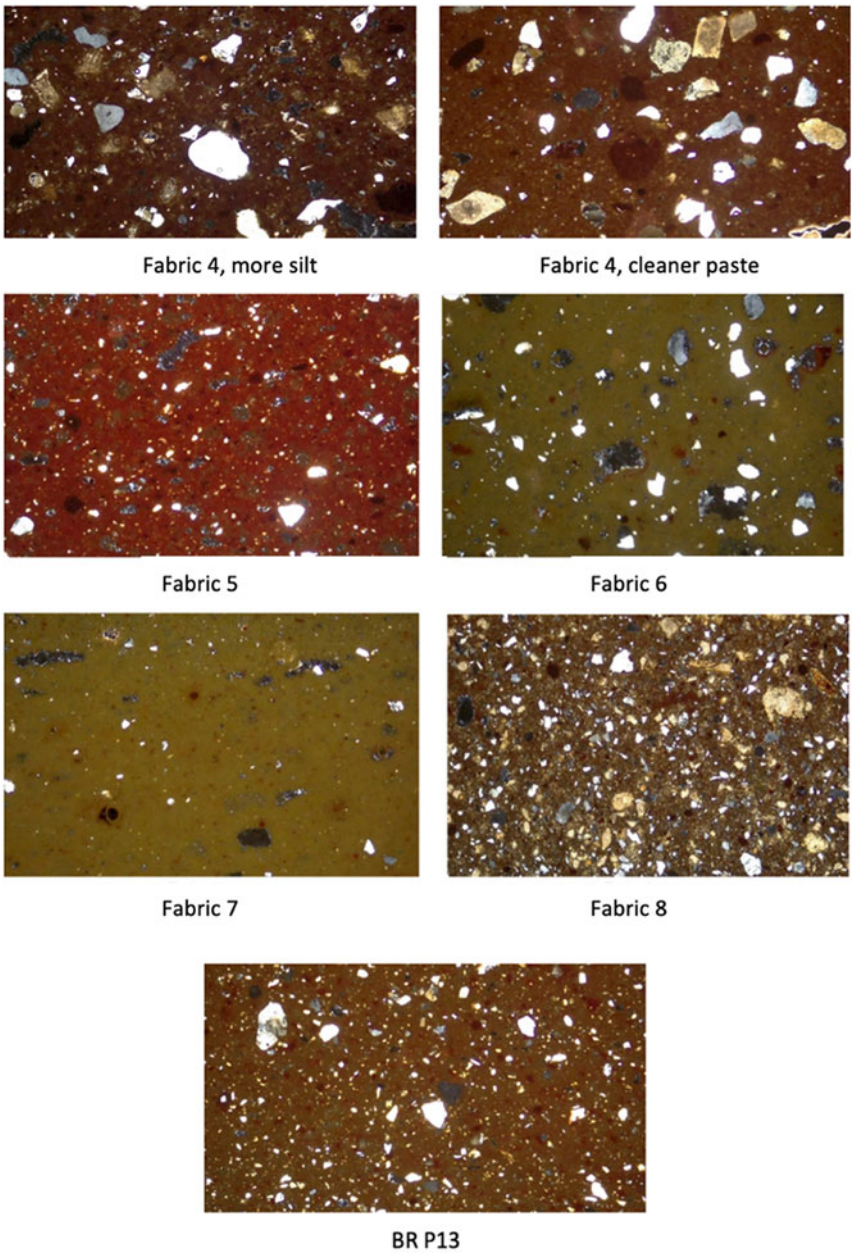

Figure 10. Thin section photomicrographs of the five main petrographic fabrics and one outlier detected in 57 painted ceramics. The fabrics differ mainly in terms of textural features. All images taken in crossed polars (XP). Image width=3.2 mm. (VO).

heterogeneous colour ranging from red to a light-brown colour due to the presence of numerous secondary micrite crystals sparse in the paste. The samples show variations in terms of the abundance of the sandy fraction, with sample BR P7 containing the highest proportion, as well as the sorting of the inclusions, with samples BR P7 and Chi P5 having better sorting.

Outliers: BR P13 is a petrographic outlier. This fabric is characterised by the presence of abundant, poorly sorted, sub-rounded to angular medium-grained sand-sized quartz inclusions (ca. 20%) in a silty calcareous clay base (Figure 10). The main distinguishing feature is that calcareous inclusions are absent, in contrast to Fabrics 1–5. Iron nodules are also frequent (ca. 7%). No other inclusions can be identified. The matrix (abundance ca. 73–80%) is isotropic of a light-brown homogeneous colour. Owing to the rather generic nature of this fabric, it has not been possible to relate it to other published examples.

Petrographic analysis of the presumed local *tubuli* sherds from Chimtou and *Bulla Regia* indicated that all samples except one (BR Tub 11) have a fabric very similar to Fabric 4, although the *tubuli* tend to have slightly more abundant quartz inclusions, which might have been added as temper (Figure 11). Sample BR Tub 11 is comparable to Fabric 5, having finer and less abundant inclusions. One sample (Chi Tub 5) presents a lighter-green calcareous clay matrix, which can be observed both macroscopically and in thin section, suggesting higher firing temperature for this sherd, similarly to what has been observed for the painted wares (Figure 11). Macroscopically, this sample contains very dark inclusions of different dimensions that under the microscope can be identified as iron-rich inclusions which are likely to have nucleated during the firing of a carbonate-rich clay (Nodari *et al.* 2007).

