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Insights into the economic organization of the Phoenician homeland: a multidisciplinary investigation of the later Iron Age II and Persian period Phoenician amphorae from Tell el-Burak

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	K. Badreshany and I are joint first authors. Sincerely, Aaron Schmitt
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Title page

Insights into the economic organization of the Phoenician homeland: a multidisciplinary investigation of the later Iron Age II and Persian period Phoenician amphorae from Tell el-Burak

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Graphical abstract

Insights into the economic organization of the Phoenician homeland: a multidisciplinary investigation of the later Iron Age II and Persian period Phoenician amphorae from Tell el-Burak

This paper details the results of a large-scale multidisciplinary analysis of Iron Age pottery from a settlement in the core of the Phoenician homeland. The research presented centres on a large corpus of Phoenician carinated-shoulder amphorae (CSA) from the later Iron Age II and Persian period contexts at the coastal site of Tell el-Burak. Traditional typological investigations are combined with a focused archaeometric approach including a new quantitative method for the morphometric analysis of amphorae, thin-section petrography, geochemistry and organic residue analyses, aimed at gaining a more detailed understanding of the organisation of the Phoenician economy. Despite gradual, but marked typological changes, very little change in the fabrics of these amphorae was noted over the 400 year Iron Age occupation of the site. The research, thus, demonstrates that the production of the Iron Age amphorae from Tell el-Burak was highly organised and was undertaken by long-lived, sustained and centralized modes. The establishment of Tell el-Burak and this new pottery industry coincides with the proliferation of the world's first great imperial powers, the Neo-Assyrian, Neo-Babylonian and Persian empires and the outcomes of this research provide new insights into socio-economic strategies adopted in the Phoenician homeland during this pivotal time.

Keywords: amphorae; Phoenicia; Lebanon; Late Iron Age; Persian period; mophometrics; petrography; organic residue analysis;

Introduction

As one of the most ubiquitous ceramic types uncovered during excavations of Phoenician settlements throughout the Mediterranean, amphorae have been intensively studied. The amphorae of the Iron Age are chronologically distinct and well suited to illuminating long-distance trade patterns. As such, a key focus of scholarship has been the establishment of typologies and identifying interregional distribution patterns across the Mediterranean (Knapp and Demesticha 2017: 102–25). As a great marker of economic activity, intensive studies of Phoenician amphorae have great potential to shed light on the organisation of smaller scale regional economies. Comparatively little attention, however, has been placed on understanding subregional variations in the context of their production and the significance of intraregional distribution patterns (see Bettles 2003b for a notable exception).

In this paper, a new multidisciplinary approach is utilised that combines traditional typological investigations with the extensive archaeometric analyses of carinated-shoulder amphorae (CSA) recovered from the 400-year Iron Age occupation at Tell el-Burak. Additionally, for the first time in Levantine pottery studies, a large detailed digital dataset containing more than 500 images and a number of tables covering all aspects of the study will be included in the accompanying online appendix, so the information can be freely used by scholars focused on Mediterranean studies. Integrating data gained from the morphometric analysis of amphorae, thin-section petrography, geochemistry and organic residue analyses provides a deeper understanding of the socio-economic significance of Phoenician amphorae in four ways.

First, a multidisciplinary approach informs on important aspects of the organization and aims of their production including materials selection, technology, standardization and craft specialisation. Second, the petrography and geochemistry can identify a shared locus of production to indicate the degree of centralization of production of these vessels and how it changed with time. Third, the organic residue analysis determines what commodities were being stored and transported in CSAs, helping better define their economic role. Fourth, the proportion of locally to non-locally produced vessels at Tell el-Burak can be determined shedding light on the degree and orientation of trade and the existence and nature of intensive interaction spheres.

Ascertaining aspects of the production, distribution and consumption of Phoenician amphorae and, especially, how these factors shift with time provides a deeper understanding of the organisation of the Phoenician economy along with insights into the potential socio-economic strategies that developed in southern Phoenicia as a response to the arrival of Neo-Assyrian, Neo-Babylonian and Persian empires. A study of similar scope has never been attempted on amphorae from the core of the Phoenician homeland, an area that remains grossly understudied.

What is currently lacking and what this study provides, is the first comprehensive site-level statistically robust typological analysis, drawing on large numbers of vessels from a long sequence of well-defined stratigraphic contexts, which integrates archaeometry. The nuance provided by this dataset and the integration of a similarly rigorous archaeometric analysis, is key to significantly expanding our understanding of amphorae production and its relationship to Phoenician socioeconomic strategies, especially those adopted in response to imperial rule.

This study demonstrates the value of utilising a multidisciplinary approach to address the major lacunae in our knowledge of the Phoenician homeland and the Iron Age Levant that are currently hindering efforts to develop region-level explanatory frameworks.

Later Iron Age and Persian period amphorae in the Phoenician homeland: our current understanding

Phoenician carinated-shoulder amphorae (CSA) form a distinct subgroup of a larger group of vessels recently and fittingly described as maritime transport containers (MTC) by Knapp and Demesticha (Demesticha and Knapp 2016; Knapp and Demesticha 2017). These vessels appear during the Early Bronze Age in the Eastern Mediterranean and by the Iron Age have developed into the standard vessel for bulk maritime transportation (Martin in: Knapp and Demesticha 2017). Bettles' proposal for a morphological denomination for the late Iron Age and Persian period MTCs identical to those from Tell el-Burak, i. e. carinated-shoulder amphora (CSA), will be followed here. What makes CSAs (Figures 8 and 9) visually distinct from other MTCs of the Iron Age, as their name suggests, is their pronounced shoulder carination. They are also characterized by relatively short necks and handles that are attached at the upper part of the vessel at the shoulder carination. The distinct look of CSAs would have made them readily identifiable and, as such, they surely would have developed into a class of material culture that served to communicate a particular image or brand (Bevan 2014). The core area of CSAs are coastal central and southern Lebanon and the northern half of the southern Levant as far south as Tel Dor (cf. Bettles 2003b: 35–38; 102–104). These vessels are found in quantity however as far north as Tell Sukas and as far south as Ashkelon (Lehmann 1996: pls 70–77). They are restricted to the coast in Lebanon, but found up to 25 km inland further south (Bettles 2003a: 74). CSAs came to be widely distributed throughout the Mediterranean forming the basis for types which developed into numerous derivatives in the central and western Mediterranean (see e. g. Bechtold and Docter 2010; Docter 2007 with further literature).

CSAs, like other MTCs share three common morphological characteristics: a narrow orifice, (at least) two handles and a narrow base varying in shape from rounded to pointed (flat bases occur rarely). Even though CSAs and other MTCs were designed for maritime transportation, they also served as storage vessels, containing commodities for long periods prior to and/or after transportation (Knapp and Demesticha 2017: 37–42). Based on morphological criteria, Stern (2015a: 438–40) proposed a distinction between Phoenician transport and purpose built Phoenician storage jars, however the criteria for doing so were not explained and therefore does not, in our opinion, produce meaningful results.

Iron Age II and Persian period CSAs are seen as the culmination of a long process of standardization and containerization that began during the Early Bronze Age. They are not the first purpose built MTCs, but, as Martin (2017: 121–2) points out they are among the most effectively designed and standardized. All of the current evidence and some new evidence presented below points to these jars representing a level of efficiency in production and use not seen in the previous periods. The shipwrecks of the Tanit and Elissa (Ballard *et al.* 2002; Finkelstein *et al.* 2011) show that large shipments almost exclusively of CSAs were packed onto the vessels of the time.

CSAs are seen as economically important and key to understanding Phoenician economic strategies and trade networks during the Iron Age (Bettles 2003b; Aznar 2005). CSAs are generally associated with standardised and centralised modes of production and far reaching distribution networks (Lehmann 1996: 75). Bettles, based on her petrographic evidence, believed that the most widely distributed CSAs in the Levant during the Persian period were manufactured at Sarepta (her fabric FC1A) and that the modes of production and distribution were consistent with the involvement of private individuals (2003b: 76). She does not discount the possibility that some of these vessels were distributed to state-associated establishments through a state-controlled mechanism. Bettles believes her data and distribution patterns are best explained through private enterprise, but she insufficiently engages with an apparent contradiction in her conclusions. Highly centralized production modes at one site, it could be argued, would not be expected in free-market type system dominated by private enterprise. Rather, multiple production loci would fit best with such modes, especially given an emphasis on efficiency, which is supported by the available data on these vessels. She herself discounts inland production for these amphorae on the grounds that it would be inefficient for vessels primarily intended for seaborne trade (2003b: 74), but does not consider the major logistical challenges presented by one major production centre supplying huge numbers of empty CSAs to the major ports throughout the region. In an efficient seaborne distribution system, one would expect multiple loci of production, probably associated with major ports. Underpinning her conclusions is the notion that Sarepta would have been unique in the number of kilns and its production capacity. A re-examination of the evidence from Sarepta, presented below as part of this study (section 6.2), challenges this commonly held suggestion.

At present, scholars have only developed a general understanding of the socio-economic significance of CSA production and their potential role in the political economies of the time. This study contributes some new information towards improving our understanding.

Previous work on CSAs in the Phoenician Homeland

A good deal of work has been conducted on Iron Age CSAs, which has very recently been comprehensively summarized by Martin (2017). As Martin's work is still current, a new overview is at present unnecessary and will not be attempted here. Instead, only work directly relevant to the study will be mentioned. CSAs are the prevalent MTC form at Tell el-Burak and other sites in the Phoenician homeland during the late Iron Age and Persian period (Stern 2015a: 338–41; 2015b: 570–1). At Tell el-Burak they compose over 95% of the MTC forms. Similar numbers were documented at Sarepta (Anderson 1988: 189), Tyre (Bikai 1978b: 44, 58) and Beirut (Jamieson 2011: 38). At Tel Kabri, Stratum E2, CSAs form 70% of all MTCs and 48% of the ceramic collections overall (Lehmann 2002: 216–217). Several authors have proposed a standard typology for Iron Age Levantine MTCs (Sagona 1982; Bikai 1978b; 1987; Regev 2004;

Aznar 2005; Pedrazzi 2007) but none of these has established itself unequivocally amongst scholars (Martin 2017: 103–104, 117–118). A number of new contributions to the understanding of Early Iron Age MTC production in the southern Levant have recently been published (Gilboa *et al.* 2015; Waiman-Barak 2016; Waiman-Barak and Gilboa 2016). While an even larger number of sites with a Late Iron Age and Persian period occupation have been investigated in the southern part of the Phoenician homeland, i. e. the Akko plain, a lack of quantitative typological or, in most cases, archaeometric analyses for the ceramic material makes the meaningful integration of information, beyond simple typological comparisons, impossible (cf. e. g. Briend and Humbert 1980; Herzog *et al.* 1989; Gilboa 1995). It is hoped rigorous multidisciplinary analyses, following the framework established in this study, will in the future be applied to a number of datasets from the core of the Phoenician homeland, allowing for the more meaningful integration of datasets and leading to the development of new robust region level explanatory frameworks.

Lehmann's (1996) important work on Late Iron Age and Persian period Levantine pottery is one of the more commonly referenced aggregated typological study, along with Bettles' (2003b) typological and large-scale petrographic study on Persian period carinated-shoulder amphorae. Bettles' study focused on Persian period assemblages from the southern Levant mostly outside of the core of the Phoenician homeland. Her work is exceptional in that it utilized petrography extensively and attempted integration with a rigorous typological assessment, however, her study was inherently based in large part on imprecisely treated datasets from stratigraphic contexts too broadly defined to provide the nuance required for an accurate understanding of the development and significance of CSAs in the context of Iron Age imperialism. The resulting problems in some of her interpretations will be discussed below in the relevant sections. Only a few typological studies have been published on assemblages from Lebanon so far and these will be treated in more detail below.

The significant integration of archaeometric analyses with more traditional pottery studies has only in two cases been undertaken on Late Iron Age and Persian Period CSA assemblages and are almost entirely lacking from Lebanon. The exception being Aznar’s (2005) unpublished PhD thesis and Bettles’ (2003b; 2003a) studies. As Aznar’s work is unpublished and the petrographic aspects are poorly supported with references and images we approach her conclusions with caution. Bettles analysed 30 samples from Sarepta as part of her larger dataset focused on materials further south and incorporated some geochemistry.

The present study, thus, represents the first large-scale petrographic dataset for CSAs covering the Late Iron Age and Persian Period from the Levant. It also presents the largest published dataset for organic residue analyses yet conducted on CSAs. Some work has been done on single vessels from the central and western Mediterranean (McGovern *et al.* 2013). The available data for contents is limited, but these jars, are often assumed to have contained olive oil and/or wine, based in part on scant residue analyses data and in part on historical data (Martin 2017: 131; Bettles 2003b: 37, 229, 267). The residue analysis conducted by McGovern on one amphora from the Tanit shipwreck allegedly found evidence of wine, but no data is presented to support this conclusion (Ballard *et al.* 2002: 160–1).

A number of ceramic assemblages, including CSAs, have been uncovered at the closest known sites to Tell el-Burak. Of those published, Sarepta, Tyre and Beirut provide the most closely comparable typological dataset to that from Tell el-Burak. A comprehensive summary of the data from Lebanon was not included in Martin’s work (2017) and will be provided here.

Sarepta

The Late Iron Age pottery collections from Sarepta and Tell el-Burak are highly comparable as can be expected given the close proximity of the two sites. The main impediment to meaningful comparisons with the Sarepta form type-series is that it is based on the study of rim fragments alone (Anderson 1988: 140), especially in the case of the amphorae (called storage jars at Sarepta). The focus on rims shape has kept Anderson from developing a more refined form type-series, as other vessel features (e. g. shoulders) were not taken into consideration (cf. Table 1). Anderson himself, however, considered his type-series as a starting point which, in his words, 'will require additions and other refinements' (Anderson 1988: 139). This study builds on his work and succeeds in realising a more complete CSA typology.

A series of well-stratified contexts from the Persian period were excavated at Tell el-Burak, but these are difficult to compare with the material from Sarepta. While Persian period ceramic material is present in larger numbers at Saretpa (Area II, Y, Stratum A; cf. Table 2), meaningful data cannot be extracted because, as Anderson stated, 'Stratum A consists of an aggregate of deposits and architecture which is difficult to associate and impossible to interpret.' (Anderson 1988: 124). This might be the reason why Anderson in his typology failed to recognise that his CSA type SJ 18 can be subdivided into distinct chronological/typological groups as is clearly shown by this study (cf. Table 1 and section 2.1, Table 7).

Sarepta	**Tell el-Burak**
SJ 9--SJ 17	A-01A--L
SJ 18	A-02A
	A-02B

	A-02C

Table 1 Showing corresponding amphorae types between the Sarepta and Tell el-Burak form-type series

As at Tell el-Burak, the evidence from Sarepta points to a marked increase in CSA production during Phase C continuing into Phase B (cf. Table 5 for a chronological overview), though some caution must be exercised as the Late Iron Age pottery collections from Sarepta are relatively small (cf. Table 2) compared to Tell el-Burak (cf. Table 6).

Stratum/Period[1]		**Body sherds**		**Diagnostics**		**Amphorae**	
Area II, Y	**Area II, X**	**II, Y**	**II, X**	**II, Y**	**II, X**	**II, Y**	**II, X**
A1	**X?**	(25.562)	--	(5.231)	9	--	--
A2	**IX?--VIIIb**		--		28		--
B		7.737	239	1.024	4.356	331 (56.48%)	481 (42.38%)
C1	**VIIIb--**	12.059		1.593		333 (34.76%)	
C2	**VIIIa**	17.654		1.477		362 (45.65%)	
D1	**VII**	7.376	144	1.179	1.222	103 (14.91%)	278
Total		**44.826 (70.388)**	**383**	**5.273 (10.504)**	**5615**	**1129**	**759**

Table 2 Pottery counting from Sarepta Area II, Y, Strata A–D1 (Anderson 1988: 466, Tab. 1-A; 469, Tab. B-2; 489–490, Tab. 9-A/B) and Area II, X, Periods X–VII (Khalifeh 1988: 238, Tab. 2-A; 240, Tab. 3-A; 241, Tab. 3-B;) (Stratum A pottery is for the most part excluded in Anderson's frequency tables due to the unclear nature of most of the Stratum A contexts); absolute dates are given in section 1, Table 5

[1] Based on {Khalifeh 1988 #2519:160/nopar}.

Tyre (Bikai excavations)

At Tyre, the total amount of pottery from late Iron Age contexts (I–IV) is again fairly limited with 804 diagnostic amphora sherds uncovered. Of these, forms SJ 1/2/4/5/6 (total 493) are the most prevalent. In comparison with Sarepta and Tell el-Burak amphorae make only a relatively small part of the total ceramic collections (max. 14.8 %), however, the small sample size must be taken into account and future excavation may increase this number.

Stratum	**Total sherds**	**Diagnostics**	**Amphorae**
I	1.894	216	32 (14.8%)
II	45.817	3.726	531 (14.24%)
III	17.169	2.603	98 (3.77%)
IV	15.776	2.182	143 (6.55%)
Total	**80656**	**8727**	**804**

Table 3 Pottery counting from Tyre (Bikai 1978b: 19, Tab. 1; 44, Tab. 10-A/B; 58, Tab. 14); absolute dates are given in section 1, Table 5

Gilboa *et al.* (2004: 688–692) have compared 9th and 8th century CSAs from Tyre and Hazor using computerized typological classification and software-based analysis and comparison of forms in order to answer questions concerning the origin of the vessels and the nature of trade relationships between the two sites. As there is only very little overlap in vessel form between the amphorae from Tyre and Hazor, they convincingly argue for two separate production centres for these jars. Consequently, previous claims for direct commercial links between the two cities based on CSAs could not be confirmed.

Beirut

The Beirut Downtown excavations of Iron Age II and Persian period layers were mostly published in short preliminary reports or remain unpublished. The Persian period remains of BEY010 and BEY039 have been published in a volume edited by Elayi and Sayegh 2000. The CSAs from BEY010 were studied by Jabak-Hteit (2003) who has developed a detailed form type-series of these vessels based on 375 rim fragments (Jabak-Hteit 2003: 82). The study makes a good effort at a robust statistical analysis; however, a lack of typological criteria and the absence of fabric descriptions make a meaningful integration with data from other sites impossible. (Jabak-Hteit 2003: 90–91). The CSAs found at BEY010 make up 80% of the ceramic collections from BEY010 (Jabak-Hteit 2003: 80), a figure comparable to Tell el-Burak (see Figure 18).

Jamieson (2011) has studied the Iron Age pottery from BEY032. Of special interest is the material from Period 2 (1175 total sherds) dating to the Late Iron Age and Persian period. 267 CSAs (31.89%) classified as Common Ware Jars and subdivided into seven subgroups were documented (Jamieson 2011: 38–44, 217, 238).

BEY03 yielded some restorable CSAs in addition to several fragments (Badre 1997: 79–85), but little information is published about them.

Sidon and Jiyeh

Iron Age ceramic material from the College Site excavations at Sidon have not yet been published in detail. The site has yielded some important contexts with complete CSAs *in situ* (Doumet-Serhal 2009: 46–47, Fig. 57–58).

The sites of Jiyeh (Fransico J. Núñez personal communication) and Jemjim (Ida Oggiano personal communication) in southern Lebanon have also produced CSAs.

1 Tell el-Burak: introduction and chronology

Tell el-Burak is a small site (ca. 120 x 120 m, h. 20 m) situated on the coast in southern Lebanon approximately 9 km south of Sidon (33.482558, 35.322487) (Figure 1). The tell itself is an artificial earthwork of the Middle Bronze Age I (MBA I) built in connection with the construction of a large mudbrick building (interpreted as a palace) (Kamlah and Sader 2003; 2008; Kamlah *et al.* 2016b). After the MBA I, the site was abandoned and only resettled in the middle of the 8th century during the Iron Age II. The Iron Age II and Persian period occupation of the site lasted for approximately 400 years and the latest remnants at the site date to the first half of the 4^{th} century. The abandonment of the site, therefore, seems to coincide roughly with the end of Achaemenid rule in the Levant in 332 BC.

A short-term marine survey conducted by Pedersen (2011) did not produce any evidence for an anchorage close to the site. Further investigations might change this picture.

The site is situated in a relatively large coastal plain well fed by several springs and creeks coming down from the mountains and hilly hinterland. The latter stretches several kilometres to the east and was well suited for growing different kinds of crops (Tachatou 2018).

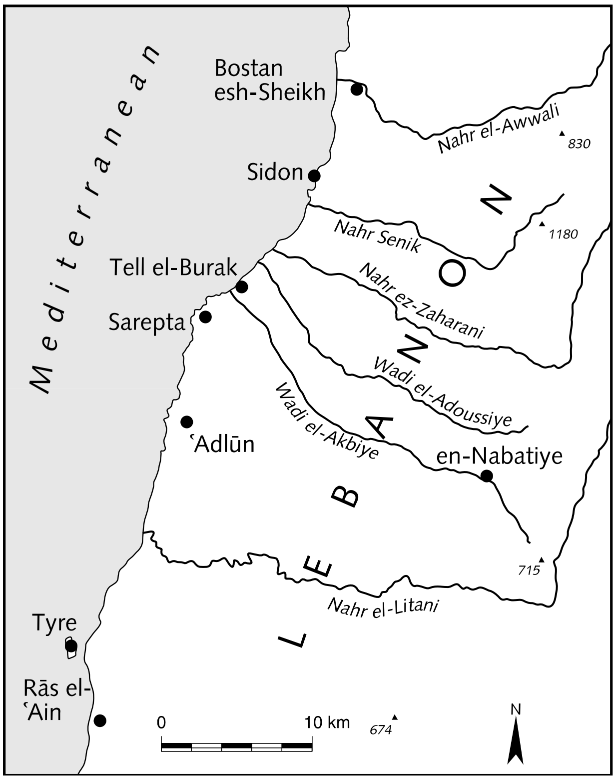


Figure 1 Map showing location of Tell el-Burak

Iron Age remains were uncovered in Areas 2–4 of the excavation, but this study focuses on the ceramics from areas 3 and 4 where most of the stratified finds originated. The Iron Age settlement can be subdivided into four zones (cf. Figure 2): The area of the settlement wall (Area 3, 4), the intra muros settlement (Area 3), the extra muros dump layers (Area 4a) and agricultural installations (Area 4b) (for a more extensive account of the Iron Age remains see Kamlah *et al.* 2016b; 2016a; Schmitt, in press).