In thin section, Fabric 4 exhibits similarities with several of the raw clay samples collected. Some differences between possible clay sources and archaeological ceramics are to be expected due to the different processing of raw materials by potters (e.g. addition or removal of material, tempering) as well as by alteration during firing and post-depositional processes. Clay samples Clay Chi 1 and Clay Chi 3 are characterised by a calcareous clay with silt-sized and less frequent sand-sized quartz grains, and micritic limestone clasts (Figure 11). Clay Chi 3 also contains rare foraminifera. Iron nodules are present in both samples. Clay BR4 has a composition comparable to Clay Chi 1 and Clay Chi 3, but presents a somewhat

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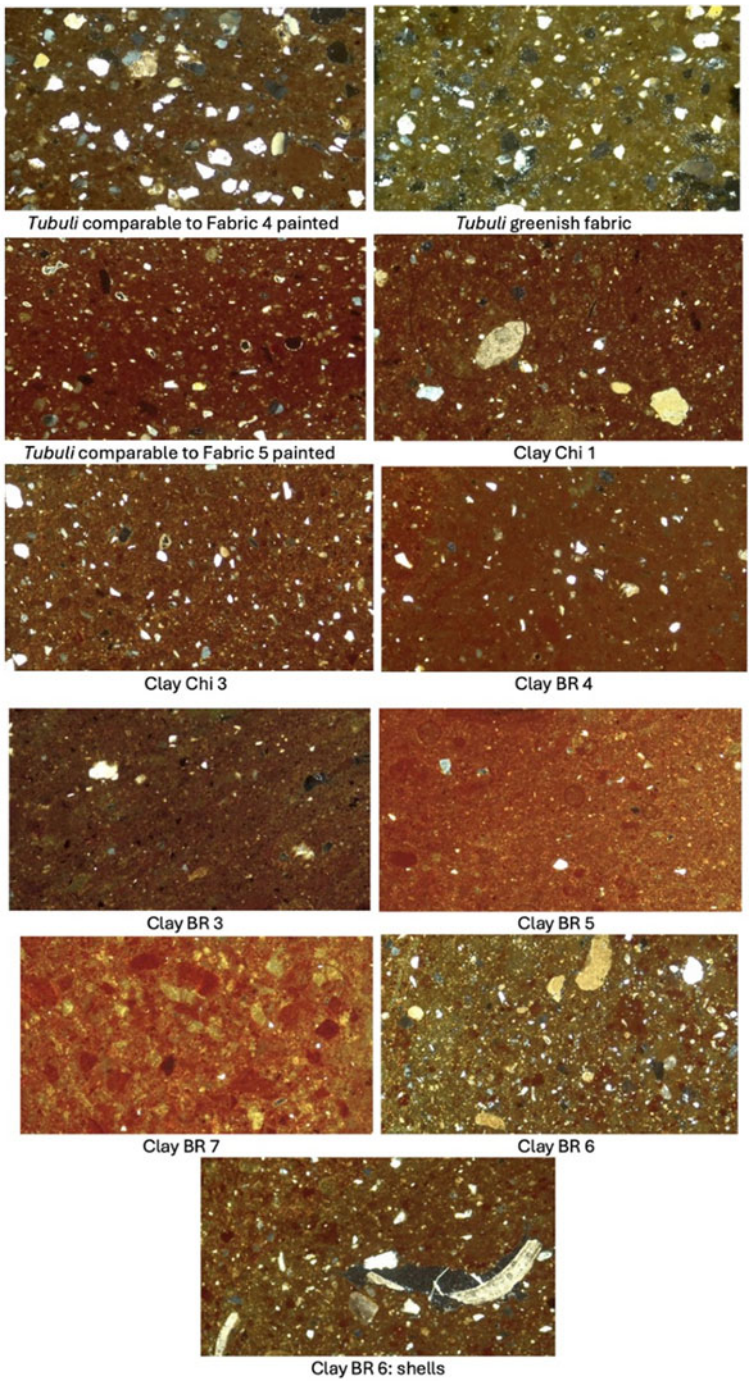

Figure 11. Thin section photomicrographs of the main fabrics detected in the architectural *tubuli* analysed and of those of clay sources sampled near the sites showing calcareous fabrics that can be related to the painted wares. Differences between clay samples and ceramics can be accentuated by clay processing methods used by the ancient potters. All images taken in crossed polars (XP). Image width=3.2 mm. (VO).

cleaner matrix, with less silt-sized grains (Figure 11). Clay BR 5 also presents a similar composition. However, it is characterised by a considerably lower proportion of grains. Clay BR 6 has a composition characterised by numerous silt and sand-sized quartz grains as well as micritic limestone grains in a calcareous clay matrix. Shell fragments are also visible (Figure 11). This sample can also be related to Fabric 4, while also showing similarities with Fabric 8 due to its higher proportion of micritic limestone inclusions. The other clay samples collected were also analysed in thin section but differ from the painted ware ceramics in thin section and so can be excluded as possible clay sources.

Geochemical characterisation and classification

The concentration of 55 measured elements (and oxides) for 94 samples was determined using LA-ICP-MS. The samples analysed encompass the painted wares and comparative materials (the large storage jars, architectural *tubuli* and raw clay samples). The concentration of 22 elements which are less likely to have been affected by post-depositional alteration, and which showed variation in the samples, have been examined in order to identify possible geochemical patterns. While all samples, except one (see below), can be classified as calcareous ceramics, with CaO contents of ca. 20%, CaO has been excluded from the analysis due to the presence of secondary calcite in several analysed samples. A plot of principal components 1 and 2, which explains 66% of the total variance, shows that the painted wares can be divided into two main groups, here called Painted 1 and 2 (Figure 12). The great majority of the painted wares analysed fall into group Painted 2 and appear quite compositionally homogeneous (Table S2 in supplementary material). Painted 1 consists of eight samples from Chimtou, which show higher concentrations of heavy minerals-related elements such as zirconium and hafnium relative to the dominant group Painted 2 (Figure 12). A comparison of the geochemical patterning

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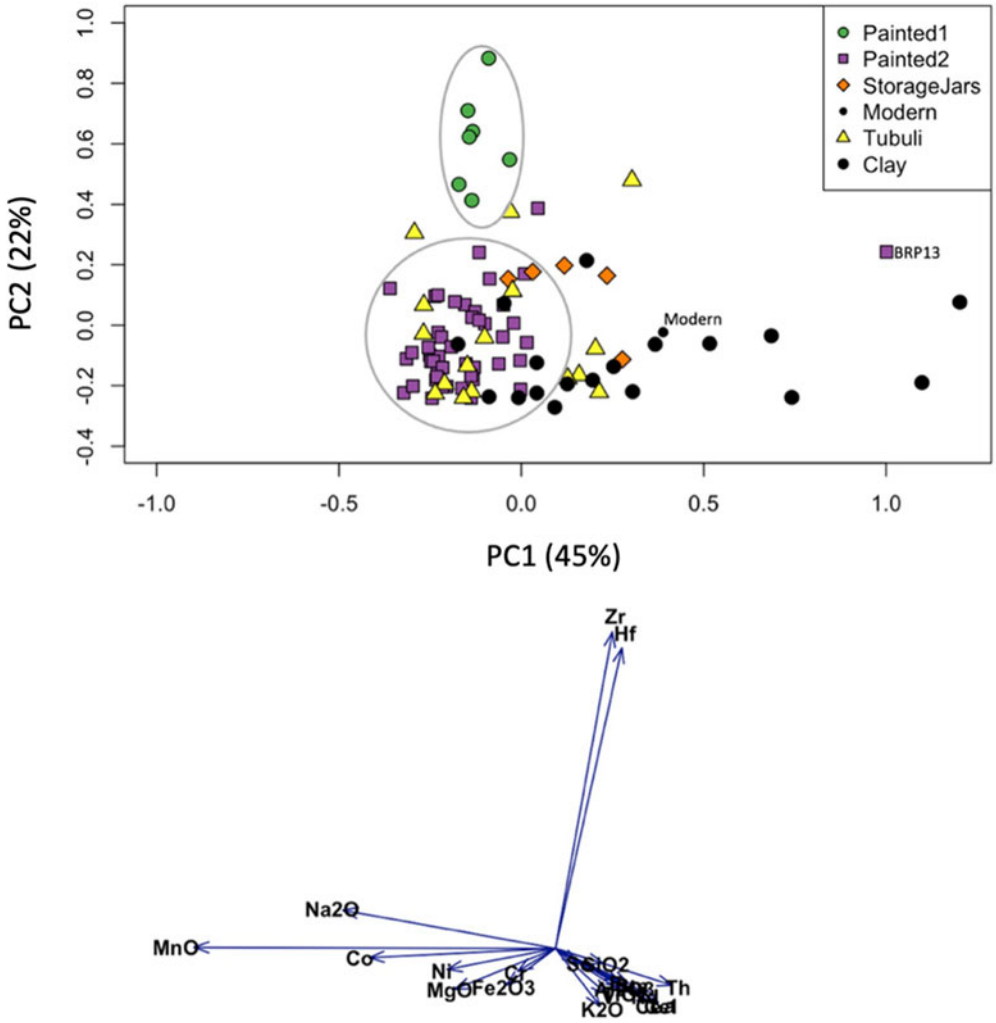

Figure 12. PCA of the 22 ceramic elements/oxides using log-ratio transformed data for the painted wares, storage jars, *tubuli* and raw materials samples (upper). Plot of loadings for components 1 and 2 determining the geochemical patterning (below). (VO).

with the petrographic fabrics identified indicates that the minor differences observed in terms of fabric texture are not reflected in the composition, thus highlighting the uniformity of the group in terms of type and nature of inclusions. The exception is the petrographic outlier (sample BR P13), which also presents a composition which is clearly different, being characterised by lower levels of Na_2O, MgO, MnO, Fe_2O_3, Ni and Co compared with the other painted ware samples. Importantly, this sherd is non-calcareous, with CaO contents well below 1% (Figure 12; Table S2 in supplementary material).

The comparative ceramics analysed showed that the majority of the *tubuli* have a similar chemical composition to group Painted 2, confirming the similarity observed in petrographic analysis. A sub-group of four sherds of *tubuli* differ mainly by having lower contents of Na_2O, MgO and MnO compared with the main group, while SiO_2 contents tend to be higher (Figure 12; Table S2 in supplementary material). Three *tubuli* sherds have a composition similar to that of group Painted 1, although it is not a clear match (Figure 12). The storage jars analysed have a somewhat comparable composition to that of Painted 2; however, they tend to form a separate group, as can be seen in Figure 12. This might be due to differences in the preparation and processing of the clay, or it might indicate the use of a slightly different clay source.

The 19 processed clay samples present some variability in terms of composition, sometimes even between samples collected in areas very close to each other (e.g. BR 1 and BR 2, in Table S2 in supplementary material), suggesting that factors such as the depth at which the clay has been collected may affect the resultant composition. This is likely to be due to the samples coming from different layers in these sedimentary clay sources. Nevertheless, Figure 12 shows that several clay samples have a related chemical composition to that of the main group of painted wares (Painted 2), suggesting that these locales might have been used as a source of raw material. Average linkage HCA shows that group Painted 2, clay samples BR5, BR6, BR7 and most *tubuli* (nine samples) are in the same cluster (Figure 13). The storage jars and clay sample BR2 form a separate sub-cluster, which nonetheless shows strong similarities with the main group (Figure 13). Group Painted 1 was also detected as a separate group via HCA (Figure 13), forming a small cluster which includes the three *tubuli* mentioned above (Tub 3, 10, 12), but no match with the clay samples has been found. The other clusters detected via HCA include one group consisting of four raw material samples, and one formed by four *tubuli* (Tub 13, 14, 15, 16), the one modern sherd, as well as several different clay sources, including Chi 3, Chi 7, BR4 and BR 8. The clay samples from Sejnane (S1, S2, SW) are clearly separated from the other groups and show similarities with sample BR P13, a petrographic and chemical outlier, as well as with other non-calcareous clays from Chimtou (Clay Chi 4, 5) (Figure 13). While clay sample BR1 is also part of the same cluster due to its similarities in terms of trace element composition, this clay source is highly calcareous (Table S2 in supplementary material) and thus it is clearly different.