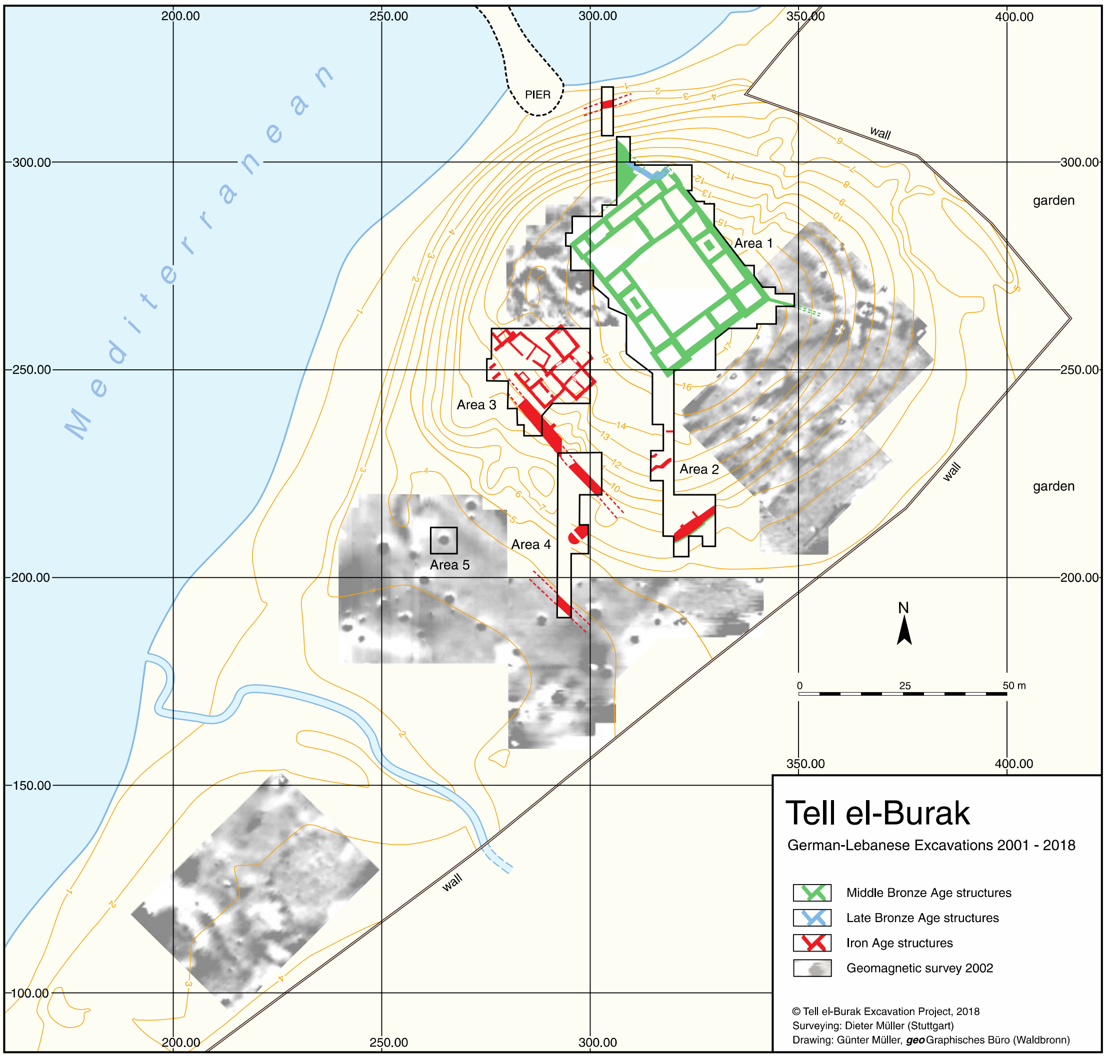


Figure 2 Top plan of Tell el-Burak showing MBA building remains (green), Iron Age remains (red) and the results of a geo-physical survey using a magnetometer

Based on changes in architecture in Area 3, a stratigraphic sequence of occupation phases was established with Phase E as the oldest and Phase A as the youngest (cf. Table 4 and 5). The absolute dates associated with the phases are as follows. There is some uncertainty surrounding the boundaries between the various Phases, reflecting gradual, rather than abrupt, transitions in material culture. Phase E begins sometime around 750 BC and continues until about 650 (+/- approximately 30 years). Phase D begins around 650 BC (+/- approximately 30 years) and ends sometime between 600-580 BC. Phase C starts around 600-580 and should end to before 500/480 as it did not produce Attic ware (cf. Lehmann 1996: 69, 78). Likewise, the lack of clear stratigraphic breaks and the presence of attic ware indicates that Phase B starts around 500/480, perhaps continuing to roughly 400/380. There is difficulty at present understanding the date of the end of phase B and the beginning of phase A. Phase A is always found as a relatively thin-layer just under the surface, indicating it is relatively short-lived and occurred near the end of the site's occupation, perhaps beginning around 400/360 BC and ending broadly around 330 BC. A precise end date remains uncertain and the estimate is based in part on the lack of Hellenistic period material culture in these layers. Radiocarbon dates in progress hope to shed more light on the duration and end of Phase A.

An immense Iron Age Pottery assemblage of over 1,000,000 sherds has been recovered from Tell el-Burak. This study draws on over 300,000 sherds from reliable contexts (26,000 of which were diagnostic), uncovered and recorded during the 2013−2017 seasons. The CSA materials forming the dataset for this paper were drawn exclusively from Areas 3 and 4 in all four of the zones defined above (an overview and a short description of the contexts including quantities of vessel classes are given in the online appendix Table 2).

Imported ceramic vessels appear frequently in all contexts in phases but only in very minor quantities, i. e. generally <1% of all diagnostic sherds. During Phase E and D Cypriot imports are prevalent (see Schmitt in: Kamlah et al. 2016b, 103, pls. 4–6). They virtually disappear during the later phases and are replaced by East Greek imports and still later Attic pottery. East Greek amphorae occur regularly in Phase C–A contexts. The situation at Tell el-Burak follows a general pattern for northern and central Levantine sites (Lehmann 1996: 75–79).

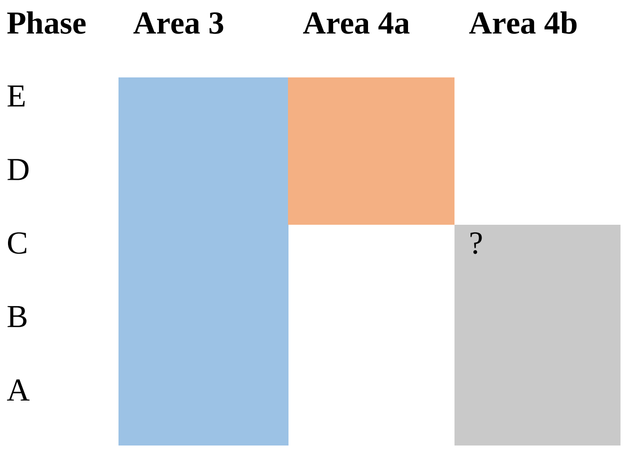


Table 4 Schematic overview of chronological distribution of contexts in Areas 3 and 4. The existence of Phase C materials in Area 4b remains uncertain

Lehmann 1996 – *Assemblage*		TB Phases	Sarepta	Tyre (al-Bass)
until 720	1	E	(D1)	III (IV)
720–700	2		C2	
700–650	3		C1	II–I (V)
650–580	4	D	B	
580–540	5	C	A	
540–440	6	B		
440–360	7	A		
360–330	8			

Table 5 Chronological overview (based on Lehmann 1996: 87, Tab. 4.9; 223, 269; for Tyre al-Bass cf. Núñez 2014: 60)

2 The development of late Iron Age and Persian period Phoenician amphora forms at Tell el-Burak

2.1 The material and research methods

At Tell el-Burak, most of the CSA materials in Areas 3 and 4 were found associated with fills, dumps and other occupation debris and only preserved as fragments. As is typical for sites in the region, vessel rims and/or necks form the majority of the diagnostic dataset. Parts of the shoulders are often preserved, including the shoulder carination and one or two handles are still attached with some frequency. Complete vessels were rarely found, with the notable exception of a cache found in House 3 dating to the end of phase D (see below). The lack of complete vessels hinders our understanding of the overall shape and carrying capacity of the amphorae dating to these periods. As a result, the establishment of our amphora form type-series relies mostly on variations in the rim/neck and shoulder. Luckily, in the case of this vessel class, these features seem to be relatable to differences in overall vessel morphology, which are chronologically and, perhaps, functionally significant (see below). Future work and the discovery of more complete vessels will hopefully allow for a better understanding of the relationship between rim/neck, handle and vessel shape.

The excavated sherds were (after washing, counting, weighing) classified according to a form type-series developed during 2013−2017 (cf. Schmitt in: Kamlah *et al.* 2016b; 2016a; Schmitt, in press). All of the CSA fragments from Iron Age contexts that were preserved from rim to shoulder were drawn and photographed. A representative number of less well-preserved amphora sherds (rims, handles, bases) were also drawn and photographed. The amphora sherds were subdivided into groups according to rim forms or in case of groups A-04 and A-05 (cf. Table 6) according to other vessel features. Imported amphorae of East Greek and other origins occur with some frequency but will be discussed in detail in a future paper, as this study will focus on locally made amphorae the amount of which far outnumber imported amphorae.

Six groups of amphorae were distinguished, but only groups A-01 and A-02 occur in quantities sufficient enough to be included in the current analysis (Table 3). Overall, 7434 amphorae (Table 3) formed the dataset used for the macroscopic aspects of this study. From this, a smaller representative number were selected for morphometric analysis, petrography, geochemistry and organic residue analysis.

Group	**Subgroup**	**Description**	**n (all contexts)**
A-01		Long, articulated neck/rim; at least 9 subgroups (see Figure 3)	1041
A-02		No neck; short, simple rim (see Figure 4)	6393
	A-02A	Rims slightly longer than A-02C, long shoulders	2314
	A-02B	Rims and shoulder slightly shorter than A-02A	N/A
	A-02C	Rims slightly shorter than A-02A/B, short shoulders	4079
A-03		Hole mouth jars	83
A-04		Red slipped and painted CSA	3
A-05		Basket handle amphorae (including handles and bases)	238
A-06		Short, triangular rim with flat top	8

Table 6 Tell el-Burak amphora groups analysed as part of this study. A-02B was only recently discovered and quantitative values for the occurrence of this type are not yet available

CSAs of group A-01 (with subgroups A-01A−L[2], Figure 3) occur in the earliest Iron Age contexts of Tell el-Burak (Phases E and D) and are entirely replaced by A-02A type amphorae during Phase D. The two groups are distinguishable by rim form and, in many cases, a slight difference in petrographic and geochemical composition (see below section 4). Group A-01 CSA are quite varied and have relatively long, articulated rims/necks and long shoulders. The group A-02 CSA (Figure 4) have short rims that seemingly represent an abrupt stylistic break with the earlier A-01 types. The A-02 subtypes are far less varied than those of A-01 despite occurring for a much longer time at Tell el-Burak.

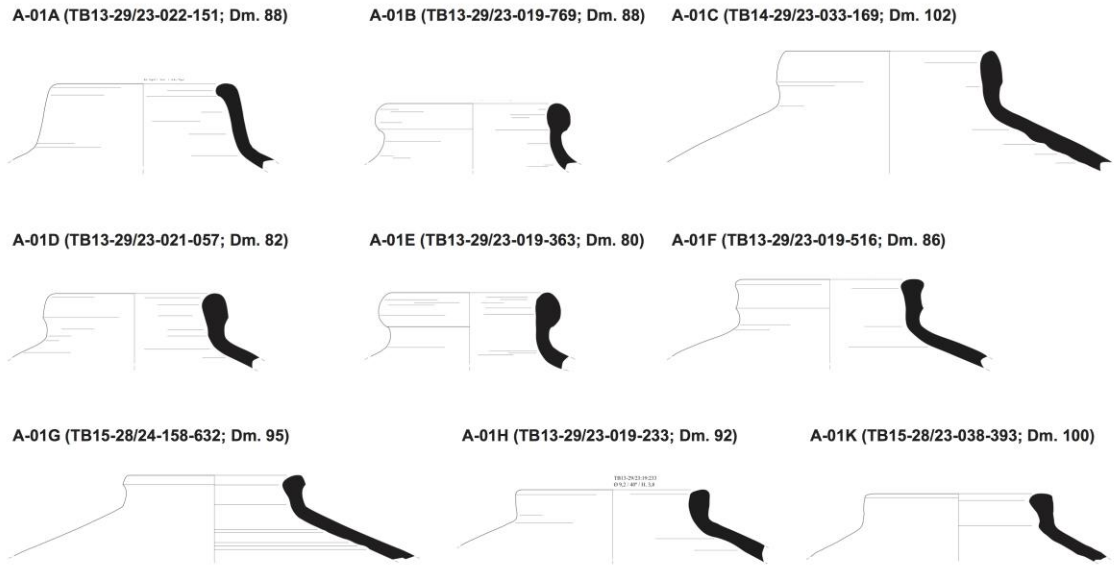


Figure 3 A-01 subgroups from Tell el-Burak

[2] Letters I and J are omitted to avoid confusion with numerical characters.

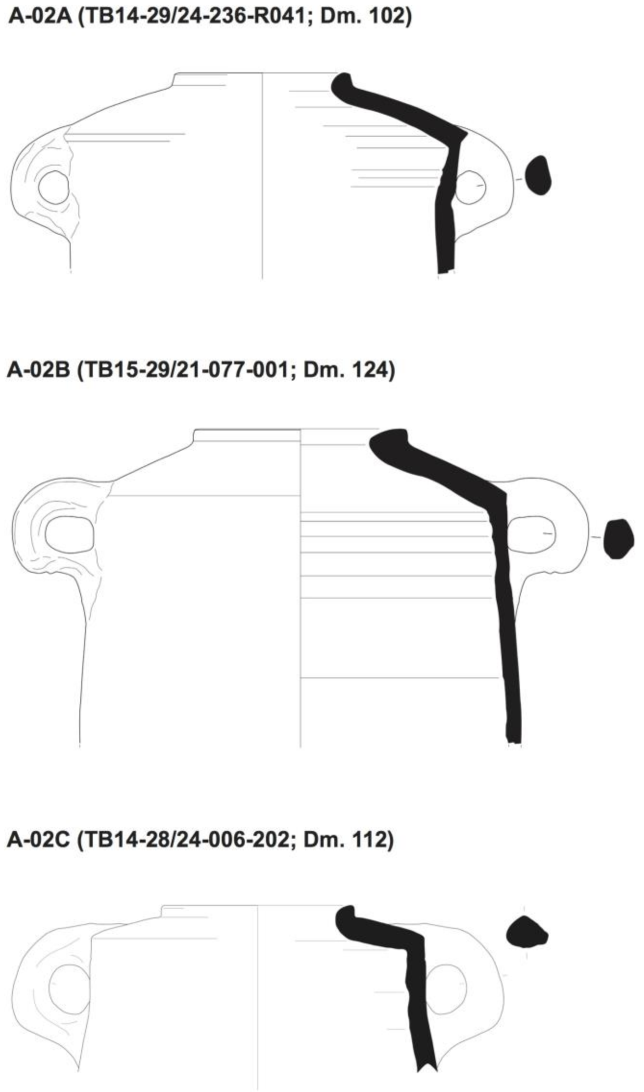


Figure 4 A-02 subgroups from Tell el-Burak

The A-02 CSA can be further subdivided into three subgroups (A-02A, A-02B, A-02C) based on differences in shoulder length and inclination, which decrease with time (Fig. 4). Type A-02A, with a long shoulder and relatively high inclination, is the earliest, proliferating in Phase D. Type A-02C, with shorter shoulders and exhibiting very low inclination, occurs later (Phases C–A). Relatively little is known about the occurrence of subgroup A-02B, which occurs sporadically and was only recognized recently. The form is mentioned here, however, as it is critical to understanding the transition from types A-02A to A-02C. The latter two types are only in a few cases found together in the same context, which might have suggested a sudden change in CSA production or an interruption in the settlement history of Tell el-Burak. A-02B, which seems to be a rather short-lived transitional form, clearly links the two more common types morphologically, indicating continuity in settlement and a gradual shift in production.

Phase	**A-01**	**A-02A**	**A-02B**	**A-02C**
E				
D				
C			?	
B				
A				

Table 7 Chronological distribution of CSA groups A-01 and A-02

2.2 The replacement of amphora group A-01 by subgroup A-02A

During phase D, the ten tall-rimed subgroups of type A-01 are gradually replaced by the more uniform and shorter rimed CSA of subgroup A-02A. The transition is best illustrated by a series of superimposed deposits in Area 4a (square 29/22) interpreted as occupational debris dumped from inside the settlement. The relevant contexts are: 13−15, 17, 18, 26, 32 in square 29/22. Figure 5 clearly illustrates the gradual replacement of A-01 by A-02A. These results are further confirmed by the observations made in Area 3 (cf. Figure 6).

In our interpretation, the contexts in Area 4a contain contemporary material. Tough, the re-deposition of older material cannot be excluded categorically, this most probably did not distort the quantitative relation between CSAs of the A-01 and A-02A groups. This assumption is confirmed by the distribution of A-01 subtypes which themselves are unevenly distributed. For example, subtypes A-01C and A-01F are more numerous in the earlier Phase E contexts whereas subtypes A-01D and A-01G appear in larger quantities in the later Phase E and early Phase D. Subtype A-01G in particular is a late from and appears only in minor quantities in pure Phase E contexts, such as 28/23-038 and 29/23-019 (see Table 2 in the online appendix).

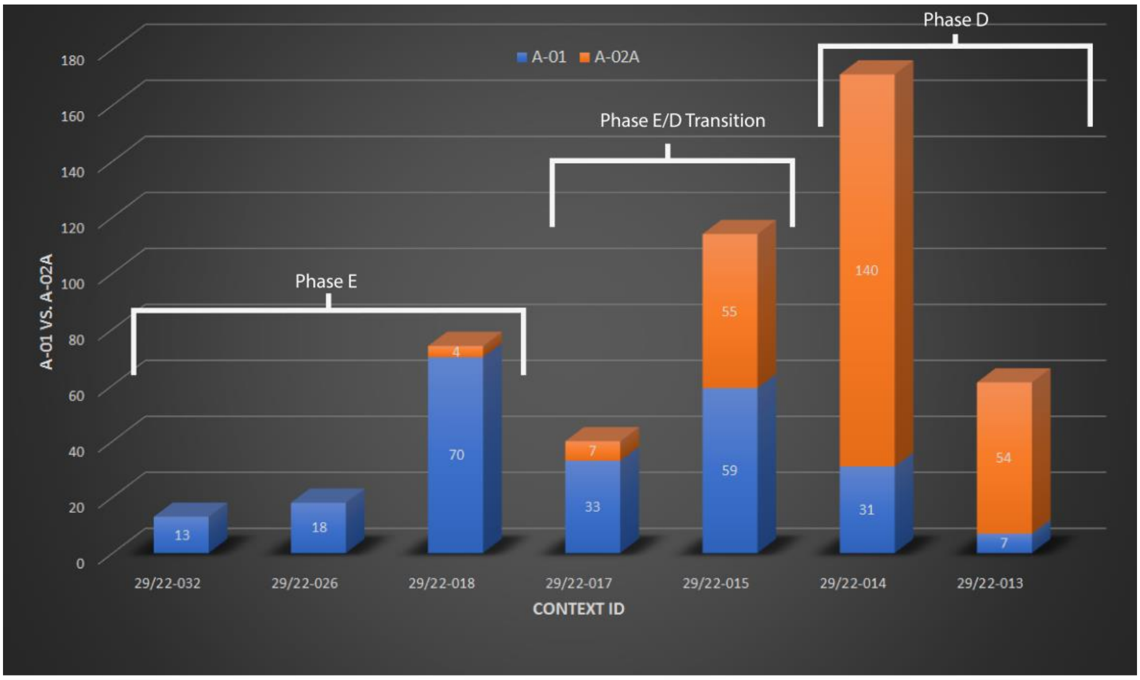


Figure 5 Chart showing the frequency of A-01 and A-02A amphorae in Area 4a contexts, contemporary to Phases E and D in Area 3. The contexts are ordered earliest to latest (left to right)

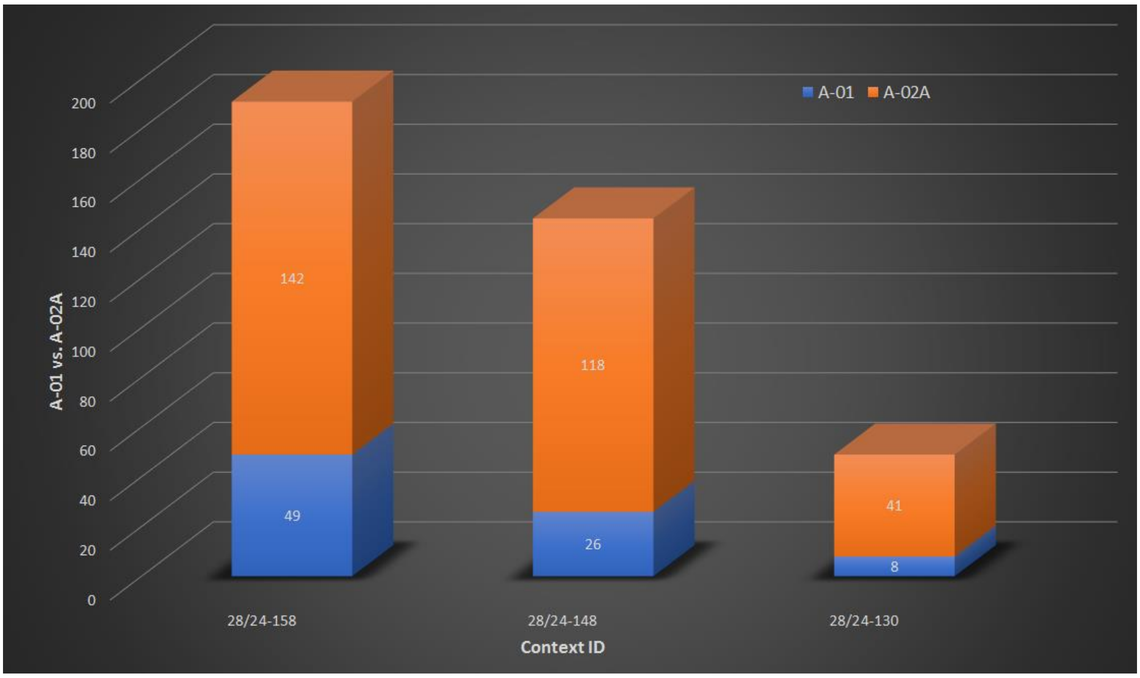


Figure 6 Chart showing the frequency of A-01 and A-02A amphorae in Area 3 contexts, Phase D (just outside of House 3, above Structure I); contexts 148 and 158 are contemporary, context 130 is later

2.3 Morphometric analysis of amphora sherds

The qualitative analysis of forms was augmented with a quantitative morphometric analysis of particular features of the preserved parts of the vessels (Figure 7), these are:

(1) Width of vessel opening

(2) Length of rim/neck

(3) Max. thickness of shoulder

(4) Length of shoulder

(5) Shoulder inclination (in degree)

(6) Width of vessel at shoulder carination

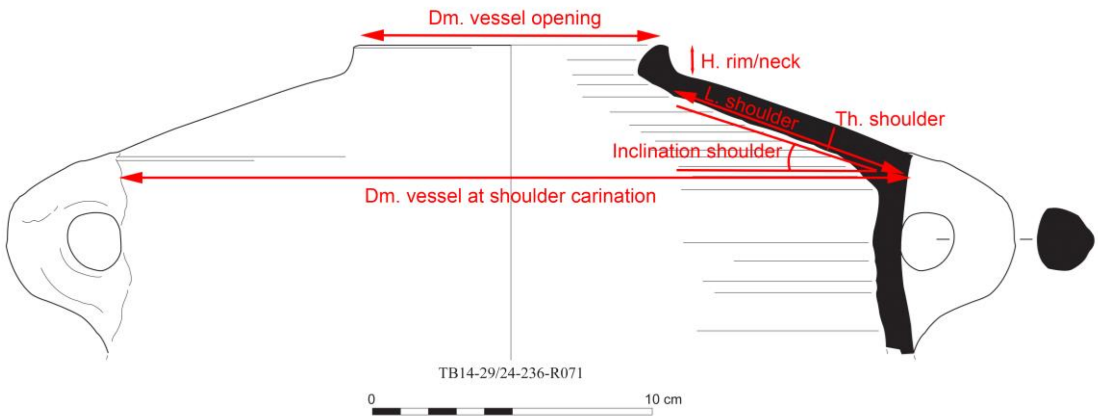


Figure 7 Red arrows indicate measured features of upper parts of CSA from Tell el-Burak

All drawings were made by hand and then digitally redrawn. The hand drawings were always double checked. Measurements were obtained using the digitized drawings in Adobe Photoshop.