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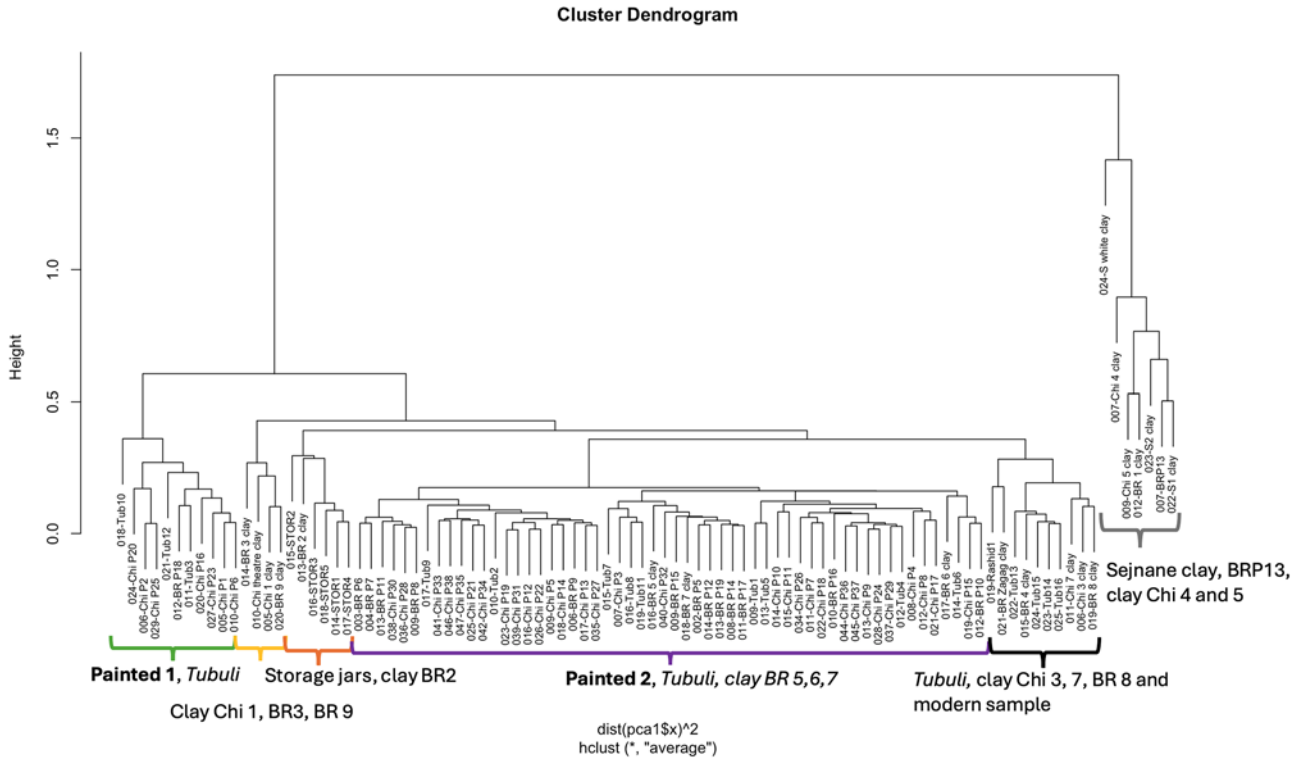

Figure 13. HCA results in the form of a dendrogram, using the average-linkage method. (VO).

Raman analysis of pigments

Raman spectra have been recorded on different shades of red and brown areas of 20 painted ceramic samples to include all the hues present and main decoration patterns. The results show that the pigment used to obtain different shades of red and brown is mainly hematite (Fe_2O_3). Notwithstanding some differences in band positions and their relative intensities, hematite can be identified by the characteristic bands at around 295, 412, 610 cm -1 which correspond to the Fe-O symmetric bending vibrations, while those at around 228, 500 cm-1 correspond to symmetric stretching vibrations (Figure 14a) (Burgio and Clark 2001; David *et al.* 2001; Edwards *et al.* 2000; Marshall *et al.* 2020). The origin of the band observed at around 1310 cm-1 is debated, with some scholars attributing it to other vibrational modes of hematite, while others attribute this band to a burnt organic matter (de Faria and Lopes 2007; Marshall *et al.* 2020). Individual coarser red particles gave particularly strong bands for hematite, while finer particles gave weaker spectra. A quartz band at around 148 cm-1 is also observable in some of the red pigments analysed (Figure 14b), probably resulting from the quartz present in the ceramic body (Krishnamurti 1958), although hematite might also have been mixed with sand. In the majority of the samples (17/20), hematite is present in combination with magnetite, discernible by the characteristic intense band at around 665 cm-1 (Figure 14b) (Goodall et *al.* 2009; Hanesch 2009; Marengo *et al.* 2005; Rosado *et al.* 2018). However, an additional Raman band at around 660 cm-1 can also appear as a result of a disordering in the crystal lattice due to different factors such as heating, grinding and weathering (de Faria and Lopes 2007; Zoppi *et al.* 2005).

Under the microscope, the dark-brown decorations contain predominantly large dark particles of magnetite as indicated by its characteristic strong signal at around 665 cm (Figure 14b) (Goodall *et al.* 2009; Hanesch 2009; Marengo *et al.* 2005; Rosado *et al.* 2018), although a smaller proportion of fine red particles are also present and have been identified as hematite, showing bands at around 228, 295, 412, 506, 615 and 1320 cm -1. As a band in the region of 640–650 cm-1 is also characteristic of manganese oxide, one of the principal components detected in black and dark-brown paint worldwide since ancient times (Siddall 2018; Vermeersch *et al.* 2022), a sub-selection of three samples showing dark-brown decoration were also analysed using p-XRF. This is because the identification of manganese oxides by Raman is challenging, as these are known for being weak Raman scatterers, while they are also easily subjected to thermal heating due to the laser and this can lead to structural and phase modifications which further hamper the interpretation of the spectra (Bernardini *et al.* 2019; Caggiani and Colomban 2011). P-XRF analysis of the dark-brown paint decorations revealed that manganese is present only in traces, thus excluding its potential use as colourant, while it confirmed the presence of iron, which was detected in high quantities of ca. 8% wt. Raman spectra of a light brown-yellowish area of one sample (Chi P14) present bands that can be attributed to the mineral goethite, and particularly the characteristic band at 393 cm-1 (Figure 14c) (Froment *et al.* 2008).

The compounds detected for the red and brown areas (hematite, magnetite and goethite) indicate that the main pigments used for the red and dark red/brown paint are iron oxides/hydroxides. It is widely recognised that the mineral hematite is also the main colouring compound constituting red ochres, while yellow-light brown ochres are based on other iron-containing mineral phases such as goethite, limonite and lepidocrite (Froment *et al.* 2008; Mastrotheodoros and Beltsios 2022). The term 'ochres' broadly refers to iron oxide and iron hydroxide-rich powders which are admixed with variable amounts of sand and clay (ibid.). Hematite can also be formed by the thermal treatment of goethite at a relatively low temperature of ca. 260°C–280°C due to a dehydration process, and several studies have attempted to discriminate between the use of heated goethite and natural hematite by Raman spectroscopy, but this has proven challenging and is still under debate (e.g. de Faria and Lopes 2007; Lin *et al.* 2021). Goethite has been identified as the chromophore of the light-brown yellowish pigment present in one sample (Chi P14). While goethite