The goal of the quantitative morphometric analysis of the amphorae was to gain a dataset by which we would be able to assess subtle morphological developments and the degree of standardization of production of these vessels during the late Iron Age and Persian periods. A particular aim was to understand if morphological changes or greater standardization could be shown to be coincident with the Neo-Assyrian, Neo-Babylonian, or Persian imperial regimes, which could provide evidence of the resulting socio-economic impacts on the Phoenician homeland.

The results of the morphometric analyses of more than 400 vessel fragments are presented in Table 8 (the measurement for each object are given in Table 1 of the online appendix). The total number of specimens analysed are listed for each variable, which depended on the state of preservation of each sample. All measurements are given in mm, except shoulder inclination, which is given in degrees. In Table 8, we give the mean ($\bar{Y}$) and standard deviation (s) (notation from VanPool and Leonard 2011: 46) for each of the measured vessel features. The mean was validated by comparing it to the median.

The results reinforce the notion that the wheel-made CSAs at Tell el-Burak are a mass-produced and highly standardised type. Still, they are a craft product and, as such, caution must be exercised when interpreting the variation in the quantitative measurement data. To ensure a high degree of accuracy all measurements were double-checked. As to the variation within groups of pottery vessels, experiments and ethnographic observation have shown that variation in specialized craft production is indeed very low (less than 5%; cf. e. g. Eerkens 2000), which is in line with the data produced by this analysis indicating these vessels are the product of specialised and centralised production.

2.3.1 Results of the morphometric analysis

The standard deviation across most measurement categories shows that many of the attributes of these vessels were produced to tolerances of less than 10 mm, indicating the vessels are a mass-produced and highly standardised type. The A-01 varieties show the highest standard deviations indicating they are the least standardised – not surprising given that they occur in the greatest variety of forms. The A-02 vessels are more standardised, which is to be expected as they occur in a smaller variety of forms. The data suggests that the A-02C Persian Period CSAs, though exhibiting signs of less carful manufacture, show similar levels of standardisation to the late Iron II A-02A types.

	Neck length			**Vessel opening**			**Shoulder length**			**Shoulder thickness**			**Shoulder inclination**			**Shoulder diameter**		
	A-01	**A-02A**	**A-02C**	**A-01**	**A-02A**	**A-02C**	**A-01**	**A-02A**	**A-02C**	**A-01**	**A-02A**	**A-02C**	**A-01**	**A-02A**	**A-02C**	**A-01**	**A-02A**	**A-02C**
Ȳ	23	10.8	9.3	96.9	104.7	101.1	65.5	69.7	37.5	8.4	10.4	11.1	25.8	21.4	17.2	227.	238.5	179

																8		
s	6.9	2.3	2.5	10.8	7.3	9.9	15.6	12.8	7.9	1.4	1.9	1.6	5.6	4.9	7.8	30.5	26.3	16.6
M	22	10.5	9	97	104	100	61	66	38	8	10	11	26	22	17	214	236	177
n	131	70	128	136	70	129	17	62	121	78	70	127	76	71	127	15	63	120
Max.	45	18	20	124	122	126	92	96	55	12	14	15	37	35	42	288	286	228
Min.	11	5	2	76	84	80	40	39	23	6	8	7	14	9	0	186	184	147

Table 8 Summary of metric data by CSA type ($\bar{Y}$ = mean of sample; s = standard deviation of sample; M = median; n = number of samples; cf. VanPool and Leonard 2011: 44, 51); all measurements are given in millimeters (mm), except for shoulder inclination which is given in degrees

Neck length is drastically reduced from group A-01 to subgroup A-02A and further decreases in subgroup A-02C. The move to a shorter neck might be explained by the introduction of a new way of closing the vessel's opening. How these vessels were closed can only be speculated about, because nothing that can be interpreted as a lids or ties appear in the archaeological record, most likely because they were made from organic materials. Lids used to close amphorae of group A-01 were most probably fixed to the rim/neck by some kind of string or other binding device. The longer rims of A-01 (Figure 3) and the commonly observed protruding ridge or bulge on the rim would have accommodated such a system. It is even less clear how the lids of amphora group A-02 (Figure 4) were closed. The A-02 types likely also involved a lid or stopper that might have been fixed by using a string applied to the handles and/or some kind of sealant, like wax.

The *vessel openings* (i.e. rim diameter) show a high degree of uniformity in all amphora groups. The reasons for a constant size might have been purely practical. An opening of 100±20 mm is perhaps small enough to easily close but large enough to allow an adult hand to reach inside during the production of the vessel, for later treatments to the interior (e. g. addition of resins), for retrieving the content, or for cleaning the vessel for reuse.

The *shoulder lengths* of group A-01 and subgroup A-02A are relatively long; the measurements for A-01 are given here only provisionally as the sample size is very small (n = 11), though comparative material from other sites indicate A-01 types always exhibit relatively long shoulders (Anderson 1988; Lehmann 1996: pl.s 70–75). The shoulder length is drastically reduced in subgroup A-02C. The observed decrease in shoulder length with time indicates that most Persian Period CSAs (A-02C) held a smaller volume than the late Iron II forms. The only way the A-02C amphorae would have held a similar volume to earlier forms is if they were significantly elongated and their lower body were wider than the shoulder area, neither of which are indicated in the Persian Period typologies from the region (Lehmann 1996: pls. 70–75; Bettles 2003b). The relatively high standard deviation of shoulder length across all types likely reflects a variety of widths in the assemblage and, thus, the existence of vessels with differing capacities. The evidence from House 3 presented in the following section shows that amphorae of differing capacities were contemporary and present in the same context.

Shoulder thickness increases slightly with time and the shoulders become flatter as indicated by the decrease in *shoulder inclination*. Lastly, the decreasing ratio of shoulder length vs. shoulder thickness (A-01: 7.7; A-02A: 6.8; A-02C: 3.3) reflects the observation that shoulders become more squat and thick during the Persian period. *Shoulder diameter* is used as an indicator of vessel size (see below section 3, Tables 8 and 9). The values indicate that the amphorae tend to become smaller with time. As with shoulder length, the variation is high and might be explained by the existence of multiple standardized size categories.

3 CSAs from the destruction level of House 3

The excavation of House 3 in Area 3 during the 2014 and 2015 seasons yielded an important assemblage of restorable Iron Age CSAs. House 3 collapsed for unknown reasons around the end of the 7th or the beginning of the 6th century BC burying an inventory of ceramic vessels that were stored in its rooms (for a more detailed description see Kamlah *et al.* 2016b: 96–8). The dating of the room is based on the stratigraphy and material culture assemblages. The collapse of House 3 marks the end of Phase D.

In Room 3.1, 3.2 and 3.3 of the building CSAs and a few smaller vessels were stored at the time of destruction with Room 3.1 containing the highest quantity of CSAs by far. The collapsing walls and roofs shattered the vessels into small fragments. During a restoration campaign in spring 2015, 55 CSAs from Room 3.1 were completely or partially restored. During excavation, samples were taken (mainly CSA bases) for content analysis (see section 5). Petrographic and chemical analyses were conducted on 16 of the vessels.

All of the CSAs from House 3 belong to subgroup A-02A, except for two amphorae from Room 3.1. One is probably an import and the other is a type A-01G. The results for the petrographic analyses (section 4) indicate these ceramics were made of clays consistent with the local geology and the most commonly occurring petrofabric at Tell el-Burak (fabric 1A). As such, they can be considered to originate in southern Lebanon. The vessels are generally well fired under oxidizing conditions and red or brown in colour.

Two types and sizes of complete CSA forms could be discerned. One with the widest point at the shoulder carination and a tapering body, called Amph01 (n = 26) and a second one with the widest point somewhere below the shoulder carination giving the amphorae a more sack-shaped appearance, called Amph02 (n = 16). 13 CSAs remain to be classified once they are more completely restored. Figures 8 and 9 show the drawings of all the specimens identified as Amph01 or Amph02 (for a complete set of dimensions for these vessels see Table 5 in the online appendix). These denominations refer to complete CSA forms otherwise rarely found at Tell el-Burak. They both belong to subgroup A-02A of the form type-series (cf. section 2.1, Figure 4).

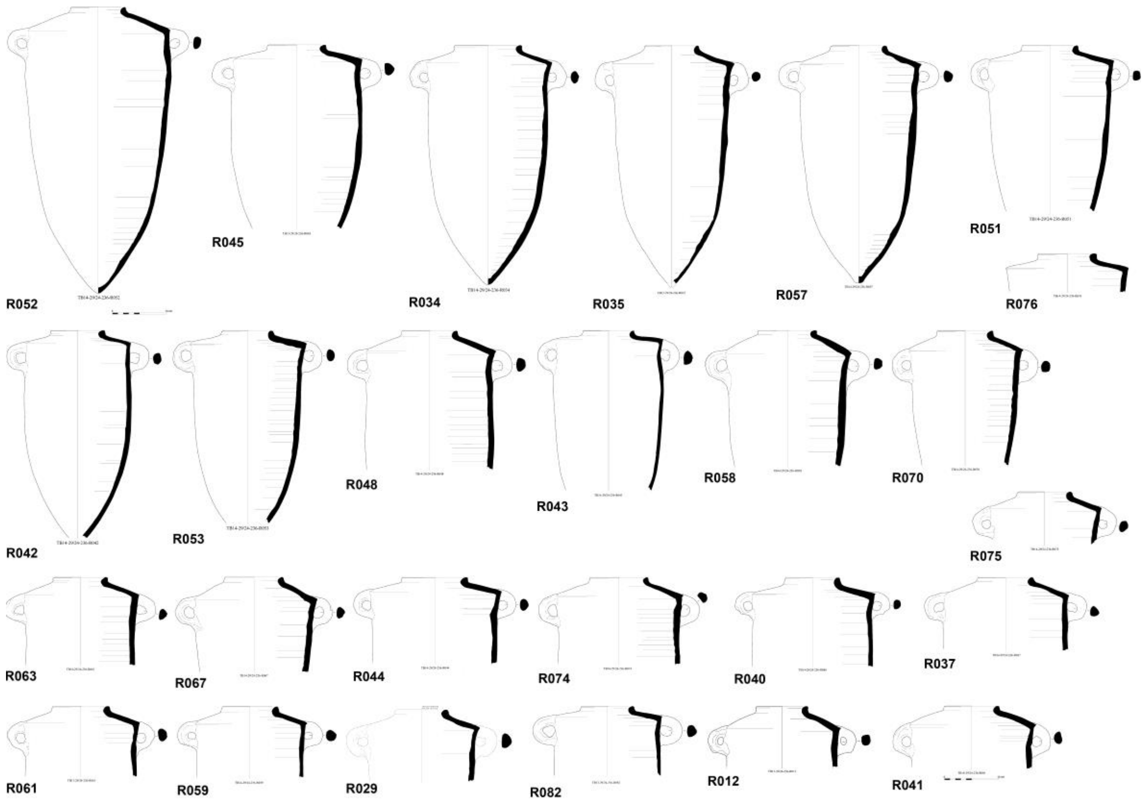


Figure 8 Amph01 CSA from House 3

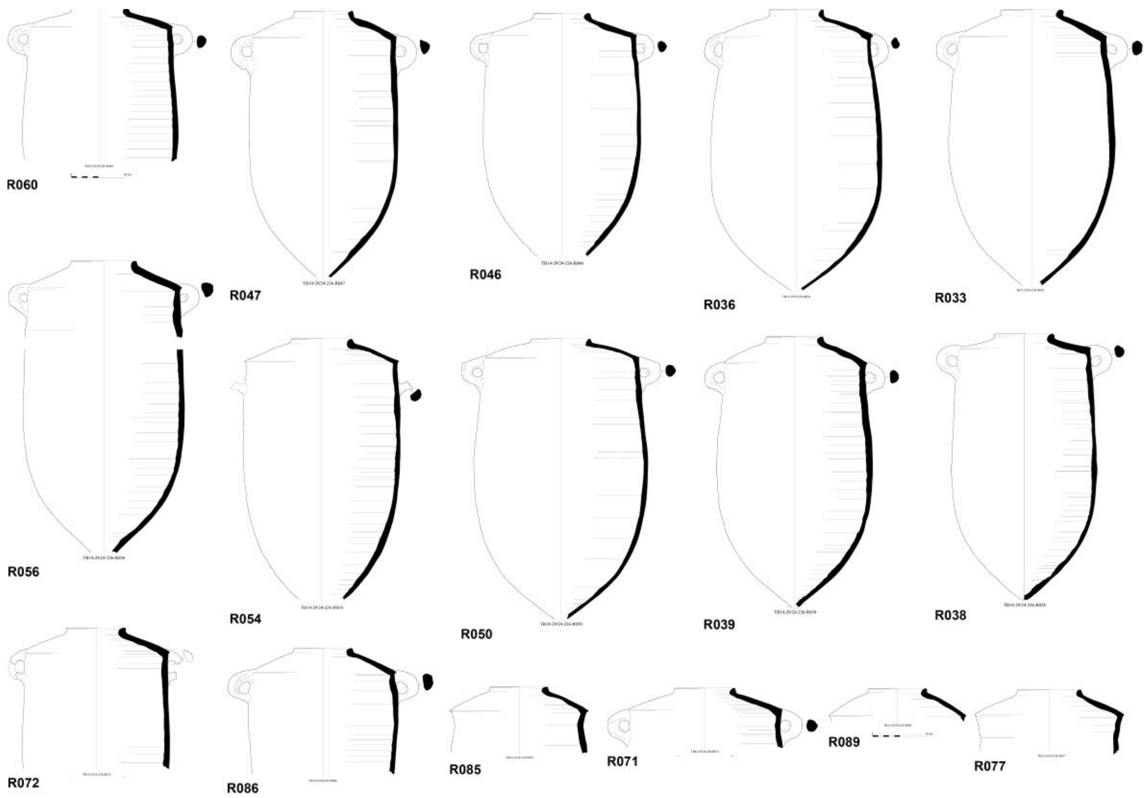


Figure 9 Amph02 CSA from House 3

The volume of the complete or almost complete vessels (n = 19) has been calculated using a measuring tool developed by J. P. Thalmann[3]. The results are given in Table 9, but have to be treated with caution as the dataset is not statistically significant. The results, however, can be taken as strongly suggesting a four-fold division in capacity for the amphorae found in House 3 with Amph01 made for smaller capacities measuring 6–7 l and 8–9 l and Amph02 for higher capacities measuring 17–21 l and 23–25 l. The results, though preliminary, seem to indicate several standard size categories existed. Understanding how these divisions relate to the broader CSA assemblage at Tell el-Burak require the discovery of more complete forms. Amph02 volumes roughly equate to volumes of CSAs from the Tanit and Elissa shipwrecks published by Finkelstein *et al.* 2011. The reasons for the size differences remain

[3] © J. P. Thalmann & ARCANE, 2006; v. 1.05 (11.01.2007).

unclear. Perhaps different amphora forms are used for different contents and/or different markets.

Measurements were taken on the complete or almost complete CSAs from House 3 (n = 19) to investigate whether the dimensions of their upper parts, commonly preserved, could be used to estimate a vessel's volume and if so, how precise this estimation would be. The postulation was that the diameter of vessel at shoulder carination (DmCar) might be indicative for vessel volume assuming a more or less fixed ratio between DmCar and vessel height.

The Amph01 vessels of the ca. 6–7 l capacity have a mean DmCar of ca. 210 mm and the Amph01 vessels of the ca. 8–9 l capacity have a mean DmCar of ca. 230 mm, which indicates DmCar values increase with vessel capacity. The results are significant as they suggest it is possible to estimate the volume of some A-02 type amphorae when they are only partially preserved using only (see Table 10). The results for Amph02 are not as decisive as volume measurements indicate a separation into two groups (ca. 17-21 and ca. 23-25 l), but DmCar measurements do not lead to a very clear distinction. As would be expected, the larger Amph02 vessels tend to have a greater DmCar than Amph01 vessels, a finding useful for more general capacity estimates, though further analyses are needed for a clearer picture.

In general, Amph01 shoulders are shorter than Amph02 shoulders ($\bar{Y}$ 63 mm/s 8 vs. $\bar{Y}$ 85 mm/s 7), though not in every single case. Still, shoulder length, seems to be a good indicator for amphora capacity, at least in this specific context at Tell el-Burak.

Sherd ID	**Volume in l**	***DmCar* in mm**	**Amphora form**
TB14-29/24-236-R070	5,8	206	
TB14-29/24-236-R053	6,3	218	**Amph01**
TB14-29/24-236-R042	6,8	198	

TB14-29/24-236-R043	7,1	204	
TB14-29/24-236-R051	8,3	234	**Amph01**
TB14-29/24-236-R035	8,5	232	
TB14-29/24-236-R057	8,7	228	
TB14-29/24-236-R034	9,4	234	
TB14-29/24-236-R045	11,2	238	
TB14-29/24-236-R052	14,4	266	**Amph01**
TB14-29/24-236-R038	17,0	242	**Amph02**
TB14-29/24-236-R039	17,7	268	
TB14-29/24-236-R047	17,7	270	
TB14-29/24-236-R046	18,9	276	
TB14-29/24-236-R054	20,8	286	
TB14-29/24-236-R033	23,0	280	**Amph02**
TB14-29/24-236-R056	23,4	282	
TB14-29/24-236-R036	24,1	276	
TB14-29/24-236-R050	24,8	286	

Table 9 Volumes and DmCar of complete/almost complete amphorae form House 3, Room 3.1

Sherd ID	DmCar in mm	Volume	Estimated Volume Group
TB14-29/24-236-R042	198	6,8	6–7 l
TB14-29/24-236-R082	202		
TB14-29/24-236-R043	204	7,1	
TB14-29/24-236-R070	206	5,8	
TB14-29/24-236-R059	210		
TB14-29/24-236-R075	212		
TB13-29/24-236-R012	214		
TB14-29/24-236-R061	214		
TB14-29/24-236-R029	216		

TB14-29/24-236-R053	218	6,3	
TB14-29/24-236-R063	218		
TB14-29/24-236-R076	226		8–9 l
TB14-29/24-236-R057	228	8,7	
TB14-29/24-236-R040	230		
TB14-29/24-236-R035	232	8,5	
TB14-29/24-236-R037	232		
TB14-29/24-236-R051	234	8,3	
TB14-29/24-236-R034	234	9,4	
TB14-29/24-236-R067	234		
TB14-29/24-236-R041	236		
TB14-29/24-236-R058	238		
TB14-29/24-236-R074	238		
TB14-29/24-236-R048	242		
TB14-29/24-236-R045	238	11,2	Outliers
TB14-29/24-236-R044	248		
TB14-29/24-236-R052	266	14,4	

Table 10 *DmCar* of all Amph01 from House 3, Room 3.1 indicate division into two groups of vessel capacity

4 Petrography and chemical analysis

4.1 A note on wares

Excluding some idiosyncratic types and the few obvious amphorae imports to the area of the site, the wares found within the Tell el-Burak assemblage present a uniform group. The examples are well fired and hard. Many earlier A-01 CSAs are often yellow, or red tending towards brown (see Figures 10 and 11 and photographs of samples in the online appendix). They often contain a grey core of variable thickness. The exception are later A-01G amphorae which do not have a core and are more similar to the A-02A which are red to red-brown and do not have a core. A-02C CSAs are most commonly red to pink (see photographs in the online appendix) and, like the A-02A amphorae, do not have a core. The Burak wares are seemingly similar to what is described by Bikai as ‘brown’ ware (Bikai 1978b: 49), however, her descriptions and the lack of photographs make a direct comparison impossible. The CSA from Tell el-Burak are generally smooth, though the Persian period CSA tend to be rougher in feel, perhaps because they are less commonly finished by wet smoothing. As will be discussed in more detail below, the vessels commonly show spalling (Figure 11: fabric 5) due to relatively high firing temperatures and often have a whitish bloom due to the use of seawater and a relatively high firing temperature.