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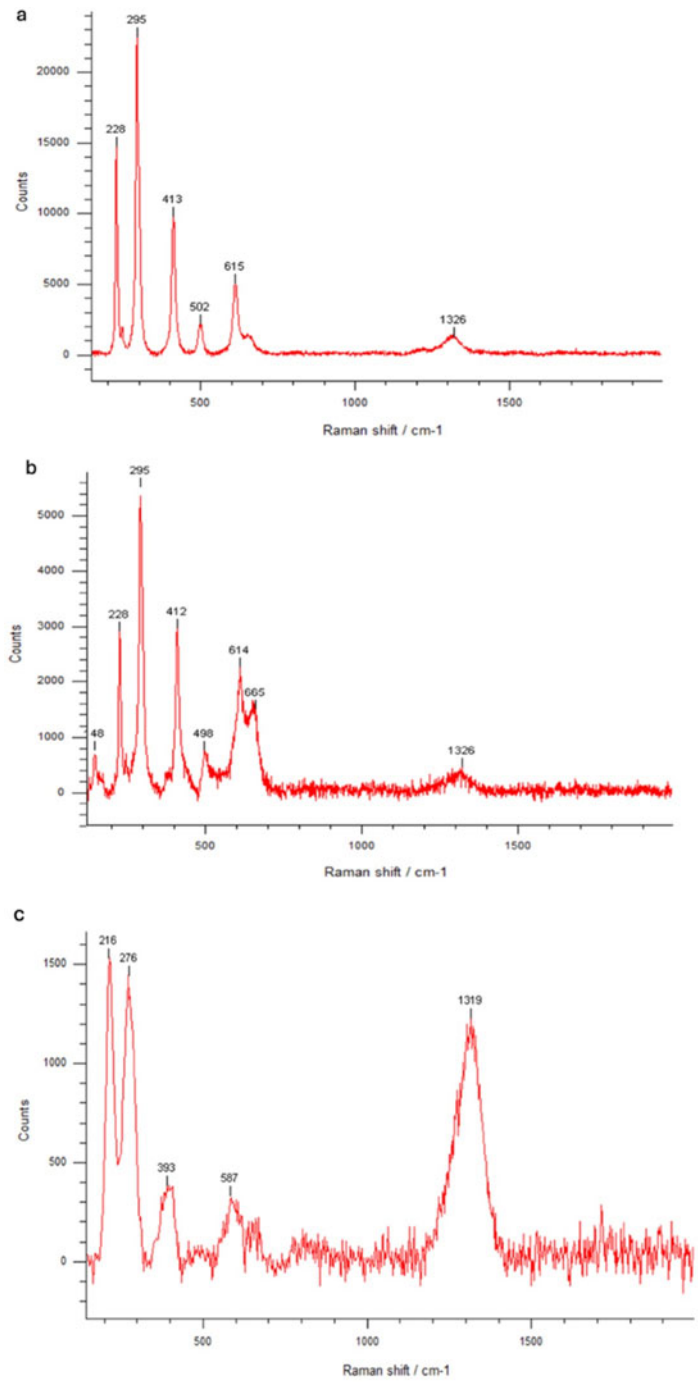

Figure 14. Examples of Raman spectra of red and brown pigments attributed respectively to hematite (sample Chi P22) (a), hematite combined with magnetite (sample BR P8, dark areas) (b) and goethite (sample Chi P14) (c). (VO).

is usually responsible for a yellow hue, goethite shifts from green-yellow to brown-yellow with increasing grain size (Buxbaum and Pfaff 2005). Firing conditions are responsible for the formation of the characteristic colouring mineral, with oxidising conditions producing red hematite, while under reducing conditions hematite is converted to magnetite at a temperature between 600°C and 900°C, conferring a dark colour (Mastrotheodoros and Beltsios 2022). The specific hue of ochre can also be influenced by other chromophores present in the mixture, such as manganese oxide (black), carbon (black) – here not present – as well as by the grain size of the powder and the overall uniformity in size, suggesting that the latter might also be responsible for the different hues observed (Mastrotheodoros and Beltsios 2022; Siddall 2018). Thus, the results suggest the use of a single raw material (hematite/ochre) for the red and brown paint decorations and a range of different firing atmospheres to obtain the desired final colour. The use of iron-bearing compounds as pigments has been documented globally since the prehistoric period due to their natural abundance (Mastrotheodoros and Beltsios 2022). In Tunisia, iron deposits as well as iron-rich clay deposits are common throughout the country (Tekki 2020, 54–56). Given the availability and accessibility of suitable raw materials for the red and brown paint, these were most likely sourced locally.

Discussion: painted ware production centres

A new production centre in the western Medjerda

Petrographic analysis of 57 samples of painted ceramics identified five petrographic fabrics which are closely related to each other in terms of type of inclusions and are separated only by textural differences. The petrographic similarity of the sherds is confirmed by the chemical analysis, which indicates that the great majority of the painted ware samples belong to a single group (*Painted 2*). This

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suggests that the minor differences between the five petrographic fabrics may represent variation within a single clay deposit or may be due to different firing conditions or, more likely, that a variety of different clay deposits were exploited within the same region by different workshops and thus these share very similar chemical compositions. A smaller group of seven samples (*Painted 1*), richer in zirconium and hafnium, may have been produced in a separate workshop which had access to a clay source that is richer in heavy mineral content, but is otherwise very similar to the clay employed to produce the main group of wares. One sherd (BR P13) has been manufactured using a non-calcareous clay, which is geochemically similar to clay samples Clay Chi 4 and 5, suggesting that this might also have been manufactured locally. However, the similarity in terms of geochemistry of this sherd with raw material samples from Sejnane might also indicate that the ceramic was imported, thus supporting Peacock's (1984: 16) suggestion that the region was a centre of production of painted wares. The chemical groups identified do not appear to relate to typological differences in the assemblage.

Though no kilns manufacturing painted wares have yet been identified in, or near, *Bulla Regia* and Chimtou, the use of a calcareous clay rich in quartz and micritic limestone inclusions strongly suggests a production in the Medjerda Valley for the analysed painted ceramics. The geology of the Medjerda Valley is dominated by the presence of Mesozoic and Cenozoic sedimentary series rich in calcareous material, such as marl and limestone (Bonifay *et al.* 2002b). The petrographic and geochemical similarity between the painted wares and clay samples collected near *Bulla Regia* and Chimtou suggests that local calcareous clays were exploited to manufacture the painted wares. A local production is further supported by the compositional similarity between the main group of painted wares (*Painted 2)* and large storage jars from *Bulla Regia* as well as *tubuli* from both sites, which are very likely to have been manufactured locally. As highlighted above, it is difficult to establish whether *Painted 2* wares were the product of a single workshop or whether different workshops or potters exploited very similar clay sources.