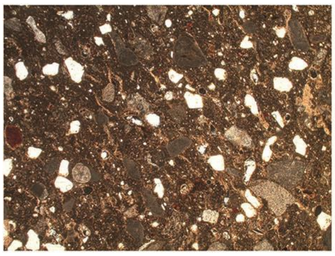
Figure 10 Images and Photomicrographs of the samples in Fabrics 1A, 1B, 1C, and 2 in Plane Polarized Light (PPL) and Cross Polars (XPL). Field of View is 2 x 2 mm for each photomicrograph. Ceramic sherds are 1:4 scale

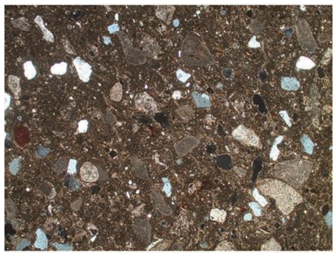
PPL

FABRIC 3

TB13 29/23-033-173

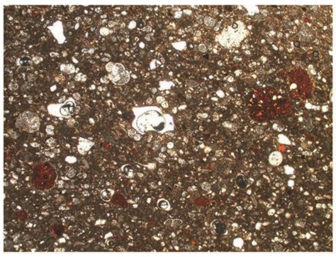
XPL

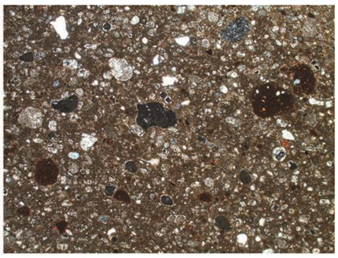




FABRIC 4

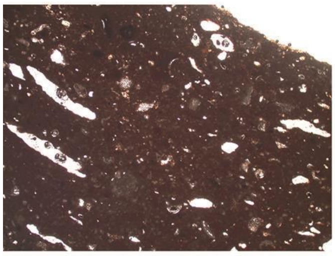
TB14 29/23-033-024

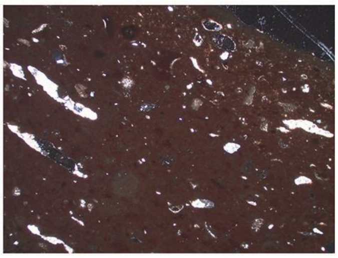




FABRIC 5

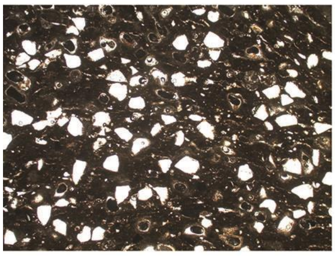
TB14 29/24-0197-265

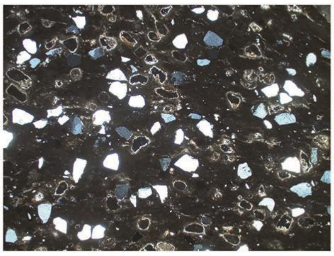




FABRIC 6

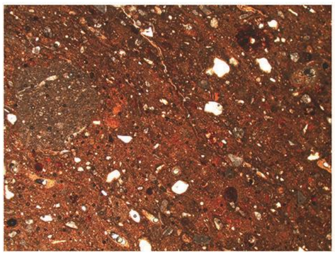
TB14 29/23-025-12





FABRIC 7

TB14 29/24-282-120



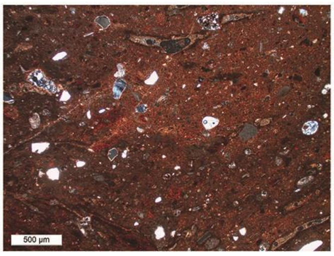


Figure 11 Images and Photomicrographs of the samples of fabric 3, 4, 5, 6, and 7 in Plane Polarized Light (PPL) and Cross Polars (XPL). Field of View is 2 x 2 mm for each photomicrograph. Ceramic sherds are 1:4 scale except for TB14 29/24-0197-265 (fabric 5) which is 1:5 scale

4.2 Sample Selection and Methodology

The samples were selected from all phases and a wide range of contexts to detect potential diachronic or functional variations in production. As local amphorae production is the focus of this study, the majority of the samples investigated were selected from vessels identified by their typological characteristics as likely to have been produced on the southern Lebanese coast. 99 samples were selected from the main typological groupings and their subgroups (see Table 11 for list of samples and relevant details and in the online appendix for tiled images of every sample analysed petrographically). These include 40 samples from the numerous subtypes of A-01, 18 samples of A-02A, three samples of A-02B and 37 samples of A-02C. One A-02 sample could not be matched to a subtype. Five specimens that based on their morphology were suspected of having origins outside of southern Lebanon were investigated for comparison. The preparation of all samples and the analytical work was undertaken at the Durham Archaeomaterials Research Centre, Durham University. Thin-sections were studied in transmitted light using a Leitz petrographic microscope. Light micrographs were taken with a Leica EC3 digital camera mounted on the microscope. The thin-sections were described using terminology and values proposed by (Klein and Philpotts 2013; Quinn 2013; Stoops 2003)(Whitbread 1995). The measurement and quantification of the aplastic fraction of each sample and grain measurements were completed using the digital image analysis software, Jmicrovision (Roudit; www.jmicrovision.com). Tiled images of an area on each thin-section measuring 1 cm^2 were produced for this purpose. Fifteen Samples were analysed using Hitachi TM3000 Scanning Electron Miscoscope (SEM) fitted with a SwiftED3000 Energy Dispersive X-ray Spectrometer (EDS) to confirm the identification of certain mineral phases. The accelerating voltage was set to 15 kV and the probe current was set to 700 pA. The bulk compositional analysis was generated by the SwiftED software using standardless matrix corrections and is semi-quantitative.

The XRF analyses were undertaken using a Bruker Tracer IV-SD portable X-ray Fluorescence Spectrometer. The samples were crushed and then powdered for four minutes in an agate jar using 25mm agate balls with a Retsch planetary ball mill set to 450 rpm. The resulting powders were dried overnight in an oven and 1.5 grams of sample were pressed into 13 mm diameter pellets for analysis. The analysis was run using the Bruker TR2 calibration and fixed conditions of 40 kV and 10 μA using a 1 mil Ti/12 mil Al filter, which measured for 23 elements. The major elements analysed included Ca, Fe, Ti and Mn and the minor and trace elements included Co, V, Ni, Cu, Zn, Ba, Cr, As, Pb, Th, Rb, U, Sr, Y, Zr, Nb, Mo, Sn and Sb.

A principle components analysis (PCA) (Orton and Hughes 2013: 176–80) was conducted using SPSS v.22 to plot the similarity of the 'chemical fingerprint' of each sample (Figure 12 and 13). Ca and Ba were removed from the multivariate statistical analyses as various processes can affect them during deposition and sample preparation (Rollinson 1993). U and Mo values were too close to detection limits for the results to be reliable and were also removed. The thin-section analysis indicated that closely related clay sources were used for the production of most of these vessels and, therefore, the geochemical analysis focused primarily on Cr, Zr, Y, Nb, Th and Rb. These elements are well-suited for geochemical fingerprinting in clays because they are resistant to weathering processes and thought to be transported exclusively in terrigenous components of sediments and clays, thus reflecting the chemistry of their source rock (Rollinson 1993; Degryse and Braekmans 2014: 195). Additionally, recent studies show that there is little fractionation of these elements in ceramics as a result of the firing process (Finlay *et al.* 2012: 89).

4.3 Results of the thin-section petrography

The thin-section analysis indicated that all but 13 of the CSA samples could be grouped into one main petrofabric, Fabric 1, which is further divided into three subfabrics (A, B and C). Of the remaining 13 samples, eleven show minor variations from the main fabric, but are consistent with clay sources theoretically available locally (i.e. consistent with the geology of southern coastal Lebanon as described below). A few of these samples, namely those from Fabric 3 and 4 show marked differences in typology relative to the rest of the dataset raising the possibility that they were not produced locally, despite exhibiting related petrographic characteristics. Only two samples have characteristics inconsistent with the local geology and, thus, are probably imported to the site from areas outside of southern coastal Lebanon. These samples were not easily identified macroscopically as they do not show marked differences in type or colour. In summary, the results of the petrography presented below show that most of the amphorae originated somewhere in southern coastal Lebanon indicating a strong regional orientation for the trade in the commodities held by the CSA from Tell el-Burak, which were presumably mostly agricultural. Some non-local amphorae types and two local types in non-local fabrics are noted in the assemblage, but they can be contrasted with a good number of imports found among other vessel classes observed, such as the East Greek pottery assemblage.

4.3.1 Locally made fabrics

Fabric 1 (Figure 10) 91 samples belong to Fabric 1, which can be further divided into three subfacrics 1A, 1B and 1C. Fabric 1A was the most common overall in the assemblage with 73 samples, followed by 1C with 14 examples. 1B was relatively rare with only 4 examples, tied with Fabric 2 for the second most common within the assemblage. The samples from Fabric 1 all exhibit a fine-grained matrix and are reddish brown to orange in plane polarized light (ppl). The samples often have a moderately sized, but well-defined core, brown to black in colour, although some examples have no definable core. The matrix is calcareous and micrite is commonly observed in the groundmass, though the samples were mostly optically inactive. Overall the fabric is very well sintered and voids occur rarely.

The non-plastic components are the same across all samples belonging to this fabric group, though the proportions of certain components vary. Samples belonging to Fabric 1A (Figure 10) generally contain roughly 25–30 % non-plastic inclusions and voids. The samples are dominated (12–18 %) by fine and medium sand-sized grains of quartz that are generally sub- to well-rounded and equant. A few elongate grains can also be noted. The quartz grains are sometimes polycrystalline and often exhibit an undulose extinction. Rounded pieces of medium sand sized grey micritic limestone also occur (5–9 %), along with infrequent highly rounded fine sand sized grains of calcite (1–3 %). Large rounded coarse sand sized argillaceous bodies are found rarely (1–3 %). These commonly contain silt-sized grains of quartz and are often surrounded by shrinkage voids. Their texture shows they are highly argillaceous and likely represent clay pellets that perhaps remained unmixed during the preparation of the clay. Clay pellets are also observed that are lighter in colour and contain an abundance of microfossils. Highly rounded grains, orange in ppl, are noted rarely < 1 %. These grains exhibited little to no optical activity, but were identified as glauconite by SEM-EDS. Grains of zircon, microcline and epidote occurred in trace amounts. Fossils occurred rarely (1–3 %), but consistently. Various species of globigerina are most common. Benthic fossils are represented infrequently by weathered fragments of nummilites. Fragments of coralline algae (such as amphiroa or mesophyllum) occurred infrequently (Figure 10: fabric 2).

Fabric 1B (Figure 10) is very similar to Fabric 1A in terms of non-plastic components, but these four samples present a heavily sintered olive colour ground mass, typical of relatively highly fired calcareous ceramics (Quinn 2013: 197–198, Fig. 6.57). The samples of Fabric 1B, thus are more highly fired relative to examples belonging to other fabrics (see below).

Fabric 1C (Figure 10) differs from 1A and 1B as it contains a larger proportion of medium sand-sized grains of quartz (25–30 %) and 35–40 % non-plastic inclusions and voids overall.

The three subfabrics follow a clear diachronic association. Since the typology is also chronologically dependent, the fabrics tend to be used for certain types. The quartz rich Fabric 1C is only found at Tell-el Burak in the earliest phase (E), as such it is only used for A-01 amphorae, of subtypes A-01A, C, E, F and H. Fabric 1A, seems to slowly replace 1C at the end of phase E, coincident with an overall reduction in the number of amphorae types which characterises all subsequent phases at the site. The replacement is also reflected in the geochemical evidence presented below. Type A-01B, C, D, F, G and H are found in the later subfabric 1A, though A-01G is the most common. Only, A-01A and A-01E are not found in Fabric 1A, indicating they may represent earlier types no longer present at the end of phase E. At Tell el-Burak, types A-02A, B and C are almost exclusively made using Fabric 1A, which changes little from the end of Phase E through all subsequent occupation phases. Only four examples were found of the highly fired Fabric 1B, so the evidence is still patchy, but this fabric seems to occur later at Tell el-Burak. It was used for type A-02C amphorae and the two examples of type A-06 analysed as part of this study, indicating the latter may be a local product, despite presenting an atypical shape.

Fabrics 2, 3, 4, 5 and 6 (Figure 10 and 11): These fabrics exhibit some minor differences when compared to Fabric 1, suggesting they may originate from similar clay sources, but represent some differences in processing methods or preferences in material selection. The majority of examples from these petrofabrics occur during Phase E and on A-01 amphorae, indicating that in addition to greater typological variability earlier in the settlement's history as detailed above, there is also greater variability in fabrics during Phase E.

Four samples belonged to Fabric 2 (Figure 10), which contains a higher proportion of limestone than other samples. The fabric was used for A-01 A, C, F and L. Fabric 3 (three samples; Figure 11) is very coarse and dominated by medium to coarse sand-sized grains of quartz and limestone (50% non-plastic inclusions and voids). Two type A-01 amphorae (C and E), from Phase E and a type A-03 amphorae of uncertain date belonged to this fabric. One sample of an unusual type, thought to perhaps be of non-local origin, was composed of Fabric 4 (Figure 11). The fabric presents a much higher number of fossils (20-30%) than the other fabrics, though they appear to be of similar species to those noted in the other groups. It is, therefore, unclear whether this vessel was produced locally or non-locally. The sample does presents a distinct geochemistry as will be detailed below, though as only one sample was found in this fabric a clear interpretation remains evasive. Fabric 5 (1 sample; Figure 11) is closely related to fabric 1A but is particularly fine textured and the ground mass is a very light pink color in ppl. Only one sample was noted in this fabric a A-01G amphorae dating to phase D. Fabric 6 (2 samples; Figure 11) contained quartz grains similar in proportion to those found in fabric 1C, but no *foraminifera.* These fossils are very common in the dataset otherwise. The lack of fossils in these two samples suggests the clays used in their production derived from a different combination of parent rocks than the majority of the samples and could have been produced in a different area. One fabric 6 sample (Figure 12 and 13) was analysed by XRF and was shown to have a similar geochemical signature to the commonly occurring fabrics. One fabric 6 example belonged to an A-01 type dating to phase E and the other was an A-02 dating to phase B/C.

Two samples belonged to *Fabric 7* (Figure 11) which contained a high degree of plagioclase feldspars and mica along with a relatively higher proportion of heavy minerals, such as epidote and zircon.

4.4 Results of the Geochemistry

The results of XRF analysis (online appendix, Table 3) reinforced the petrography and, additionally, provided data that allowed for the identification of geographical and temporal subgroupings. Three components were extracted cumulatively explaining 78.6% of the variation in the dataset. The loading plots associated with the PCA analysis (Figure 12 and 13) showed that Fe, Sr, Zr, Y, Th and Rb had the most impact on the variability between samples. The PCA indicated that most samples fall within one large chemical group, which is composed of CSA mostly from petrofabric 1, but which also contained examples of fabrics 2 and 6, indicating that these two samples probably are formed of related materials to petrofabric 1.

In general, the geochemistry of the majority of samples is highly uniform. The analysis shows that vessels composed of Fabric 1 A, B and C share a broad chemical signature, reinforcing our assessment that a geographically discreet group of clays and centralised production modes were used to make most of the Iron Age and Persian Period amphorae from Tell el-Burak. The Fabric 1 ceramics tend to be relatively high in Cr, Fe and Mn, moderately high in Zr and low in Co compared to those from the two outlier petrofabrics 4 and 7. The chemistry of the clays in the main grouping can be subdivided into two subgroups well-differentiated by type A-01 and A-02. The A-01 types tend be slightly enriched in Cr, Fe and Zr relative to samples from the A-02 type. The A-02 types tend to be enriched in Ca, Mn and Cu, relative to the A-01 types. The values for all other elements are similar in the A-01 and A-02 types. Given that the types are chronologically correlated, the data indicates a gradual shift to a different, albeit related, clay source (or preparation) with time. However, there is some geochemical overlap between the two types, supporting the contextual and petrographic data presented above which shows a gradual replacement of the A-01 by the A-02 amphorae. A small subgroup to the left of the main group is composed mostly of A-02C amphorae from the latest phases and is characterised by especially high Ca and Sr values. Only two outliers were found from fabrics 4 and 7, which reinforces the results of the petrographic analyses that fabrics 2 and 6 are probably locally produced but perhaps not affiliated with the mainstream production of most of the vessels found at Tell el-Burak. One outlier on the graph is a sample from the fossiliferous petrofabric 4, which, unsurprisingly, showed the highest Ca values of any sample, Sr is also high, showing the two values are correlated and that fabric 4 is probably related to the main fabric despite presenting an idiosyncratic shape and plotting as an outlier on the PCA. Fabric 4 perhaps contains more input from the highly calcareous and fossiliferous chalks relative to the samples from fabric 1. Likewise, with time the clays utilised at Tell el-Burak for amphorae production are more calcareous, perhaps containing a greater contribution from the same chalks, relative to earlier examples, though not as much as fabric 4. Fabric 7 represents an outlier on the PCA and is probably the only vessel that was surely produced elsewhere from the southern Lebanese coast. The petrography of the sample showed some contribution from elements related to igneous sources. The geochemistry confirms this with relatively high levels of Cr/Ni ratio of 1.67, which is typical of clay derivation from ultramafic source rock (Degryse and Braekmans 2014: 194).

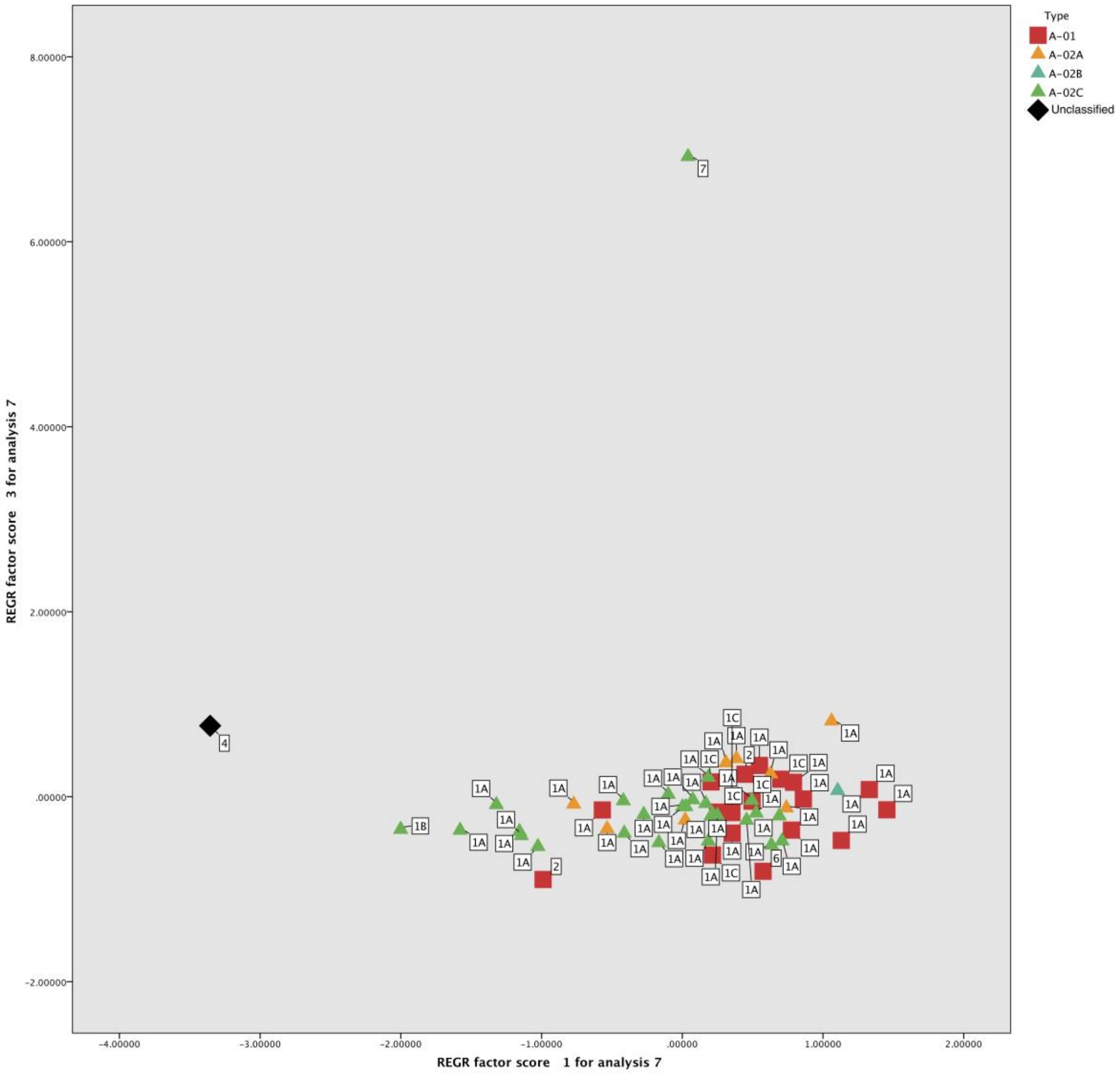


Figure 12 Plot of the factor scores generated from the principle components analysis of the chemical data generated by XRF sorted by type and labeled by petrofabric. Factor 1 explains 61.4% of the variation and factor 3 explains 17.2%