Technologically, the painted ceramics found at Chimtou and *Bulla Regia* appear quite homogeneous, pointing to a shared 'know-how' of the potters in selecting raw materials for pot-making and for the painted decoration. All sherds (except one) were made using a fine calcareous base clay, to which sand has been added as temper, probably to decrease the plasticity of the clay, making it easier to handle and shape it into a vessel. Non-calcareous clays are also available near the sites (e.g. clay samples Chi 5, BR 8; Figure 9), but these do not seem to have been exploited for these wares. One possible reason for the preference for calcareous clays is that, apart from their local abundance and availability, they tend to fire to a buff colour (Molera *et al.* 1998), thus serving as a better background for the subsequent painting decoration. The presence of still-intact calcareous inclusions in most of the ceramics suggests that most were fired at temperatures $<800^{\circ}$C, or just above 800°C (Drebushchak *et al.* 2005; Gliozzo 2020). A firing temperature above >800 can be suggested for those calcareous sherds presenting a more greenish colour (Maniatis *et al.* 1983; Molera *et al.* 1998), as also suggested by the degree of decomposition of calcareous inclusions. The paint uses the same type of iron-bearing compounds as pigments, while the ceramics are also relatively homogeneous in terms of painted decoration, although some differences can be observed between the decorative motifs of closed and open shapes, as discussed above.

Painted wares: multiple regional productions

Recent work has identified the existence of different regional – or sub-regional – economies in late antique and early medieval North Africa, some of which were largely dependent on Mediterranean trade, while others focused more on 'local' markets (Bonifay 2013, 2019; Fentress 2013, 332; Reynolds 2016; Fenwick 2020: 105–28). The petrographic and chemical evidence showing that the vessels at *Bulla Regia* and Chimtou were probably produced locally is in line with the increased 'regionalisation' observed for inland regions in Tunisia, starting from the third century onwards (Bonifay 2013). Painted wares seem to be manufactured locally in several centres for local and regional consumption, similarly to the regionally produced ARS and so-called late antique Rouletted Kitchenware (e.g. Andreoli and Polla 2019, 179). Although archaeometric analyses of APW from other sites are lacking, the different fabrics signalled by Hayes (1976), Fulford and Peacock (1984) and others at Carthage strongly suggest the existence of north-eastern Tunisian workshop(s) that produced painted ware (Peacock Fabric 2.1) – in addition to north-western workshop(s) probably located in the *Bulla Regia*/Chimtou region. Density of APW at a site may point to the presence of production centres in north-eastern Tunisia as Hayes suggested for *Thuburbo Maius*. Peacock's suggestion of a possible production centre in or around Sejnane is worth further exploring through archaeometric analyses of the Carthage APW. The different styles and pastes also suggest that there may have been one or more APW production centres in central Numidia. One highly likely candidate is *Tiddis,* where kilns have been excavated and direct evidence of production is postulated based on ceramic density in the vicinity of the workshops and wasters in the same fabric (Berthier 2000, 334).

Examination of the forms and decorations in the limited published literature further supports our thesis for a north-western Tunisian and north-eastern Tunisian production group. The APW in the Tell and western Medjerda ('north-western cluster') are comparable typologically and decoratively. The single-handled jug (APW 10) from *Uchi Maius* (Biagini 2007, 425.236) has parallels at Chimtou and *Bulla Regia*; the larger jug is closely related to APW 4a (Biagini 2007, 425.237); three different jugs from Aïn Wassel (Andreoli and Polla 2019) are comparable to APW 6–7 and APW 4 (cf. Table 2). The bird motifs from *Althiburos* and *Uchi Maius* are also stylistically comparable to the motifs from *Bulla Regia* and Chimtou, but stylistically different to that of Carthage. Petrographic and chemical data is needed to establish whether the same production centres supplied this large region or whether there are multiple production centres using similar motifs. Conversely, APW in the 'north-eastern cluster' of sites (Figure 15) seem to share similar decoration patterns, such as spirals (see Figure 15), and vessel types such as APW 20 and related forms occur on or near the coast (Carthage, Nabeul, Oued R'mel), but are otherwise currently unattested in the 'north-western cluster'.

Similar regional groupings appear for Tunisia when considering distributions of regionally produced ARS and so-called late antique Rouletted Kitchenware (RKW). At both Chimtou and *Bulla Regia*, for example, the assemblages are dominated by regionally produced ARS, probably of an unknown workshop, around Henchir Hamdoune (Bonifay and Capelli for Chimtou ceramics, pers. comm.), which supplied the surrounding area, a phenomenon that was widespread in late antiquity (Bonifay 2013, 542–47). Neither site has large quantities of the 'classic' ARS D from north-east Tunisia or ARS C from Central Tunisia which were exported across the Mediterranean. Aside from the few ARS C finds, closer contact between the Central Medjerda Valley and central Tunisia is suggested by the numerous finds of RKW in *Bulla Regia* and Chimtou. Although the RKW fabrics from *Bulla Regia* and Chimtou have not yet been examined petrographically, the similarity of forms and decoration to those at *Althiburos* suggest they could have been produced in the identified workshop near Sidi Marzouk Tounsi/ Oued