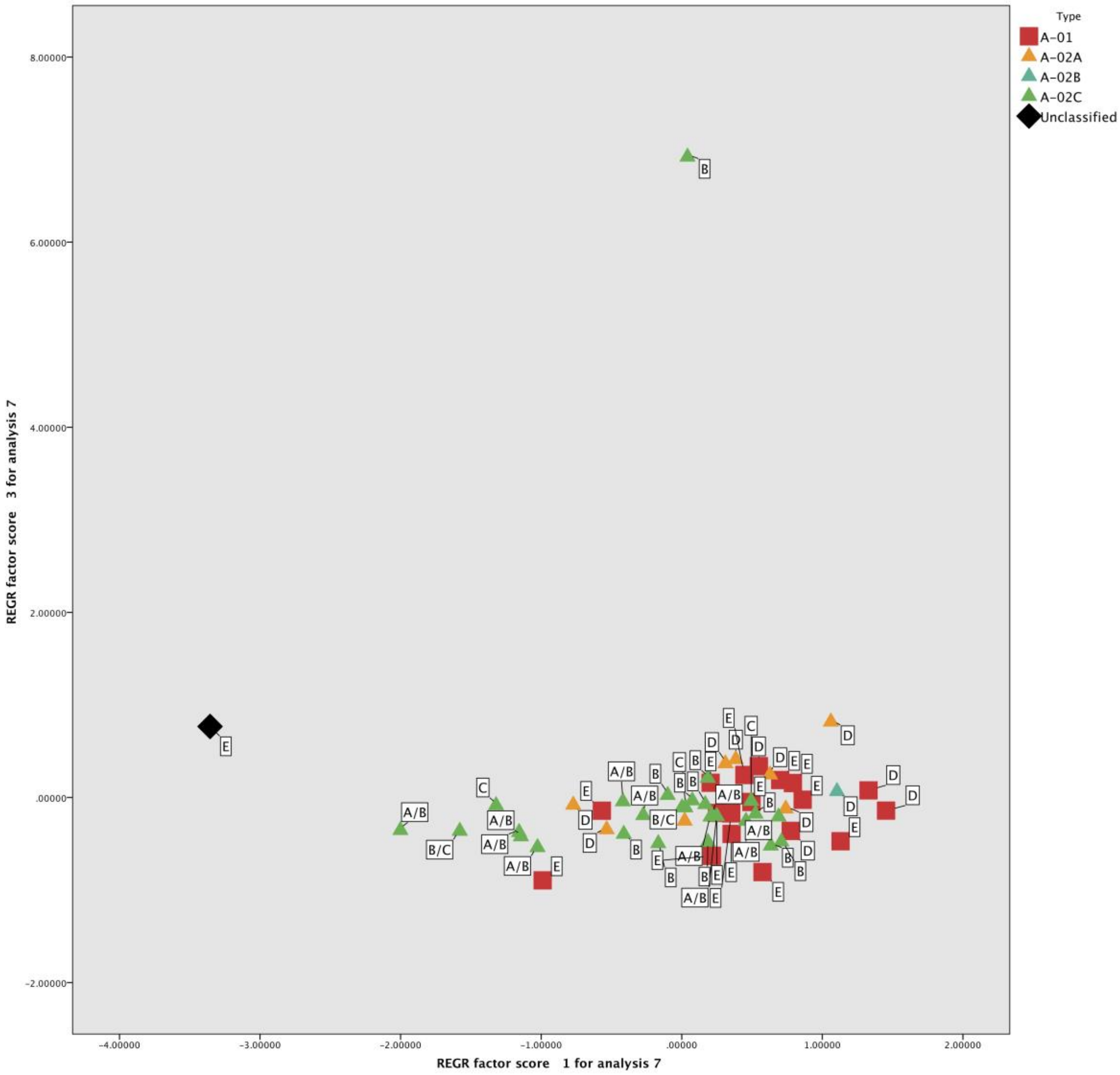


Figure 13 Plot of the factor scores generated from the principle components analysis of the chemical data generated by XRF sorted by type and labeled by Phase. Factor 1 explains 61.4% of the variation and factor 3 explains 17.2%

4.5 Raw material processing, forming and firing

Overall the vessels fabrics range from fine-grained to coarse, but most exhibit similar proportions of non-plastic inclusions. Some samples are so fine, it is likely they were levigated or sieved. The dominant non-plastic inclusion is usually quartz, which was probably used as a temper. The amount of quartz used seems to diminish with time and the A-01 vessels tend to be coarser with most belong to Fabric 1C. The later A-02 examples, which mostly belong to Fabric 1A. The well-rounded nature of the quartz indicates highly transported materials typical of coastal resources (see below). Rilling characteristic of formation on the fast wheel was observed on a large number of vessels, indicating widespread and consistent use of the potter's wheel in the production of these amphorae. The petrography showed the presence of well-defined pellets of clay that were either red or light coloured, containing fossils typical of Eocene and Miocene chalks. The presence of these two distinct types of clay bodies might indicate that clay-rich materials from two different sources were being mixed to produce a fabric with desirable properties (Quinn 2013: 167). The clay pellets remain intact in thin-section probably because the clay was not mixed thoroughly enough. The presence of clay-pellets of different composition in the samples could also be the result of natural mixing or bioturbation. Geoprospection is planned in the near future and clays available locally at Tell el-Burak will be collected for analysis. The outcome of this investigation should allow for a better understanding of whether the mixture of clay- rich materials in our samples is due to their natural composition or if it was the result of selective clay mixing by the Iron Age potters.

The samples show indications of a particularly high and sustained firing, as the carbonate fraction is often significantly degraded and the clay matrix is commonly well sintered. Spalling is also commonly observed on vessels. According to Shoval (1988) this likely indicates kiln firings sustained for long periods at temperatures above 800 °C. Additionally, the white bloom found associated with the surface of many samples only begins to develop at roughly 800 °C, further suggesting sustained temperature above this threshold (Daszkiewicz 2014: 187). Samples of fabric 1B were particularly highly fired relative to other samples in the dataset, though an absolute temperature is difficult to estimate, as there were so few examples. A program of X-ray diffraction is planned for the future, which will provide a better understanding of firing temperature ranges across the assemblage.

4.6 Provenance of the local fabrics

The samples from the first six fabrics at Tell el-Burak can be said to be composed of related petrofabric and geochemically similar. The minor differences found in the samples are not enough to differentiate their source geographically with confidence. The fabric composition indicates slight differences in the paste mixtures of some samples, but using related materials. Their similarity to the main fabric group indicates that they may have been produced in the same workshops, or, at the very least, belong to a broadly similar production tradition that is geographically and temporally linked.

The samples attributed to the main locally produced Iron Age fabrics from Tell el-Burak contained highly rounded quartz (Figure 12), which was likely transported relatively long distances. Quartz rounded to such a degree suggests a coastal origin for the materials used to produce the vessels – possibly beach sand or a highly transported fluvial deposit. Given the topography of southern Lebanon, the coastal plain is the most likely place in the area around Tell el-Burak to find well-rounded quartz grains such as those observed in the samples. Additionally, a white bloom noticed on many samples indicates the use of saltwater in their production (Daszkiewicz 2014: 186), further supporting a coastal origin for these amphorae. More diagnostic for purposes of provenience are the globigerina and nummulites mentioned earlier, which are reported in the literature as occurring regularly in the Eocene and Miocene chalk, which extend roughly from just north of Sidon down to just south of Tyre (Boudagher-Fadel and

Clark 2006; Dubertret 1955). These outcrops are found within the vicinity of Tell el-Burak (Figure 14).

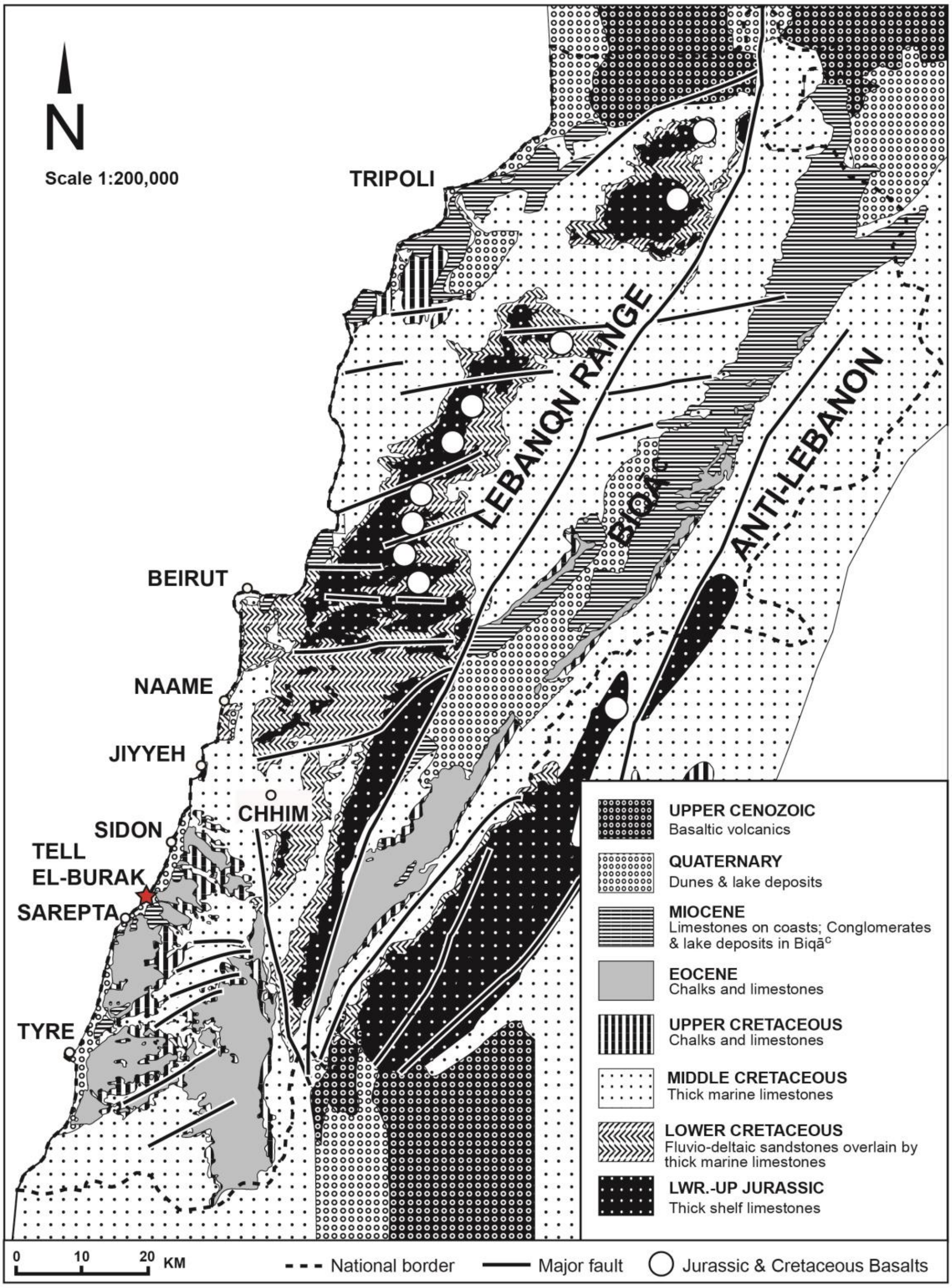


Figure 14 General Geological Map of Lebanon after (Dubertret 1955)

The evidence from the petrographic analyses indicates with certainty that the production centre or centres for most of the CSA found at Tell el-Burak are to be located on the southern Lebanese coast. Samples of the clay around Tell el-Burak are currently being analysed to see how they compare to the main petrofabric (Fabric 1) identified in this study. Previous studies and preliminary observations during geoprospection around the site show that the clay found in the vicinity of Tell el-Burak is composed largely of smectite (montmorillonite) swelling clays (Sayegh *et al.* 1990 and personal observation). These types of clays are rarely used for potting (Rice 2015: 87) and seem different in colour and composition to those observed in thin-section and used to make the amphorae. The clay resources used for potting as identified by the petrography, do exist within 2-3 km of the site, however, no evidence of pottery production has yet been uncovered at Tell el-Burak.

The two samples from fabric 7 contained minerals inconsistent with the geology in the area of Tell el-Burak and the southern Lebanese coast (Dubertret 1955) and, thus, these vessels were probably produced elsewhere. As only two samples were observed, a provenance cannot be confidently proposed, though a number of areas of the coastal southern Levant and parts of Cyprus are known to yield similar petrofabrics (Bettles 2003a: 73 FC 2D) and Goren, Finkelstein and Na'aman 2004). Fabric 7 was found in commonly occurring types. The fabric was used for an A-01D, belonging to phase E along with a A-02C from phase D, reinforcing the notion that different regions, though using different clay resources, are aiming to produce similar types.

The lack of evidence for production at Tell el-Burak, coupled with the large number of kilns discovered at Sarepta (Sarafand) (Pritchard 1973; Anderson 1988), just a few kilometers to the south of Tell el-Burak, make Sarepta a good candidate for the source of at least some of the CSA found at Tell el-Burak. A visual examination of the fabrics from Sarepta (Sarafand) undertaken in the summer of 2017 shows they are consistent with those from Tell el-Burak, supporting the idea that some of these amphorae were produced at Sarepta. Our main fabric 1A matches the description of Bettles's fabric Class 1A (FC1A, Bettles 2003b: 67) from her analysis of Sarepta materials.

Sherd ID	Vessel Class	Vessel Group	Vessel Subgroup	Petrofabric
TB14-29/24-282-064	A	A-01	A-01B	1A
TB14-29/24-273-073	A	A-01	A-01C	1A
TB14-29/24-273-069	A	A-01	A-01D	1A
TB13-29/23-019-0567	A	A-01	A-01F	1A
TB13-29/23-019-0574	A	A-01	A-01F	1A
TB14-29/24-282-024	A	A-01	A-01G	1A
TB14-29/24-282-118	A	A-01	A-01G	1A
TB13-29/23-019-0718	A	A-01	A-01G	1A
TB14-28/24-030-096	A	A-01	A-01G	1A
TB14-29/24-197-294	A	A-01	A-01G	1A
TB14-29/24-197-297	A	A-01	A-01G	1A
TB14-29/24-274-016	A	A-01	A-01G	1A
TB14-29/24-282-060	A	A-01	A-01H	1A
TB14-28/24-030-091	A	A-01	A-01H	1A
TB15-29/22-015-345	A	A-01		1A
TB15-29/22-018-005	A	A-01		1A
TB15-29/22-017-024	A	A-01		1A
TB14-29/24-282-067	A	A-02	A-02A	1A
TB15-29/22-015-336	A	A-02	A-02A	1A
TB14-29/24-236-petro001	A	A-02	A-02A	1A
TB14-29/24-236-petro009	A	A-02	A-02A	1A
TB14-29/24-236-petro013	A	A-02	A-02A	1A
TB14-29/24-236-petro015	A	A-02	A-02A	1A
TB14-29/24-236-petro016	A	A-02	A-02A	1A
TB14-29/24-236-petro017	A	A-02	A-02A	1A
TB14-29/24-236-petro018	A	A-02	A-02A	1A
TB14-29/24-236-petro019	A	A-02	A-02A	1A
TB14-29/24-236-petro020	A	A-02	A-02A	1A
TB14-29/24-236-petro021	A	A-02	A-02A	1A

TB14-29/24-236-petro022	A	A-02	A-02A	1A
TB14-29/24-236-petro023	A	A-02	A-02A	1A
TB14-29/24-236-petro026	A	A-02	A-02A	1A
TB14-29/24-236-petro028	A	A-02	A-02A	1A
TB14-29/24-236-petro029	A	A-02	A-02A	1A
TB14-29/24-236-petro031	A	A-02	A-02A	1A
TB14-28/24-021-230	A	A-02	A-02B	1A
TB14-29/24-286-005	A	A-02	A-02B	1A
TB14-28/24-017-137	A	A-02	A-02B	1A
TB14-28/24-002-020	A	A-02	A-02C	1A
TB14-28/24-006-013	A	A-02	A-02C	1A
TB14-28/24-006-095	A	A-02	A-02C	1A
TB14-28/24-006-205	A	A-02	A-02C	1A
TB14-28/24-019-010	A	A-02	A-02C	1A
TB14-28/24-021-046	A	A-02	A-02C	1A
TB14-28/24-021-053	A	A-02	A-02C	1A
TB14-28/24-021-206	A	A-02	A-02C	1A
TB14-28/24-021-208	A	A-02	A-02C	1A
TB14-28/24-022-008	A	A-02	A-02C	1A
TB14-28/24-022-089	A	A-02	A-02C	1A
TB14-28/24-022-127	A	A-02	A-02C	1A
TB14-28/24-022-170	A	A-02	A-02C	1A
TB14-28/24-017-151a	A	A-02	A-02C	1A
TB14-29/24-268-188	A	A-02	A-02C	1A
TB14-29/24-286-059	A	A-02	A-02C	1A
TB14-28/24-006-181	A	A-02	A-02C	1A
TB14-28/24-006-188	A	A-02	A-02C	1A
TB14-28/24-022-236	A	A-02	A-02C	1A
TB15-29/21-065-194	A	A-02	A-02C	1A
TB15-29/21-065-197	A	A-02	A-02C	1A
TB15-29/21-011-590	A	A-02	A-02C	1A
TB15-29/21-066-115	A	A-02	A-02C	1A
TB15-29/21-066-199	A	A-02	A-02C	1A
TB15-29/21-066-201	A	A-02	A-02C	1A
TB15-29/21-066-194	A	A-02	A-02C	1A
TB15-29/21-011-657	A	A-02	A-02C	1A
TB15-29/21-065-183	A	A-02	A-02C	1A
TB15-29/21-011-610	A	A-02	A-02C	1A
TB15-29/21-064-036	A	A-02	A-02C	1A
TB15-29/21-011-602	A	A-02	A-02C	1A
TB15-29/21-011-608	A	A-02	A-02C	1A
TB15-29/21-064-033	A	A-02	A-02C	1A
TB15-29/21-064-051	A	A-02	A-02C	1A

TB14-29/24-282-081	A	A-06		1A
TB14-28/24-002-043	A	A-02	A-02C	1B
TB14-28/24-002-060	A	A-02	A-02C	1B
TB14-28/24-022-178	A	A-06		1B
TB14-29/24-273-043	A	A-06		1B
TB13-29/23-019-0135	A	A-01	A-01A	1C
TB13-29/23-019-0754	A	A-01	A-01A	1C
TB13-29/23-019-0781	A	A-01	A-01C	1C
TB14-29/23-019-1108	A	A-01	A-01C	1C
TB14-29/23-033-169	A	A-01	A-01C	1C
TB13-29/23-019-0267	A	A-01	A-01C	1C
TB13-29/23-019-0363	A	A-01	A-01E	1C
TB13-29/23-019-0876	A	A-01	A-01E	1C
TB14-29/23-019-1075	A	A-01	A-01E	1C
TB13-29/23-019-0516	A	A-01	A-01F	1C
TB13-29/23-019-0587	A	A-01	A-01F	1C
TB14-29/24-274-030	A	A-01	A-01F	1C
TB13-29/23-019-0227	A	A-01	A-01H	1C
TB13-29/23-019-0140	A	A-01		1C
TB14-29/23-019-0951	A	A-01	A-01A	2
TB14-29/23-019-1088	A	A-01	A-01C	2
TB14-29/24-276-018	A	A-01	A-01F	2
TB14-29/23-019-1098	A	A-01	A-01L	2
TB14-29/23-033-173	A	A-01	A-01C	3
TB14-29/23-019-1000	A	A-01	A-01E	3
TB14-29/24-267-012	A	A-03		3
TB14-29/23-033-024	A	uncertain		4
TB14-29/24-197-265	A	A-01	A-01G	5
TB13-29/23-025-012	A	A-01	uncertain	6
TB14-28/24-021-192	A	uncertain	uncertain	6
TB14-29/24-282-120	A	A-01	A-01D	7
TB15-29/21-065-184	A	A-02	A-02C	7

Table 11 List and description of samples analysed petrographically as part of this study. High-resolution tiled photomicrographs all thin-sections are available in the online appendix, along with images and drawings of each sample

5 Organic Residue Analysis

The Fatty acid and wine biomarker analysis of 14 type A-02A CSA samples from House 3 (see section 3) were conducted in the facilities of the Department of Soil Science at Mainz University. The analysis was aimed at identifying the contents of these jars and represents the first of its kind conducted on material from Lebanon. The results of these analyses will allow for the identification of organic commodities, and further elucidate production, consumption and trade patterns in the region. No obvious indicators of what the amphorae may have contained were apparent, like inscriptions (e.g. Stern *et al.* 2000) or readily identifiable solid organic remains, thus we considered a variety of solid and liquid foodstuffs as possibilities in order to positively identify the organic residues found on the vessels.

The options considered, included plant oils, brine made from salt and/or wine/vinegar containing solid foodstuffs (e.g. olives, fish), fishsauce/fishpaste and meat. The analysis protocol has been designed to allow the detection of these potential commodities specifically. This list purposely excludes wine, as a biomarker analyses was conducted on these samples beforehand and found very little evidence for wine (see below). The list of foodstuffs above was compiled based on other research that highlights the key agricultural commodities found throughout the (southern) Levant (e.g. Faust 2011; Langgut *et al.* 2015; Milevski 2011; Weiss 2015). Additionally, diachronic information on potential foodstuffs was gathered from studies conducting organic analyses on other types of amphorae and other pottery (e.g. Koh *et al.* 2014; Namdar 2015; Serpico and White 1996; Stern *et al.* 2000), archaeobotanical evidence (e.g. Haldane 1990, 1993) and archaeozoological evidence from Mediterranean contexts (e.g. Bonetto 2014).

In addition to the 14 CSA samples analysed, 6 vessels from House 3 displayed a black discoloration on the inner surface that forms a thin layer and appears to originate from a liquid which has seeped into the ceramic matrix (Figure 15). During sampling it was observed that this black layer was softer than the ceramic, and grinding it down resulted in a fine black powder. Similarly described residues were shown to be a lining of pitch from coniferous trees, which was applied to reduce the vessel's permeability

(Beck *et al.* 1989; Romanus *et al.* 2009). To confirm the identity of the residue a separate analysis of the layer is currently underway at Durham University.

Figure 15 Sample 14SF 217 under plane polarised light black discoloration visible on the inner surface forming a thin layer and seemingly seeping into the ceramic matrix.

5.1 A note on wine biomarkers

Prior to fatty acid analysis, 14 samples were sent to the Institute of Microbiology and Wine Research at Mainz University (Germany) for the analysis of wine biomarkers. The three biomarkers characteristic for wine are syringic acid, tartaric acid and malic acid – which indicate the presence of red wine residue, especially when they occur in combination. The analyses were conducted via GC-MS by Christiane Grünewald, separately to the fatty acid analyses presented in this paper. The methodology was based on (Barnard *et al.* 2011; Romanus *et al.* 2009). However, only one of the 14 samples showed all three characteristic biomarkers (Table 12), the other 13 samples were devoid of wine biomarkers. Several short to long chain fatty acids were preliminarily traced in the same batch of samples, which triggered the initiative to conduct the more in depth fatty acid analyses on all 14 samples the results of which are presented below.

	Retention Time	Sample 29/24-236 #22
Lactic acid	7.818	+
Hexanoic acid (C6:0)	8.181	-
	9.857	-
	10.133	+

	10.468	+
	10.575	+
	11.071	-
Octanoic acid (C8:0)	11.435	-
	11.580	+
Nonanoic acid (C9:0)	12.874	+
	13.546	-
	14.202	+
	14.393	-
	14.442	+
Malic acid	14.577	+
	15.223	-
	15.870	-
	16.276	-
Tartaric acid	16.379	+
Dodecanoic acid (C12:0)	16.601	+
	17.850	-
	18.453	-
	18.520	-
Tetradecanoic acid (C14:0)	18.742	+
Syringic acid	19.225	+
	19.358	-
	19.670	+
Pentadecanoic acid (C15:0)	19.759	+
	20.252	+
	20.366	+

Palmitoleic acid (C16:1)	20.465	+
Palmitic acid (C16:0)	20.748	+
	21.254	-
	21.418	+
	21.557	+
Margaric acid (C17:0)	21.640	+
	21.740	+
Vaccenic acid (C18:1)	22.286	+
Stearic acid (C18:0)	22.550	+
	22.806	+
Resin acid	23.792	+
	23.964	+
Eicosanoic acid (C20:0)	24.178	-
	24.624	-
	25.043	+
	25.625	+
Docosanoic acid (C22:0)	25.716	-
	26.057	+
	26.194	-
	26.415	+
	27.022	-
Tetracosanoic acid (C24:0)	27.150	-
	27.604	-
	28.889	-

Table 12 Results of GC-MS analysis of ample 29/24-23 #22; + substance present in traceable amounts; – substance not present in traceable amounts

5.2 Fatty acid analysis

5.2.1 Collecting and Handling the Samples

During the excavation of the amphorae, the sherds chosen for organic residue analyses were selected from bases and some lower body sherds to increase the chances of recovering usable residue. All amphorae sampled were of the A-02A type. To limit contamination these samples were taken immediately upon excavation in the field before the vessels from Room 3.1 could be reconstructed. Consequently, it is unclear which of the samples used for this preliminary analysis belong to the Amph01 or Amph02 variety, though it is likely that both are represented amongst the samples. Future analyses are underway specifically targeting samples identified as belonging to either the Amph01 or Amph02 variety. Nitrile-gloves were worn during all sampling and analysis operations. In the field, the samples were wrapped in aluminium foil and placed directly into a sealable plastic bag for storage. The samples were stored in a dry, cool and dark repository for approximately 18 months before being analysed. After removing the aluminium foil in the laboratory, we observed that the foil was black and brittle – i.e. corroded – where it had been in contact with the sherd. The corrosion of aluminium can be brought about when the material is being confronted with a sufficiently high salinity, acidity, or high temperature (Bassoni *et al.* 2012; Davis 1999; Zubaidy *et al.* 2011). In this case it was probably the high salinity of the soil in which the sherds were deposited, due to the site being located directly on the Mediterranean coast. Sterile and solvent cleaned equipment composed of solvent resistant materials (e.g. glass, stainless steel) was used. Each individual sherd was handled as follows: First, the adhering soil was separated from the sherd, where possible. Second, the surfaces, were cleaned mechanically. Third, the inner and the outer surfaces were subsampled separately using a dental drill, grinding down approximately 2 mm of each surface until ideally 2–3 g ceramic powder accumulated. The separate subsampling of the inner and outer surface wall can help in distinguishing between original contents and contamination from outside (Barnard and Eerkens 2007; Condamin *et al.* 1976; Condamin and Formenti 1978; Eerkens 2007; Malainey 2007; Stern *et al.* 2000: 401–402; 412). After subsampling, approximately 1 g of ceramic powder and/or soil was separated and individually put into round-bottom centrifuge tubes. A few samples produced slightly less than 1 g, due to either the small size of the sherds or the small quantity of the adhering soil (see Table 13).

Lab Nr.	**Inner surface sample**	**Outer surface sample**	**Soil sample**
14SF 200	0,9847 g	-	0,7311 g
14SF 201	0,9865 g	0,1867 g	-
14SF 202	1,0183 g	-	0,3892 g
14SF 203	0,9845 g	-	-
14SF 204	1,0087 g	-	-
14SF 205	1,0350 g	0,6063 g	-

Table 13 Analysed samples, and weight of samples

Substance	**Concentration**	**Solvent**	**Addition to extract**
IS1			
Heptadecanoic acid ($C_{17:0}$)	2.016 ng/µl	Dichlormethane	100 µl
n-Hexatricontane	2 ng/µl	Hexan	50 µl
IS2			
Methyl nonadecanoate	0,954 ng/ml	Toluol	50 µl

Table 14 Internal Standards (IS). Organic compounds which are contained in the organic residue naturally

5.2.2 *Extraction and Sample Treatment*

Samples were taken from the inner surface and outer surface of each sample, along with two soil samples (see Table 14). We used methanol (MeOH), dichlormethane (DCM) and a methanol-dichlormethane mixture (MeOH+DCM v/v 1:1) – in this order – as solvents to extract the total lipids from the solids. For the lipid extraction, we added 4 ml of the solvent/solvent mixture in three separate stages to the solids in the round-bottom tubes. The samples were sonicated (30 minutes, 30 °C) and centrifuged (6 minutes, 3000 rpm), at every stage. Afterwards the solvents were transferred with a pipet into a micro reaction vial. After each transfer of solvents, the vial was put under a gentle stream of nitrogen to vaporize the liquid quickly, leaving the organic compounds behind. The extracts were then stored in a refrigerator at -20 °C. Internal Standards (IS1; see Table 2) were used to quantify the substances and for quality control. To obtain the free and esterified fatty acids we used saponification, adding 1.5 ml 1 Mol potassium hydroxide (KOH) in methanol (MeOH) to the micro reaction then using a heating block for derivatisation (100 °C for 1 h). This was followed by liquid-liquid extraction to rid the extract of unwanted neutral lipids. In the next step the extracts were methylated, resulting in fatty acid methyl esters (FAME). Before analysis the Internal Standards were added a second time – for quality control – (IS2; see online appendix Table 4) and 350 µl toluene was also added to the FAME. The mixture was sonicated (10 minutes, 30 °C). The FAME were measured in an Agilent Technologies gas-chromatograph, coupled with a flame ionization detector and glass tubing, by Agilent Technologies. Additionally, an Agilent Technologies gas-chromatograph coupled with a mass spectrometer (MS) was used to confirm peak identity of the chromatograms. We used 37 External Standards (Sigma Aldrich Supelco 37 Component FAME Mix) as reference, to cover the range of short- and long-chain methylated fatty acids mentioned above.

5.2.3 Results and Interpretation

The majority of the samples from the type A-02A type amphorae found in House 3, yielded fatty acids found in most vegetal and animal fats. Two samples so far have yielded more specific results, one soil sample (14SF 200 soil) and one sample from the interior of a sherd (14SF 200 inner surface). As can be seen in (Figures 16 and 17**),** both of these samples show a high relative abundance in C18:0 and C16:0. The soil sample shows a higher abundance in C16:0, which can be an indicator for plant residue (Namdar *et al.* 2015: 71), though the fatty acids within the soil could have been introduced by unrelated plant material. Since the result is rather unspecific, it cannot be assumed that the detected fatty acids originate from spillage of the stored commodities[4]. One sample taken from a sherd's inner surface wall (Figure 16), showed a high relative abundance of C16:0 and C18:0, with C18:0 being slightly more abundant. This sample also produced C18:2ω6, a compound found in a variety of plant oils, including olive oil. The abundance of C16:0 in combination with C18:2ω6 suggests that at least one commodity stored in this amphora was either solely plant oil, or a solid commodity stored in plant oil. Given the abundance of olives in the charred remains dating to the Iron Age (Orendi and Deckers 2018), the plant oil could have been olive oil though more evidence is needed for verification.

[4] Such a scenario is possible, if the amphorae were full during the buildings collapse. Nevertheless, soil can be an ambiguous source, since it introduces random plant material and does not shield the fatty acids the same way the ceramic matrix does.

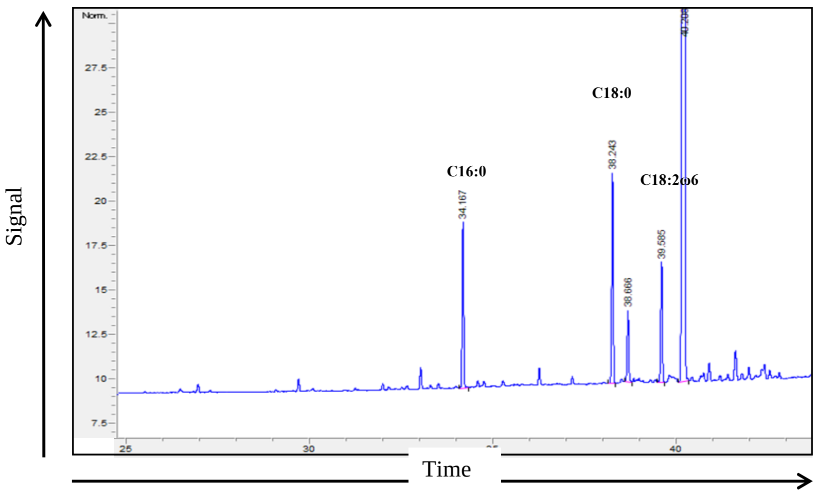


Figure 16 GC chromatograph of inner surface of House 3 amphorae sample 14SF 200

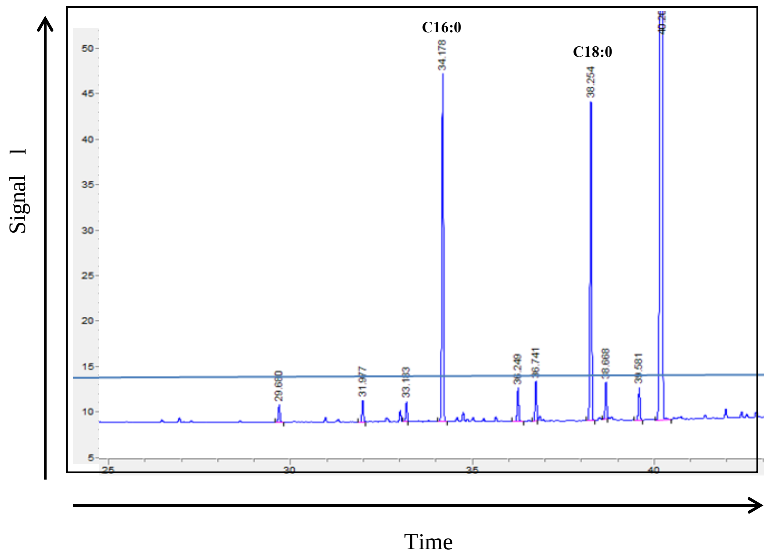


Figure 17 GC chromatograph of adhering soil from House 3 amphorae sample 14SF 200

Generally, results achieved from fatty acid analysis tend to be more ambiguous than they might appear. One amphora could have contained a variety of commodities during its use-life (see Abdelhamid 2013: 99–100). Additionally, dissolution and degradation of the residues compounds within a vessel occur all throughout the vessels use life and during deposition (Barnard *et al.* 2007; Barnard and Eerkens 2007; Eerkens 2007; Malainey 2007; Namdar *et al.* 2015; Stern *et al.* 2000: 400). Fatty acids can be affected by heat, light, bacteria and water, which can result in the alteration of the carbon chain, elution of the compounds and contamination. Elution can affect individual fatty acids differently: C16:0 for instance is rather volatile in this regard. It is most abundant in plant oils and can therefore indicate plant oil when occurring in higher abundance than C18:0 (see previous paragraph; Copley *et al.* 2005; Namdar *et al.* 2015: 71).

In the case of our 14SF 200 inner surface, C16:0 does not exceed that of C18:0, but the former may have been impacted differentially during deposition. Still, the high abundance of C16:0 paired with the presence of C18:2ω6 is indicative of plant oil – possibly olive oil. The same sample displays a total absence of C18:1, which is typical for olive oil, as well as other plant oils (Boskou 2011; Copley *et al.* 2005; Evershed 1997). The suggestion that the plant oil could be olive oil is supported by the archaeobotanical results. The archaeobotanical evidence from Iron Age Tell el-Burak suggests the inhabitants were focused on grape and olive cultivation and processing: Charred remains of *Olea europaea* stones, olivewood charcoal are ubiquitous and appear in large quantities (relative and absolute) throughout the Iron Age phases (Orendi and Deckers 2018). Curiously, wine was only attested in one sample from House 3, though *Vitis vinifera* seeds are the most abundant taxa during the Iron Age context of Tell el-Burak, indicating wine production took place at the site. The excavation of a large stone built and plastered winery consisting treading floor and basin with a capacity of ca. 5500 m^3 on site further points to large scale wine production. Samples of this vat are currently being analysed for wine biomarkers to confirm its function.

The preliminary results of the organic residue analyses suggest that the type A-02A amphorae found in House 3 mostly did not contain wine, but rather contained some short to long chain plant or animal fats. The results are curious given the evidence for large numbers of grapes in the paleobotanical record. Orendi and Deckers (2018) do note, however, the presence of grape greatly increases during Phase C, after House 3 was destroyed perhaps explaining why mostly evidence for plant/or animal fats were found. The advanced degradation of the organic residues within the vessels means the materials stored in the jars could not be precisely identified using the above analytical program, though plant oils (perhaps olive oil) are suggested by two results. Moving forward we hope to integrate stable isotope analysis into the analytical program as these isotopes are not affected by degradation of the carbon chain and can give valuable information about the original source of fatty acids (e. g. (Mottram *et al.* 1999; Steele *et al.* 2010). The use of isotopes is hoped to provide a positive identification of the commodities stored and transported in the Phase D amphorae and whether the Amph01 and Amph02 subtypes held differing materials.

6 Organizing amphorae production and distribution: insights into the Phoenician economy

The multidisciplinary analytical program utilized in this study demonstrates that the production of the Iron Age amphorae from Tell el-Burak was highly-organised and was undertaken by long-lived, sustained, and centralized modes, drawing on similar technologies and stemming from related knowledge networks. Despite gradual, but marked, typological changes during the 400-year occupation of the site, the vast majority of the samples analysed share a common fabric and, thus, likely originated from workshops located in relative proximity to each other, somewhere on the southern Lebanese coast. The results from the analysis are integrated in the summary table below (Table 15).

Phase	Analysed CSA Types	Petrofabrics	Major Changes
E	A-01A, B, C, D, E, F, G, H A-02A A-06	1A, 1C, 2, 3, 4, 6, 7	Mostly long necked A-01 forms; only one example of short necked A-02A and A-06; greatest variety of types and petrofabrics, but 1C is most common; at Tell el-Burak, proportion of CSAs is less than 40% of total assemblage; CSAs from this phase show greater morphometric variability than in later phases.
D	A-01C, D, F. G A-02 A, B, C A-03 A-06	1A, 1B, 1C, 3, 5	Number of types and petrofabrics greatly reduced; A-01G and A-02A by far most common types along with the 1A petrofabric; short necked A-02A gradually replaces long necked A-01G types; proportion of amphorae at Tell el-Burak increases to more than 60%; CSAs show very little morphometric variablitiy.
C–A	A-02C	1A, 1B, 6, 7	A-02A type disappear during this phase and short necked A-02C become most common form; 1A petrofabric dominates; perceptible

			decrease in size of amphorae and quality of finish; propportion of CSAs increases to 75% at Tell el-Burak; CSAs show very little morphometric variability

Table 15 Summary of the results by phase from the multidisciplinary analysis of the CSA assemblage

The earliest CSAs, the type A-01 amphorae exhibit a relatively high degree of typological variability compared with the later type A-02 amphorae, a trend paralleled in the petrofabrics. A subfabric of the main petrofabric 1C and in almost all cases the lesser occurring fabrics 2‒7 are restricted to A-01 types. By Phase D only A-01G is found regularly among the A-01 types, and the A-02A type dominates the assemblage. A commensurate reduction in petrofabrics is also observed, with the majority of CSAs from phase D being made in the most commonly occurring fabric 1A. The results undeniably show an increase in standardisation and centralisation in amphorae production beginning in Phase D (roughly 650 BC) relative to earlier periods.

The typological trend evidenced here, is not restricted to the immediate area of Tell el-Burak as the CSA assemblage from Tell el-Burak is broadly similar in character and development to those reported from coastal sites in the southern Levant (e. g. from Tel Keisan, levels 6–3 Briend and Humbert 1980; Tel Michal Herzog *et al.* 1989; Tel Kabri Lehmann 2002; for an overview cf. Lehmann 1996: pls. 7075‒). The currently available petrographic evidence for CSA assemblages does not allow for a similar comparative analysis because the main studies do not cover material from the whole of Iron age II and Persian period (Aznar 2005; Bettles 2003a; 2003b) meaning diachronic changes in fabric preferences cannot be determined.

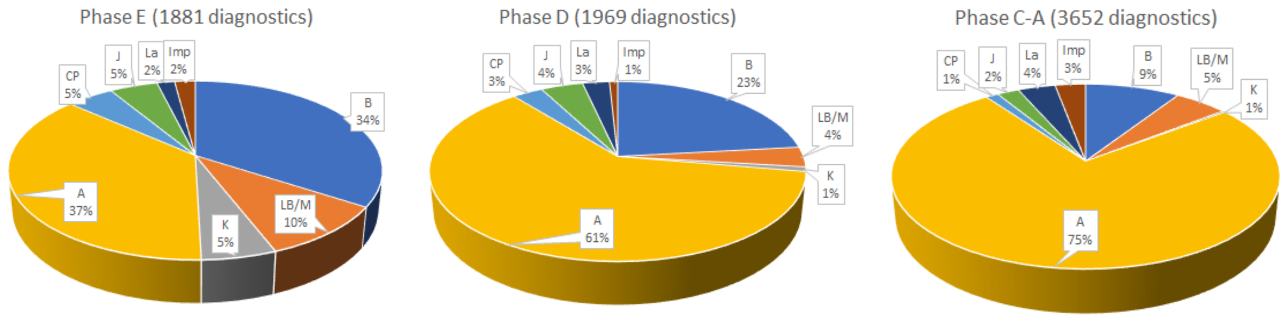


Figure 18 Distribution of vessel classes in Phases E, D and A–C in excavated contexts from Area 3 and 4 at Tell el-Burak; A = amphorae; B = bowls/plates; CP = cooking pots; Imp = Imports; J = jugs and juglets; K = kraters; La = lamps; LB/M = large bowls/mortaria

The increase in standardisation is coupled with increase in the proportion of CSA in the ceramic assemblage from Tell el-Burak with time (Figure 18), going from amphorae comprising ca. 37% of the total assemblage in Phase E, to ca. 61% in Phase D, and ca. 75% in Phases C/B/A – Sarepta seems to have similar proportions. Quantitative analysis are missing from many other sites and comparisons are not yet possible (see above Introduction). Additionally, these numbers correspond to an overall rise in the absolute number of amphorae at Tell el-Burak with time. The increase in the scale of amphorae production could point to a commensurate increase in agricultural production in this part of southern Lebanon throughout the later Iron Age.

The most significant change in CSAs is the move to a short-necked type (A-02A) and the change to a common fabric 1A, well established by Phase D. During the Persian Period a new but similar type of short-necked CSA (A-02C) appears, though the fabric does not change significantly (Phases C/B/A). A-02C is associated with a greater scale of CSA production noted during the Persian period but is coupled with a perceptible decrease in the quality of the finish.

The reason for the development of shorter-neck amphorae with, presumably, a new system for sealing is uncertain, but perhaps the A-02 types could be closed more quickly, more reliably, or using more readily accessible materials. Another possibility is these new types were intended for one or a small number of specific commodities and reflect greater agricultural specialisation at the site. However, as these types appear throughout the region following a similar development this seems highly unlikely[5].

Another possibility is that the simplification and standardisation of the rim represents one aspect of an overall trend towards the simplification and standardisation of CSA forms as a whole to increase the efficiency of their production and firing by regularising how they were stacked in the kiln, thereby maximising space. The morphometric analyses (see *supra* section 2.3) also seem to indicate that the production of smaller and sturdier vessels was desired. This might have facilitated transportation and storage (on ships?) and might have reduced the breakage rate of amphorae during transport.

6.1 Contextualizing Phoenician amphorae production

The widely utilized theoretical framework describing craft-production developed by Costin (1991; 2001) will be drawn upon here to contextualize and further define the production of the CSA found at Tell el-Burak. The quantitative results of the morphometric analyses presented earlier show that the amphorae from the site have a low metric variability, giving clear evidence for standardization in their production as defined by Roux (2003; also cf. Kotsonas 2014). Additionally, the vast numbers of

[5] We thank the anonymous reviewer for pointing out this issue in the original draft.

amphorae found at Tell el-Burak throughout the Iron Age occupation (tens of times greater than the number of all vessels recorded during the Middle Bronze Age at the site (Badreshany and Kamlah 2010-2011), shows that their production was relatively high intensity and high scale, as defined by Costin (1991), within the context of the pre-Classical Levant. The number of amphorae at Tell el-Burak increases in absolute number and in proportion from the earliest to latest phases (Figure 18). The scale and intensity, therefore, increase with time.

The sustained use of similar materials and the low number of forms (especially starting in Phase D) indicate the potters aimed for some degree of efficiency – the relative measure of the time, energy and raw material expended in the production per unit of output (Costin 1991: 37). The shortening of the neck and the increased standardization of forms beginning in Phase D, as mentioned above would have helped facilitate the kiln stacking of a larger number of vessels making firing more fuel and time efficient.

A key factor in understanding efficiency, in this context, would be some measure of the average failure rate of vessels over a number of firings, which would only be possible to assess with a large-scale experimental program. A high degree of spalling and other defects on the surface of many vessels and the large number of wasters reported at the nearby site of Sarepta (Pritchard 1975: 71), hints that the rate of failure of these vessels may have been relatively high. The producers of the Tell el-Burak amphorae, therefore, may have struggled to consistently achieve high levels of efficiency.