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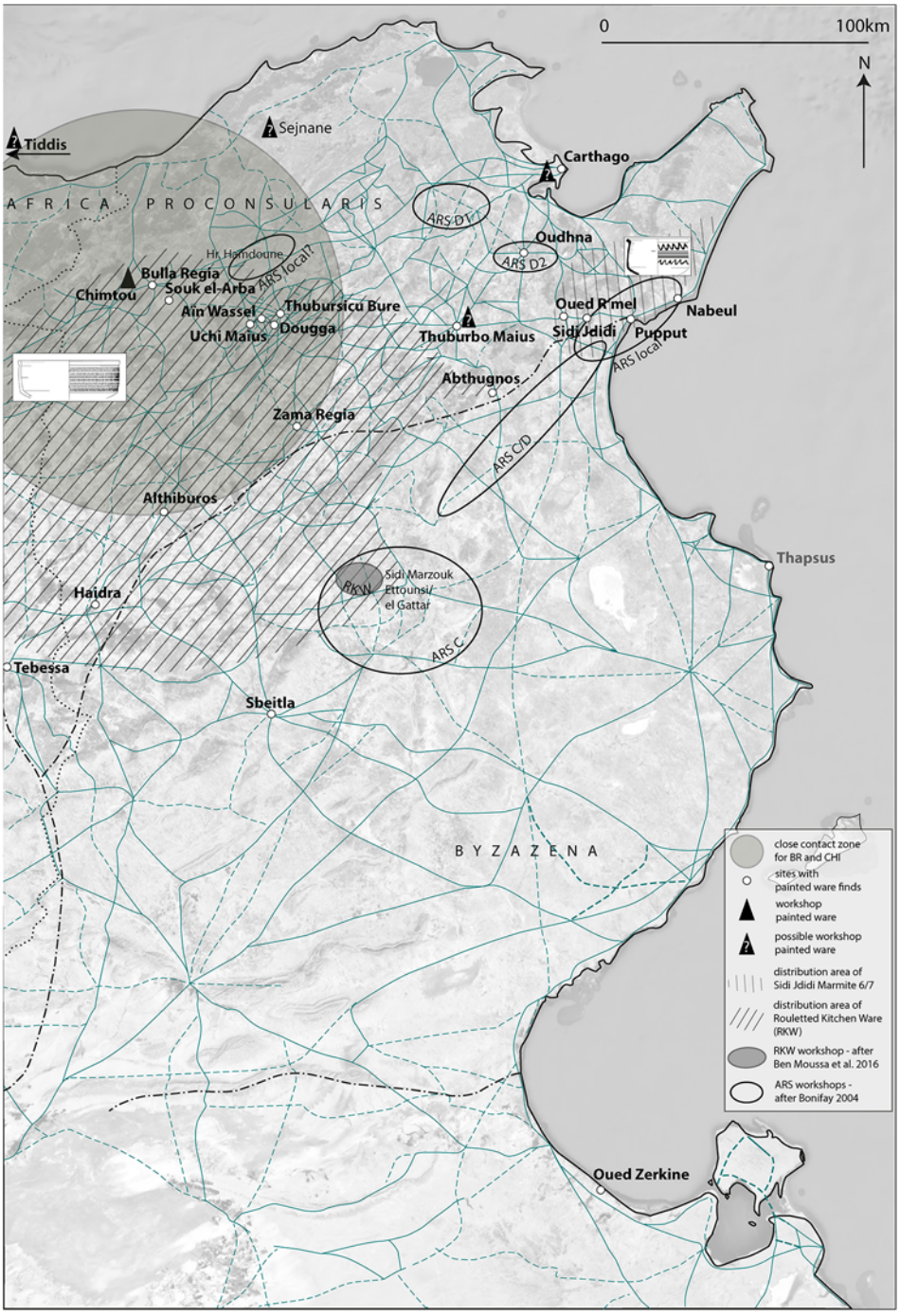

Figure 15. Late Antique workshops and distribution patterns (drawings: Mukai 2016, figure 15.5; von Rummel and Möller 2019, figure 15.40) (HM).

el Gattar (Ben Moussa and Revilla Calvo 2016, 185). Just as with the APW, there is a similar 'koine' of form and decorative technique for RKW in the region spanning from central Tunisia via *Althiburos* to Chimtou, *Bulla Regia, Uchi Maius,* Aïn Wassel and Dougga (Figure 15). A similar phenomenon is apparent in cooking pots, where, for example, those from coastal Sidi Jdidi (Sidi Jdidi Marmite 6 and 7; Bonifay 2004, 235–37) are similar or identical typologically to RKW but distinct in style and technique.

At present the picture suggests multiple local inland workshops operating within a small radius which supplied local areas and influenced each other. This picture of scattered local workshops producing APW with a relatively limited distribution area is consistent with that of the distribution of late antique local ARS productions (Fentress 2013, 332 for Numidia; Bonifay 2013, 542–47). As Fentress argues, ceramics were a low-value good and their distribution 'probably depended on local, periodic markets, never more than 2 days at most from the kiln' (Fentress 2013, 332). Nonetheless, some APW decoration patterns (e.g. grit-pattern: DP (3), Figure 5) and vessel forms do seem to circulate across a much larger region (Figure 16). APW 12 small bowls (Figure 15), for example, are known from *Abthugnos* (Ben Nejma *et al.* 2023, 426, Figure 16), Nabeul (Bonifay 2004, 302.1) and Carthage (Kalinowski 1993, 174.33), but are also found in *Bulla Regia* and also in *Tiddis* (Amraoui 2017, 297, Figure 310.4–5) though with different decorative pattern. Those examples suggest the presence of a wider 'koine' of painted ceramics with a shared repertoire of motifs

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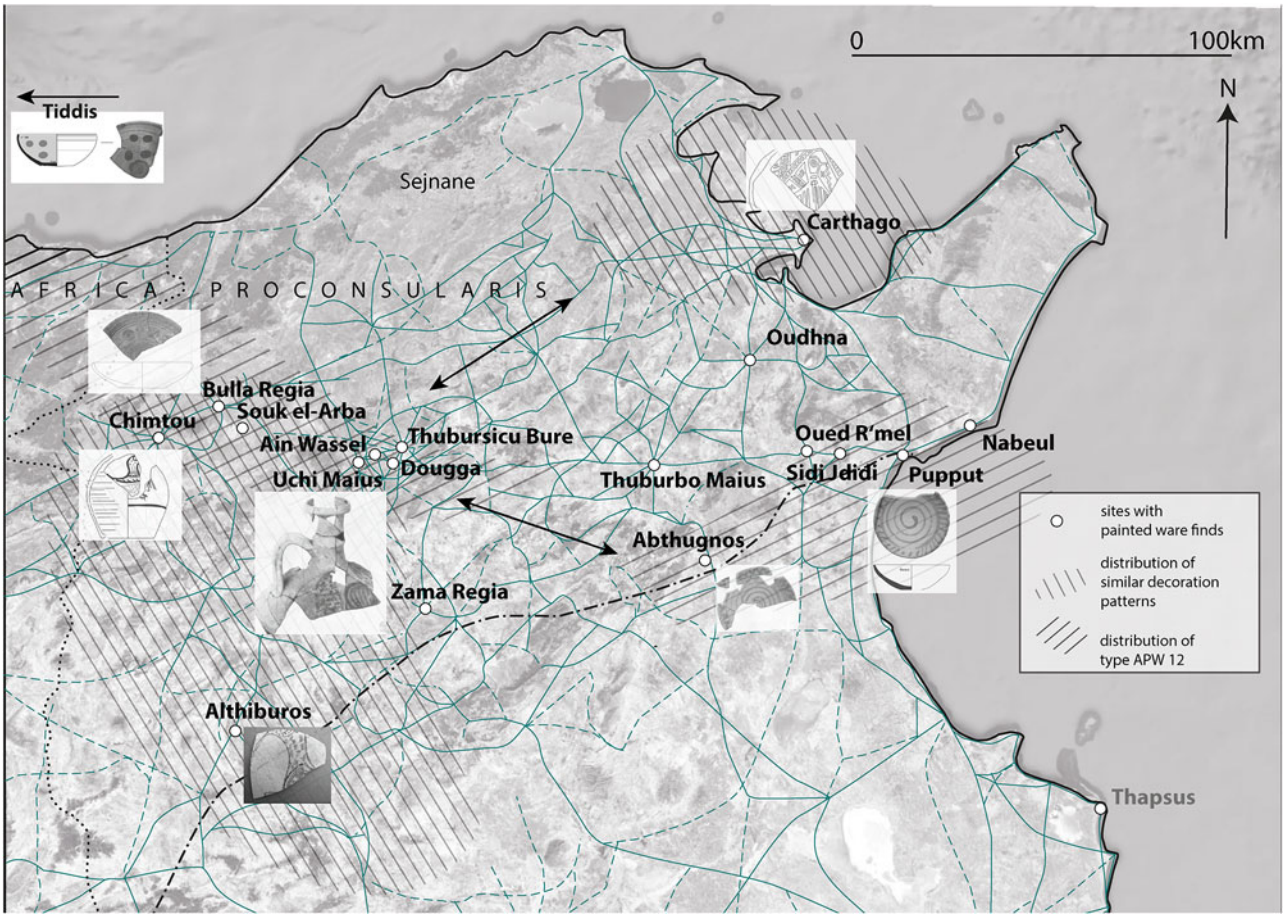

Figure 16. North-western and north-eastern production groups: BR/CHI APW 12 and BR/CHI DP (2) (photos/drawings: Bonifay 2004, 302, Figure 169.1; Ben Nejma et al. 2023, 425.; Fulford 1984, Figure 89; Biagini 2007, 425.23; von Rummel and Möller 2019, figure 14.37; Fenwick et al. 2023, figure 15.6) (HM).

and forms that could be drawn upon by local potters for local markets.

Conclusion

This paper marks the first step in a detailed study of typology, chronology and distribution of late antique African painted wares (APW). For many years, this distinctive ware has been neglected by scholars due to a limited dataset and the challenges of identification and classification. Systematic mapping of the published data shows that APW are found in small quantities in fifth to seventh-century – and some probable early eighth century – contexts at most urban and rural sites excavated in recent decades in northern Tunisia and inland Algeria. However, APW does not appear to have diffused or been produced further south and are not present in well-studied contemporary assemblages from southern coastal Tunisia.

The neighbouring sites of *Bulla Regia* and Chimtou have comparatively large assemblages of well-preserved painted jugs, pitchers, dishes and bowls from *Bulla Regia* and Chimtou, which permitted the creation of an APW typology which can be expanded in the future as new forms and variants are identified. Chemical and petrographic analysis identified the first compositional 'fingerprint' for the production of APW in the Central Medjerda Valley. Five different fabrics were identified in thin section based on minor textural variations; compositional analysis confirmed the homogeneity of the group for most of the samples analysed, pointing to the use of very similar clay sources. The compositional similarities between the APW and some of the clay samples collected near Chimtou and *Bulla Regia* suggest that local calcareous clays were probably sourced for their production. A local production is further supported by the compositional similarity between the main group of APW (*Painted 2), tubuli* from both sites and large storage jars from *Bulla Regia.* This suggests that workshops producing APW were located at, or near, these two late-antique towns.

Differences between the fabric, decoration and forms of APW found at *Bulla Regia* and Chimtou, and those of other published APW in North Africa, strongly suggest the presence of multiple APW production centres and fairly limited regional distribution networks. North-western and north-eastern Tunisian production groups have been distinguished, as well as possible groups in less well-studied Algeria. This model of multiple regional production centres producing APW for local and regional consumption fits with patterns identified by scholars for other late antique ceramic productions, such as local ARS imitations and RKW (Rouletted Kitchenware), which were produced locally and did not circulate far. At the same time, the distribution pattern of similar forms and decorations across northern Tunisia and inland Algeria points to a supra-regional 'koine', in which know-how, forms and decoration were shared. This koine was not simply a North African phenomenon: regional productions of decorated painted wares with geometric patterns, birds, fish, plants are characteristic of Eastern regions of the Mediterranean from the late fifth or sixth centuries (e.g. Vroom 2004, 297–300) while painted wares with simpler geometric patterns also appear in Italy and the central Mediterranean in the later fifth and sixth century (e.g. Arthur 1998). Further research is needed to characterise these often neglected regional productions and understand their development.

The results underscore the urgent need to prioritise the full analysis of commonwares alongside ARS and amphorae in North

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Africa. The aim of any further analyses must be to combine careful typological study of all the ceramics in context with both petrography and chemical analysis to establish the provenance of wares and technologies and to identify the fingerprints of different workshops. Publications of the complete ceramic assemblages of late antique sites are urgently needed to establish distribution and consumption patterns of different wares at both urban and rural sites and the degree to which regional ceramic supply networks differed for inland and coastal sites in late antiquity. The next step will be to integrate the analysis of the production and distribution patterns of other types of late antique goods (particularly glass and metalwork) to build a more detailed picture of craft organisation, cross-craft interaction and exchange networks in late antique North Africa.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/lis.2025.4.

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Notes

1 All dates are AD.
2 Ancient site names are written in italics.
3 All supplementary material is available online.

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