Skill is another metric used by Costin (1991: 40), which refers to the proficiency with which activities are executed. Other classes of Phoenician style pottery from the period found at Tell el-Burak and other Phoenician sites in the Levant and Cyprus are generally classified as table wares (Bikai 1978a; 1978b; Bikai 1987; Lehmann 1996; 1998; 2008). These have a fine texture and are generally slipped and decorated, the execution of which would require some level of proficiency. The amphorae themselves, increasingly with time, are often roughly finished and show traces of hasty manufacture. The level of skill required to produce them would have been comparatively low relative to the so-called table-wares. Still, if we use Costin's definition, regardless of their aesthetic qualities, the ability to produce these amphorae to the tolerances indicated by the morphometric analysis, would have likely required some level of skill. What remains unclear, is whether the same potters producing the amphorae are producing other classes of pottery, including the finer wares. The data from Tell-el Burak, neighbouring Sarepta (Anderson 1988) and Tyre (Miguel Gascón and Buxeda i Garrigós 2013) show broad similarities in fabrics across much of the Iron Age assemblage, providing some evidence that potters of the time produced a broad range of forms.

The evidence presented above indicates that the amphorae from Tell el-Burak were produced by highly specialized craftspersons along centralized modes. Costin (Costin 1991: 4) defines specialization as a differentiated regularized, permanent, and perhaps institutionalized production system in which producers depend on extra-household exchange relationships at least for part of their livelihood, and consumers depend on them for acquisition of goods they do not produce themselves. Costin argued that specialization should be described in terms of 'degrees'. An increasing degree of specialization refers to a lager ratio of consumers to producers. The high degree of standardization, coupled with the apparent high scale and intensity of the production of these amphorae suggests the vessels found at Tell el-Burak are products of a highly specialized production, where a relatively small number of producers are producing large amounts of pottery.

Highly specialized production with fewer producers, it is assumed, will manifest in a low degree of variability as was clearly evidenced across the whole amphorae assemblage by the morphometric study, but especially beginning in Phase D with the introduction of the type A-02 amphorae. During the Persian period (Phases C/B/A), a greater scale of production is coupled with a perceptible decrease in the quality of the finish, though not a significant decrease in standardisation. For example, during the Persian period, handles are formed and attached with less care relative to earlier periods and the step of wet smoothing of the finished vessel is often omitted, giving the later CSAs a rougher look overall. One interpretation of this evidence is that the increase in the scale of production put craftsman under increasing pressure, resulting in a greater variability in vessel finish through the Persian period. Alternatively, or additionally, a greater number of potters could have meant that lower skilled potters played a larger role, accounting for the perceptible decrease in the aesthetic qualities of the CSA during the Persian period. The perceived reduction in vessel quality, however, is synchronous with the amphorae becoming smaller and seemingly sturdier. This gradual development likely led to a product that exhibited variable and often poor finishing but would experience less breakage and was more effective for transporting goods, which was of primary importance.

Fully understanding the organisation of the production of the Tell el-Burak amphorae assemblage lacks one key variable from Costin’s framework, i. e. context. The morphological and petrographic evidence indicates that the amphorae found at Tell el-Burak were more likely produced using centralized modes in a few geographically related locations rather than many dispersed throughout the landscape. Where these vessels were produced, however, and how this production was mediated remains unclear. Kilns, wasters, or any architecture that can clearly be associated with the production of pottery at Tell el-Burak have not yet been recovered from the substantial excavation areas. Likewise, a geomagnetic survey at Tell el-Burak and in the immediate surroundings failed to produce any evidence of kilns at the site. Without clear architecture related to production sites it is difficult to understand details about the organisation of production and the degree to which the production of the amphorae at Tell el-Burak was 'administered' by elites following Sinopoli's definition (1988) ('attached' in the language of Earle Brumfiel and Earle 1987). The high degree of centralization and a limited number of production locations evidenced by this study could be interpreted as involving some degree of elite administration or control.

For the late Iron Age and Persian period, it is fortunate that some production facilities related to these types of amphorae have been excavated at the nearby site of Sarepta. In contrast, to Tell el-Burak, which has yet to produced evidence for the production of pottery, neighbouring Sarepta, just 4 km to the south, has produced ample evidence that it served as a locus of ceramic production, including kilns and large deposits of wasters (Anderson 1987; 1989; Pritchard 1978). Future excavations at Tell el-Burak may produce evidence of pottery production, but it seems unlikely that a substantial and long-lasting ceramic production, such as that in evidence at Sarpeta, took place on or in the vicinity of Tell el-Burak. Given the evidence for pottery production at very nearby Sarepta and the evidence from this study for shared production locations for many of the samples, it is reasonable to suggest that Sarpeta played an important role in supplying Tell el-Burak with some proportion of its pottery. The role of Sarepta as a major or the primary production centre for various types of Phoenician pottery, including amphorae has long been perpetuated in the literature (e. g.

Bettles 2003b: 204; King and Stager 2001: 138–9; Martin 2017: 117). Based on a re-examination of the published data below, however, we argue that the contribution of the industrial area uncovered at the site (Area X) to the supply of pottery on the southern Phoenician coast rests on ambiguous data and is likely overstated.

6.2 A re-examination of the evidence for pottery production from Sarepta

The evidence from Sarepta has potential to shed light on the context of pottery production, how it was administered, and its role in the broader economy of the region during the Iron Age and Persian periods.

24 kilns were reported from Sarepta (Anderson 1987), however, the stratigraphy as presented in the reports (Anderson 1987; 1989; Khalifeh 1988; Pritchard 1975; 1978) limits our understanding of how many of the kilns in Area X are in operation at one time, especially for the later Iron Age II and Persian period. The two kilns from Area Y date to the Late Bronze Age/Iron Age transition and it would seem that area was not used for potting in the Iron Age II or Persian period, but rather had a domestic character at that time (Pritchard 1978: 82–84. Pritchard (1978:113) estimates perhaps 100 kilns might eventually be uncovered at Sarepta with perhaps a dozen kilns in use at one time and Anderson (Anderson 1989: 199) estimates the potting industry may have covered 3000 m^2. Both of these estimates are based on the presence of kilns in Area Y and depend on the postulation that the space in between Areas Y and X (separated by some 100 m) was dedicated entirely to potting. The short duration of kiln activity in Area Y and the noted difficulties in connecting the stratigraphy from Areas Y and X (Schreiber 2003: 163), leads to questions about whether an industry of such a size ever existed at Sarepta. More relevant to this study, is that there is certainly no basis to suggest that the industrial activity at Sarepta covered such a large portion of the site

during the Iron Age II and Persian period as domestic architecture is noted at this time in Area Y.

Continuity in the use of Area X for pottery production through the late Iron Age II is implied by Anderson, but never explicitly stated or evidenced. In short, which kilns exist when, remains somewhat unclear. Anderson does seem confident that at least one kiln (C-D) dates to the Persian period, though is less sure about the date of another (kiln A-B), which might be contemporary.

A reanalysis of the stratigraphy and phasing from Sarepta as presented in Anderson's and Pritchard's work indicates that during the Iron Age II and Persian period only one kiln, or at most two, were active at any given time in the Area X industrial quarter. The possibility even exists that there are times when no kilns are active during the late Iron Age II (or parts of the late Iron Age II) in Area X, though a broad continuity for the use of the area for industrial purposes through the Iron Age and Persian periods seems likely given the available evidence.

In light of this reanalysis of the evidence from Sarepta, significant doubt must be cast on the assumption by many that Sarepta is a unique in its status among Phoenician cites as a primary pottery production centre. The presence of kilns is not unique to Sarepta during the Iron Age as kilns similar in type and number are found at contemporary settlements throughout the southern Levant, including Iron II kilns at Akko, Kfar Menahem, Meggido, and Ashdod and Persian Period kilns at Tell en-Nasbeh and Tel Mikhal (Anderson 1989: 208–10; Ben-Shlomo *et al.* 2004; Killebrew 1996; Wood 1990). A structure interpreted as a pottery workshop and a number of wasters were also discovered at Tyre (Bikai 1978b: 13). The evidence from Sarepta, suggesting that one or two kilns with a capacity of perhaps 200 vessels each (capacity estimate from Anderson 1989: 203) were active at a given time during the Iron Age or

Persian period is comparable to the evidence from the sites mentioned above where perhaps one to three contemporary kilns are reported. The scale of production at Sarepta, though perhaps relatively high and based around specialist labour, may have been fairly typical for many sites at the time. To add perspective, the excavations at Tell Arqa, produced evidence of six contemporary kilns, dating to the MB I with a capacity of perhaps 150−300 vessels each (Thalmann 2010) and associated workshops. Yet, an analogous impact on the pottery distribution of MB I northern Lebanon to that suggested for Sarepta has, to the authors' knowledge, never been proposed.

Further excavation at Sarepta might produce more evidence for the synchronic existence of more Iron Age II and Persian period kilns. Regardless, the kilns at Sarepta are large and the production there still could be considered high scale within the theoretical frameworks utilised above. Currently, there is no evidence to suggest, however, that the capacity for pottery production at Sarepta is extraordinary in scale within the context of the Iron Age Levant.

Bettles (2003b: 197, 200) has argued for Sarepta as one of the major production centres for CSAs in the southern Levant and large parts of Bettles' (2003b: e. g. 197, 200) further argumentation and model building are based on this assumption. Our critical evaluation of the Sarepta evidence now puts Bettles' interpretations seriously into question.

Little is known about Phoenician coastal settlements in Lebanon, but it is conceivable that the area near the port in Phoenician cites perhaps was commonly a locus for general industrial activity and that pottery production, such as that found at Sarepta, was just one category of industrial activity common to Phoenician ports. Sarepta itself produced good evidence in Area X for other industries including many types of metalworking and purple dye production, indicating that the site benefited from a diverse industrial economic base (Pritchard 1978: 126–130). Impressive and extensive installations for olive oil production were also uncovered in Area X though these were dated to the Hellenistic period. The wide distribution of clays and other resources of the type used for the production of the amphorae across southern Lebanon, the number of pottery kilns known from other sites in the region, and the probable need for containers generally at ports, make it likely that pottery production occurred at multiple loci across the region, rather than one, which would have been more sensible from a logistical standpoint under normal circumstances.

6.3 Imperialism, economy and the role of Phoenician settlements

Historical sources detail the occurrence of quite violent upheavals with some regularity in the area as a result of the proliferation of imperial power (Bagg 2011: 166, 246, 255, 262; Briant 2002: *passim*; Rainey and Notley 2006: 258–75). The archaeological evidence presented in this study, however, indicates remarkable long-term stability in craft-production modes, supply networks, and role of Tell el-Burak within the wider economy of Iron Age and Persian period southern Phoenicia. Some changes potentially associated with the rise of imperial hegemony in the area can be observed in the material culture, but they are subtle and gradual.

The architectural, botanical (Orendi and Deckers 2018) and residue analyses evidence a focus on the processing and containerization of agriculture commodities at the site, therefore, the ceramic data can be interpreted as indicating trends towards an increase in agricultural production in the region of Tell el-Burak through the Iron Age and Persian periods. Combined with the botanical data from Tell el-Burak, the analysis indicates that the coastal plain and surrounding hills around Tell el-Burak were consistently harnessed over long periods for large-scale agricultural production. The evidence suggests that agricultural production played an important role in Phoenician economy, in contrast to suggestions that Phoenicians relied largely on far flung trade networks to supply their settlements with agricultural produce (e. g. Aubet 2001 [1993]; Elayi 1980; Katzenstein 1997; Spanò Giammellaro 1999). The relative standardization and stability of amphorae production suggests very little shift in the political economies directly associated with ceramic and agricultural production in southern Phoenicia, despite historical evidence for changes in both imperial and local regimes. In short, the archaeological evidence from Tell el-Burak indicates that Neo-Assyrian, Egyptian (26th Dynasty), Neo-Babylonian and Persian periods can broadly be characterised by long periods of stability to daily-life of those living in this part of southern Phoenicia, which enabled growth and increases in agricultural production. A greater understanding of the causality of this growth, though it is in part enabled by systemic stability, can be gained by integrating the available settlement data with the ceramic data.

Evidence for the organisation of Iron II and Persian period settlements in the core of southern Phoenicia is scant, with Tell el-Burak and Sarepta providing the only extensively excavated examples. As a result, the role of individuals and the orientation of their settlements in the broader economy of the time remain unclear. Do individual Phoenician settlements tend to fill specific economic roles? Historical sources give an impression of periods of political flux with the arrival of imperialism in the Levant. If true, does archaeological evidence exist for fundamental shifts in the role sites play in the broader Phoenician economy or do they subtly adapt to meet the challenges brought by periods of political insecurity?

The archaeological evidence from both Sarepta and Tell el-Burak indicates a dichotomy in the economic base of the two sites. Though representing only one area of southern Phoenicia, these two sites do seem to show some economic specialisation at sites or within areas of sites. The data from Tell el-Burak, which is extensively excavated, shows a long-term focus on administering and processing agriculture materials. Preliminary evidence from the on-going botanical and residue analyses points to a focus on wine and olive oil production and storage (Kamlah 2015; Orendi and Deckers 2018). Sarepta is decidedly more industrial in character compared to Tell el-Burak, though the excavations were more limited than those of Tell el-Burak, so an additional agricultural economic focus at the site should not be excluded.

What can be more conclusively drawn from the work at Sarepta than evidence of the scale of craft-production, and what is perhaps more informative about the Phoenician economy and the impact of imperialism, is evidence for continuity. The work at Sarepta showed that similar types of facilities existed near the port in Area X for more than 1000 years, indicating the location and the economic role of the port as an industrial hub seems to have been fixed from at least the Late Bronze age and is broadly continuous despite sweeping political changes in the broader Near East. The only major change to the character of Area X comes with the Hellenistic period when the entire area is given over to olive oil production (Pritchard 1978: 130), which indicates a shift in economic focus at Sarepta or perhaps a fundamental shift in the nature of its port at that time.

The position of the industrial area, long entrenched, just near the port at Sarepta perhaps represent a long-term emphasis on efficiency in craft production and distribution which served to directly link craftspeople with needed materials while allowing them to easily export finished products upon completion. In the case of CSAs, it is generally assumed that they were filled with commodities and shipped from port, though they were probably also at times shipped empty (by sea or land) to places like Tell el-Burak where they were then utilised. Ceramics could double as ballast, making the movement of empty vessels by sea generally economical (Crowe 2002: 22; Martin 2017: 119).

Such modes would fit with the evidence for highly centralised production presented in this study. Centralising industrial activity to a few locations, however, would additionally serve to facilitate the administration by elites of craft-production along with the necessary supply chains and distribution networks. The direct administration of trade and ownership of the relevant infrastructure by the state (or figure of the king) is mentioned by a few historical sources, for example in the early 7th century BC treaty between the Assyrian king Esharhaddon and Ba'al of Tyre (Parpola and Watanabe 1988: 24–27, No. 5; Bagg 2011: 176–7) which describes 'towns, manors, and wharves' as 'his' (that is belonging to Ba'al). The Phoenicians were famed in the ancient world for the quality of their craftsmanship, especially of high value objects intended for conspicuous consumption. Assyrian tribute lists indicate that the Phoenician cities at certain occasions had to muster great wealth (Bagg 2011: 384–401), highlighting the importance of these industries as a source of wealth to the local political establishment. There is no evidence for the direct shipment of agricultural stocks in CSAs to Assyria or Persia for tribute or trade. The increase in CSA and agricultural production, rather, may have been driven by an internal region-level reorganisation and centralisation by Phoenician elites of the Phoenician economy to free up craftsman or provision expeditions to meet tribute demands for precious metals or imperial military demands. However, the documented quantities of tribute to Assyria seems to be much lower than usually suggested (cf. Bagg 2011:166 and the tables in his appendix) and therefore a stimulus by tribute demands should not be overemphasized. The advantages of an imperial environment are often downplayed or over-looked. As Radner (2004) has pointed out, the expansion of the Assyrian empire in the Levant will have brought the Phoenician cities in direct contact with an enormous market and will probably have enhanced trading activities which before were hampered by intermediate states.

In any case, direct/indirect imperial pressure or new opportunities for trade, likely meant the political elite needed to ensure the ability to draw on resources when needed, which must have been generated in part through the mediation of the production and distribution of high-status objects and other commodities. Policies of integration, ensuring that craft-production took place in a few, rather than many places, would allow elites to efficiently administer these critically important activities.

Tell el-Burak, on the other hand, represents another type of Phoenician settlement in comparison to Sarepta – one focused on agricultural production. The site is situated to oversee an extensive, fertile, and well-watered agricultural plain. Unlike Sarepta, which is centred on a good natural harbour (Pedersen 2011: 184), Tell el-Burak, though located directly on the coast, did not have access to reliable harbourage. An underwater study of the area by Pedersen (2011), highlighted shallow water, strong currents, and the presence of a natural reef which would have made boat travel to the site impossible for large ships and difficult and unreliable for smaller ships, though the latter could have beached to the south of the site in good conditions. According to Pedersen, the original placement of the site in this area, along with a very steep glacis on the seaward side, would have protected the monumental Middle Bronze Age building from seaward attack.

The decision to re-established Tell el-Burak on the site of the MB mound, was made despite the lack of a good port. For a settlement focused on agricultural production and storage, access to water, fertile land, a defensible position mediating an important agricultural area, was more important than predictable sea trade. In good conditions, the produce from Tell el-Burak, could have been transported by small boat, to larger ships waiting off shore (at least 50 meters, according to Pedersen), or by small boat or even land to the nearby port of Sarpeta for loading on to larger vessels. The absence of a good port at Tell el-Burak is perhaps reflected in the lack of evidence of craft-production, in contrast to the ample evidence found at Sarepta. Large-scale craft-production at Tell el-Burak may never have taken root because the necessary materials were more difficult to bring to the site reliably in large quantities. The lack of evidence for craft production at Tell el-Burak may support the idea that sustained craft-production was intrinsically bound up with the political economy of the time and restricted to the port or other designated industrial areas of cities to facilitate its administration. Continued work in the region, currently underway, will provide a better understanding of the organisation of the Phoenician economy and the placement of industrial areas within cities.

More details related to the economic organisation of the Phoenician economy awaits further archaeological evidence. The data provided by the investigation of the CSA assemblage from Tell el-Burak along with the data from the excavations at Tell el-Burak and Sarepta, never-the-less, highlights the existence of a long-term stability in modes of craft production perhaps stretching back to the Late Bronze Age.

The changes perceptible in response to the arrival of imperial power and other international events during the Iron Age and Persian period in this area of southern Lebanon are subtle. The evidence from Sarepta would suggest continuity with structures and modes largely in place during the Late Bronze Age and Iron Age I. Some impacts of imperialism, include greater economic integration with other parts of Mediterranean as evidenced by a number of imported pottery of types other than amphorae (e. g. Cypriot, cf. Schmitt in: Kamlah *et al.* 2016b: 106–107), especially during the Persian period, at both Tell el-Burak and Sarepta, a steady increase in the scale of amphorae demand and production starting around 650 B.C. until the end of the Persian period can be noted. This study confirms, however, that most of the amphorae at Tell el-Burak, were produced in southern Lebanon, suggesting that its trade in agricultural products was largely intended for intraregional consumption. Tell el-Burak, thus, was an important node in an intensive economic interaction sphere linking parts of southern Phoenicia. Aside from finished agricultural products, the large amounts of charred grape and the ubiquity of olive wood at Tell el-Burak indicate that the cuttings and pomace resulting from the processing of these products was probably burned as fuel.

The very reestablishment of Tell el-Burak and the establishment of Jiyeh to the north of Sidon during the Iron Age II coincides with the intensification of Assyrian activities in the area (Bagg 2011 #3041:213–269}. Thus, the reoccupation of Tell el-Burak reflects an increase in production fostered largely by imperial regimes (*contra* Mierse 2012: 293) that, while at times exacting tribute, brought long periods of stability and economic growth (e.g the so-called 'Pax Assyriaca') to the broader region in return. Whether the economic growth resulted in greater prosperity in the region for many remains to be determined.

During the Iron Age, imperial administration seems to have reduced the periods of near constant conflict between regional polities that existed in earlier periods (see Late Bronze Age Amarna letters for numerous examples), which facilitated trade and increased economic integration. For the most part, the Assyrian and Persian leaderships, understood that the southern Phoenician economy and its emerging colonial enterprises in the Mediterranean, was best left to manage itself, utilising the proven systems that had been in place for hundreds of years (Bagg 2011: 166, 176; Elayi 2014: 114; Elayi and Elayi 2014: 112). The key to good policy for the imperial regimes was to ensure their demands on the whole were not consistently excessive, as they surely were from time to time, and did not stress the economy of the area to breaking point. The growth in agricultural production throughout the period evidenced by the reestablishment of Tell el-Burak (and establishment of Jiyeh), along with a steady increase in the scale of amphorae production was perhaps facilitated by the continued development of new agricultural areas and better infrastructure enabled through the long-term stability brought by the imperial power.

Only the documented upheavals at the end of the Persian Period, where Sidon and its elites are said to be completely wiped out (Briant 2002: 683–4; Elayi 2014: 117), and the coming of Alexander, who decisively conquered the Phoenician territories, seems to significantly impact the settlement pattern and the character of settlements in the immediate area. Tell el-Burak was abandoned at this time, and the port area of Sarepta is reorganised and given over to olive oil production.

7 Conclusions and future directions

The results of a large-scale multi-disciplinary analysis indicates that production of the Iron Age carinated shoulder amphorae from Tell el-Burak was highly-organised and was undertaken by long-lived, sustained, and centralized modes. Despite gradual, but marked typological changes, very little change in the fabrics of these amphorae was noted over the 400-year Iron Age occupation of the site. The establishment of Tell el-Burak along with this new pottery industry coincides with the proliferation of the world’s first great imperial powers, the Neo-Assyrian, Neo-Babylonian and Persian empires. The work at Tell el-Burak and neighbouring Sarepta evidence continuity and only gradual changes in the material culture and architecture at these sites through the Iron Age II. The archaeological evidence, therefore, indicates that the advent of imperialism in the region had little direct or sudden impacts on daily life or the day-to-day workings of the economy of this part of southern Lebanon. The scale of amphorae production grew at Tell el-Burak during the Persian period, which suggests trends toward overall economic growth in the area. Growth could be explained in part by the economic reorganisation of the area by local elites stimulated by access to new markets and long periods of stability brought to the region by imperial powers, but also to help meet their new tribute demands. Tell el-Burak, however, is a relatively small site, and the impacts of imperialism may have been very different for those living in and around the main regional centres of Sidon and Tyre. Additionally, important questions remain as to what degree coastal areas were integrated with the uplands, how this integration was mediated, and how these areas were affected by imperialism.

The core of the Phoenician homeland, in modern day Lebanon, has seen comparatively little archaeological research relative to areas in the southern Levant. This study provides a key dataset and shows that the application of integrated and rigorous multidisciplinary analyses yields new pathways towards understanding important aspects of production and distribution modes, giving some clarity on questions related to socio-economic change in response to imperial rule in this part of Iron Age Lebanon. An ambitious new agenda and framework, further incorporating multidisciplinary analyses and generating accessible multi-user datasets, such as that provided by this study, is required to facilitate the development of robust region-level explanatory frameworks to address open questions. Current interpretive schemes for multi-site ceramic and petrographic datasets dealing with the period (e.g. Bettles 2003b) are built around simplistic and polarised theoretical frameworks that emphasise state sponsored vs independent/free market modes of production and distribution. The reality more likely involved a complex interwoven economic tapestry with multiple actors, governed by a number of socio-political factors. Key to reshaping our understanding of the Iron Age of the region are the generation of accessible multi-site ceramic datasets contextualised within new theoretical frameworks, based on archaeological, historical and ethnographic data, that are sophisticated enough to arbitrate the complexities of highly integrated economies, such as those in operation in Phoenicia during the Iron Age and Persian period.

Current excavations in the core of the Phoenician homeland at Tyre and Sidon and the continued work at Tell el-Burak, will surely contribute important new evidence toward our understanding of the Phoenician economy. The Zahrani Regional Survey project currently underway investigating the region around Tell el-Burak, promises to shed more light on changes in settlement pattern during the Iron Age II and Persian Period in the area (Schmitt/Gries, in prep).

Combined with the new data from these sites and surveys, a follow-on project to this study is currently underway investigating ceramic samples, including CSAs, from Sarepta, Sidon, Jiyeh, and Beirut. The study is aimed at broadening our understanding of CSA production throughout central and southern Lebanon and promises to provide key insights into regional variations, propulsion towards the Phoenician settlements in the central and western Mediterranean, and the interplay of these themes with the advent of imperialism in the region.

One aspect of the follow-on study currently being conducted by the authors directly compares the petrographic and geochemistry of the assemblages from Sarepta with that of Tell el-Burak, informing on the degree to which the amphorae from Tell el-Burak were produced at Sarepta. The work will also shed more light on the production of other vessel classes at the site, such as bowl, jugs, juglets, and cooking pots and how these relate to the production of the CSAs. A larger-scale programme of residue analysis is also ongoing, the results of which will be incorporated into this regionally focused work to provide much needed information on the range of commodities that were carried by these amphorae.

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Please find our responses to the reviewers query. Where appropriate changes and additions are highlighted in yellow in the text

Review 1:

1.The data is thoroughly discussed in the context of the Iron Age economy of Lebanon and placed in the wider context of imperial domination (Assyrian, Babylonian, Persian, - it is not clear, why the short Egyptian interlude of the 26th Dynasty was omitted in this context).

- **A short mentioned has been made to the "Egyptian interlude of the 26th Dynasty" as suggested by the reviewer, see p. 78**

Review 2:

Reviewer suggest shortening paper:

"The only fault I find with the paper is its length; toward its end it becomes tedious. The authors should find a way to shorten it, either by eliminating repetitions (and there are quite a few of those, some noted below), or by transferring more sections to the on line part. As well, the residue analyses part can be shortened considerably since it did not produce clear cut results. Perhaps move the methods of the RA to the online part.

- **The reviewer has suggested to shorten the paper; we have removed paragraphs at different spots following the suggestions by the reviewer and removed some more where possible in our opinion**
- **We have moved the methods section for the residue analysis to an appendix. We are open to removing the method section for the petrography to an appendix as a way of shortening the paper. We leave this for the journal's editor to decide. We also leave it for the journal's editor to decide if this appendix appears in print or online.**

General comments/questions, in no particular order:

1. Having said all the above, I would qualify a bit the declaration in the beginning that this paper is unique and groundbreaking in relation to pottery studies in the Levant in general. It is certainly so regarding Phoenician pottery or ceramics in Lebanon in general.

- **We appreciate the reviewer's comments here, but we do <u>not</u> say that our paper is unique and groundbreaking in general for pottery studies in the Levant. We say, that for the first time a single site dataset which included detailed contextual information, measurements, raw-data, more than 500 images of pottery and 50 3-D models is published (online) and made available to the reader. We think this is true and therefore, we do not see the need to change the wording. If this is not the case and a similar scope of raw data is presented in such and easily accessible format, we are happy to change this statement (and even happier to read the publication!)**

2. A fundamental issue: if I understood correctly, currently you do not have any indications regarding

possible differences in fabric between the presumed(?) Burak production and that of other sites in south Lebanon. So to play the devil's advocate, were I to suggest that the Burak assemblage originates in several sites in this region - could this be negated? So I wonder if the following statement on p. 63 can be really substantiated: "the vast majority of the samples analysed share a common fabric and, thus, likely originated from workshops located in relative proximity to each other, somewhere on the southern Lebanese coast." Please address this explicitly.

- **The reviewer raises an important point here. The reviewer is correct that petrographically the samples should theoretically present the same fabrics up and down the southern Lebanese coast, at least based on data from the available geological maps (we have not seen samples from some key sites so we cannot confirm this). We would, however, expect geochemical variation across these areas. It is mostly the clear geochemical similarity from the XRF analysis that suggests to us geographically related production centres for the amphorae, rather than dispersed production across the Lebanese coast. This combined with the observed petrographic and typological similarities, we think, serves to reinforce this conclusion. The usefulness of geochemical similarity (fingerprinting) to link ceramic production centres is discussed on p.39-40 and referenced. Additionally, we have emphasized this point in the relevant sections.**

3. The first thing I asked myself when I started to read this paper is whether Burak has an anchorage or agricultural hinterland. It took me 78 pp. to receive an answer. Add some short environmental introduction in the beginning.

- **The info has been added in section 1, p. 13**

4. Pls. make sure that it is clear which types exactly occur in each phase.

- **Section 2.1 explains the type distribution in clear words and it is illustrated in table 7; We feel we have made this as clear as possible.**

5. Regarding the crucial 'transitional' Phase D: pls. say something regarding the depositional nature of the contexts. Could it be, for example, that early types are re-deposited in this phase? This is a crucial issue.

- **Paragraph added in section 2.2, p. 23**

6. Explain how the morphometrics where obtained: a. Were the vessels drawn manually or by computerized means? B. Were the measurements obtained directly from the vessels or from the line-drawings?

- **Paragraph added in section 2.3, p. 25**

7. Consider referring to the computerized typology of Phoenician jars in: Gilboa, A., Karasik, A., Sharon, I., and Smilansky, U. 2004. Towards Computerized Typology and Classification of Ceramics. Journal of Archaeological Science 31/6: 681–694.

- **Paragraph and citation added on p. 11 and in bibliography**

8. Why are no dimensions provided for the complete vessels?

- **We have created a table with all dimension which will be put in the online appendix (Table 5)**

9. Please say a few words, however short, regarding ceramic imports to the site in the different phases.

- **Paragraph added in section 1, p. 16**

10. Regarding the very important observations concerning the scale of pottery industry at Sarepta, please address the following: a. What would this mean for Beetles' model; B. What, then, does your assessment of the 'industrial' character of Sarepta rely on (p. 76)?

- **Ad question a: paragraph added on p. 76**
- **Ad question b: this issue is explicitly addressed on p. 76-77 with reference to the relevant literature. We should suggest, we define 'industrial' as sustained relatively high-scale production of non-food products.**

Other, more specific points:

P. 5: Regarding Bettles, it should be noted here that she mainly dealt with the Persian period and hardly with the Iron Age.

- **Added some words to clarify on p. 5**

P. 8: repeated and redundant sentence: "Aznar's study focused mainly on the Late Iron II, while Bettles focused on the Persian period."

- **Sentence has been deleted**

p. 8: See if you can delete the following entire paragraph, which is repetitious: "What is currently lacking and what this study provides, is the first comprehensive site-level statistically robust typological analysis, drawing on large numbers of vessels from a long sequence of well-defined stratigraphic contexts, which integrates archaeometry. The nuance provided by this dataset and the integration of a similarly rigorous archaeometric analysis, is key to significantly expanding our understanding of amphorae production and its relationship to Phoenician socioeconomic strategies, especially those adopted in response to imperial rule."

- **This paragraph has been deleted in its current position and combined with a paragraph in the introduction on p. 3**

p. 9: not a good place for Table 1. Move it to the typological discussion.

- **We appreciate the reviewers comment but would prefer to leave the table where it is. The table serves to illustrate what Anderson did not recognize in the Sarepta material. In our opinion, it would cause more confusion in the section suggested by the rev. We have added a reference to the section where the Tell Burak typology is discussed and hope this will be acceptable to the reviewer**

p. 10, table 2. Provide some absolute dates for orientation. If you do not want to commit, you can cite Anderson's.

- **We feel that Table 2 is already very densely filled with info. Absolute dates for the Sarepta phases are given in Table 5, a reference to this table was added. We hope this will be acceptable to the reviewer.**

P. 11. Ditto regarding Tyre.

- Please see the above comment

P. 13: strange order of references: “see Schmitt, in press; Kamlah et al. 2016b; 2016a”

- **Order of references changed per reviews suggestions, now p. 14**

P. 15: the chronology in table 5 is quite fuzzy because you did not insert horizontal lines between the phases. Even if this was done on purpose – change; it is very unclear to the reader.

- **We have altered the graph as suggested by the reviewer. The graph reflects the remaining uncertainty in chronology. We also added a short paragraph on pp. 15-16 clearly stating and explaining the absolute dating and some unresolved issues in the text above the table**

P. 17, table 6: refer to illustrations where possible

- **References added in Table 6**

P. 24: table 8 requires formatting. Also explain in the caption what n is.

- **Rev. does not specify what has to be formatted; We hope the issue will be solved during copy editing.**
- **We have added info on n as suggested.**

P. 26: Make sure you made it clear in which Phase was House 3 destroyed.

- **A Sentence was added to clarify, now p. 29**

P. 35: move Table 11 further down or immediately after the petrography section.

Table 11 moved to the very end of section 4

P. 39: pls. provide some information regarding the plausibly non-local vessels.

- **We have added a bit more information about the non-local types and referred the reader to images in the text and in the online appendix.**

p. 40: unclear sentence, please simplify: “Some non-local amphorae types and two local types in non-local fabrics are noted in the assemblage, but they can be contrasted with a good number of imports found among other vessel classes observed”

- **Sentence has been clarified as suggested.**

p. 44: 4.4 Results of the Geochemistry – simply chemistry?

- **Geochemistry is preferred in this context.**

P. 52: unclear sentence: “Additionally, diachronic information was gathered from studies conducting organic analyses on Phoenician amphorae and other pottery”

- **Sentence clarified through additions, now p. 55**

P. 53: something is wrong with this reference: Serpico,White 1996,

- **Reference Corrected, now p. 55**

P. 56: unclear what the 3rd column in table 12 means.

- **Explanation added to table caption**

P. 57: correct: Stern et al. 2000: 401402;

- **Reference Corrected**

P. 62: The Occurrence of olive stones and grape seeds does not automatically mean industry. Pls. explain this inference.

- **We have not mentioned an industry; large scale wine production is evidenced by the winery and the large number of charred grape seeds**
- **We added some words to clarify, now p. 64**

P. 66: “Another possibility is these new types were intended for one or a small number of specific commodities and reflect greater agricultural specialisation at the site.” This can hardly be the correct answer since this typological development happens everywhere in Phoenicia.

- Now p. 69: Very good point, Rather than remove, we have reworked the sentence reflecting the reviewers valid point, as we feel there is value in specifically negating the likelihood of a relationship between types and the commodities utilising the reviewer’s argumentation (credit will be added in the acknowledgements). We hope this is acceptable to the reviewer but will remove the sentence if not

P. 73: for another 8th c, kiln site in Israel (Kfar Menahem in Philistia), see: Late Philistine Decorated Ware ("Ashdod Ware"): Typology, Chronology, and Production Centers Author(s): David Ben-Shlomo, Itzhaq Shai, Aren M. Maeir Source: Bulletin of the American Schools of Oriental Research, No. 335 (Aug., 2004), pp. 1-35

- **Now p. 75: We thank the reviewer for this valuable reference, which we have added.**

P. 77: something is wrong with this sentence: Assyrian tribute lists indicate requirements that the Phoenicians at certain occasions muster great wealth

- **Corrected, now p. 80**

P. 81 (now 82): “the successive Assyrian and Persian”: the Assyrian and Persian periods are not successive…..

- **“successive” removed**

P. 81 (now 83): the conclusions are repetitious and I would delete them. Leave only the future directions.

- **We prefer to keep the conclusions if acceptable. Though repetitious (as conclusions often are), we feel they are important for the reader to sum up the data and provide some context for those who have not read the whole text. We are however open to removing them, if the journal’s editor decides it improves the text.**

P. 82 (now 84): “The core of the Phoenician homeland, in modern day Lebanon, has seen comparatively little archaeological research relative to areas further south in Palestine.” : Decide which geopolitical or other terminology you use. Since you mention modern Lebanon – the last I checked, the modern state south of it is called Israel and not Palestine. If you feel you must refrain from using that name perhaps use a geographical terminology? Or Lebanon vs. the southern Levant (a very useful term…).

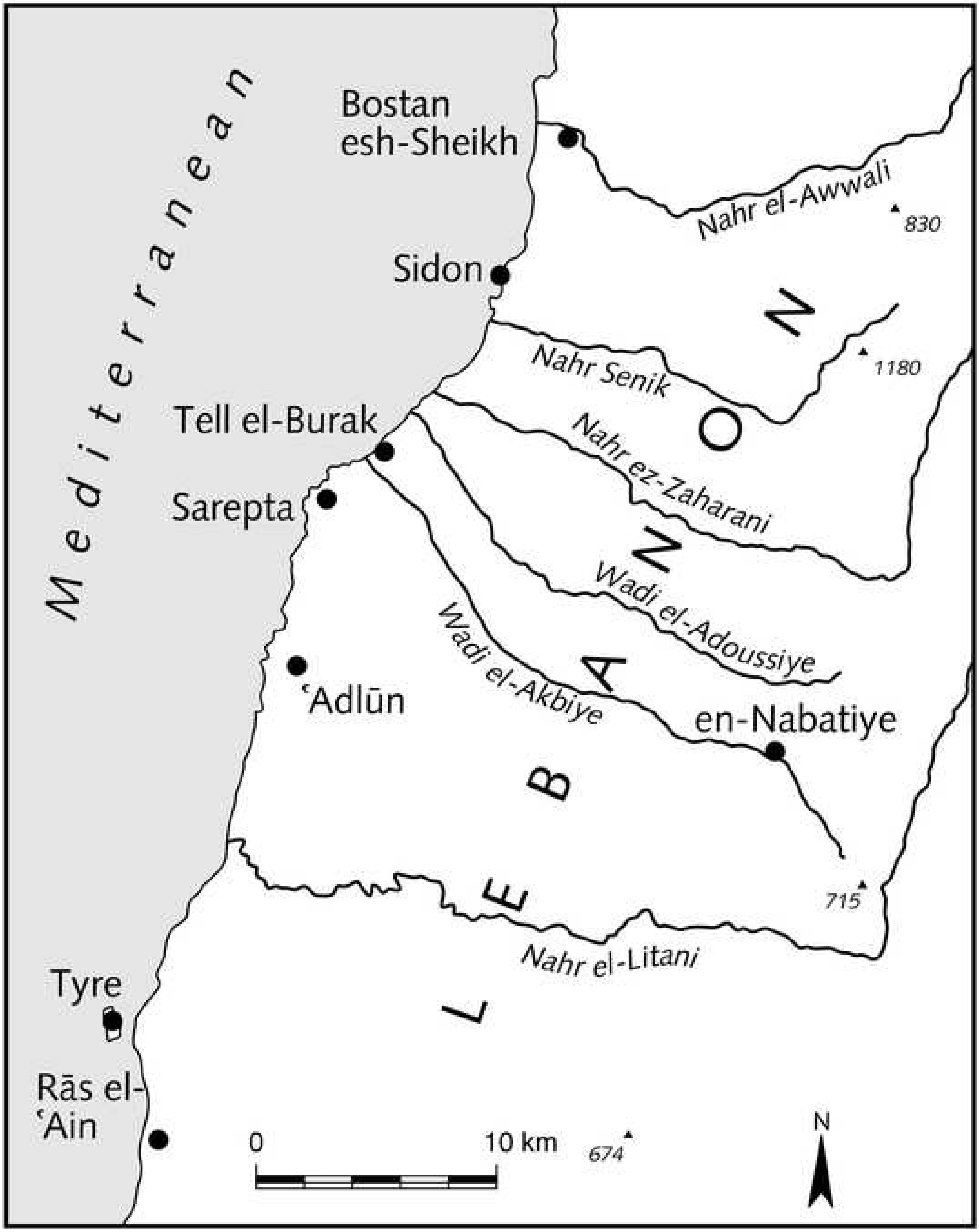
- Good point! Palestine changed to “southern Levant” throughout

Bibliography: Needs some more work. Especially, words in titles are sometimes capitalized and sometimes not. Goren, Finkelstein and Naaman is unfinished. P. 88: (Library of ancient Israel. P. 89: Knapp, A. B. and Demesticha, S.(eds) 2017 appears twice.
Typos etc.

- The paper requires careful editing. A few examples follow.
- P. 2: helping better define; Forth (Fourth…)
- p. 3: (Martin in: (Knapp and Demesticha 2017b).
- P. 37: One A-02 samples
- P. 39: A few of theses
- P. 62: as well other
- P. 65: to immediate area
- P. 75: in the southern Phoenicia

The reviewer rightly pointed out the necessity for careful editing. We have made the suggested changed and, in addition, have carefully gone through the bibliography and the whole text again to correct mistakes.

Non-colour figure



Colour figure (print: author charge applies - please contact the Editor for cost details)

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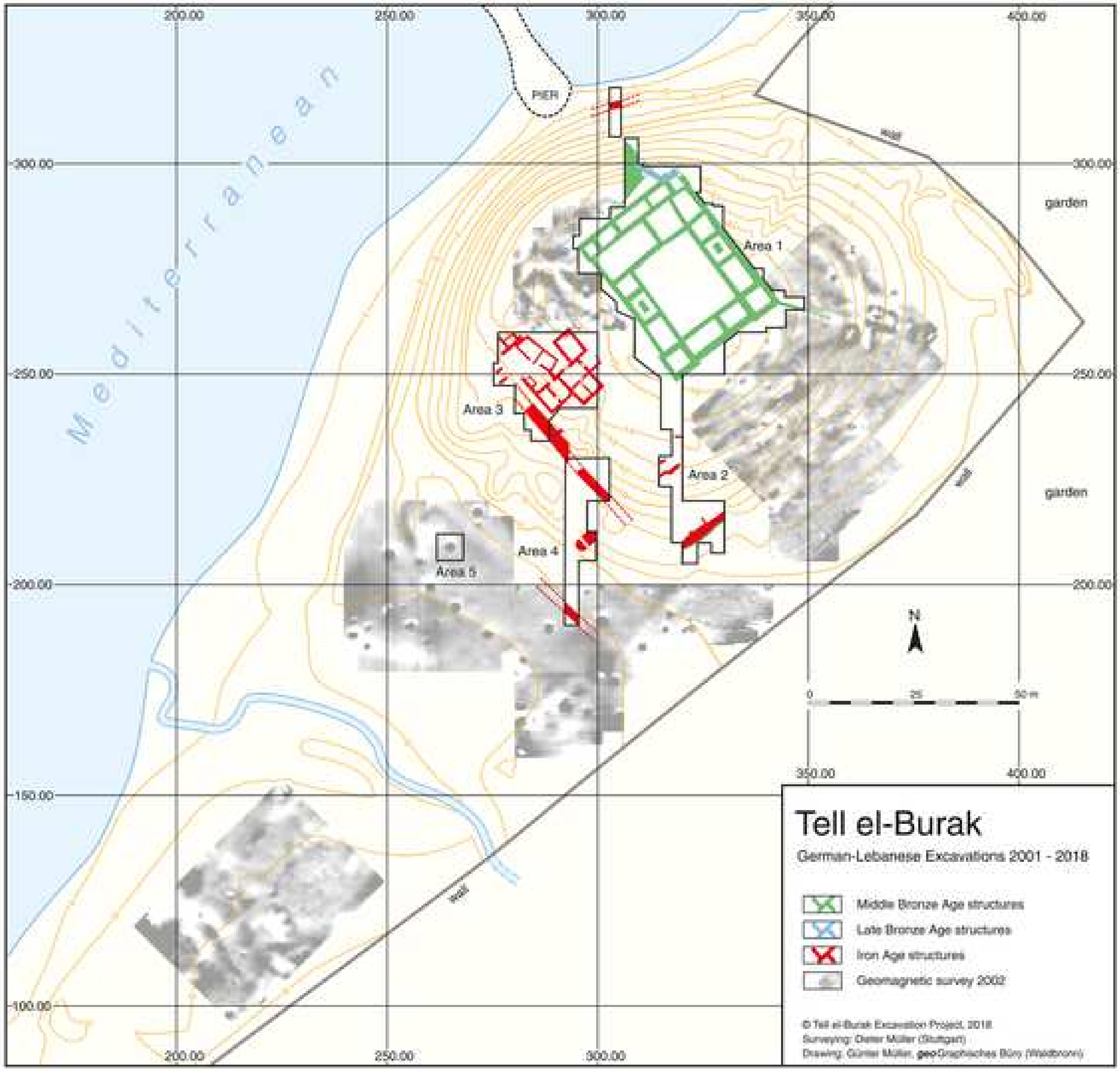

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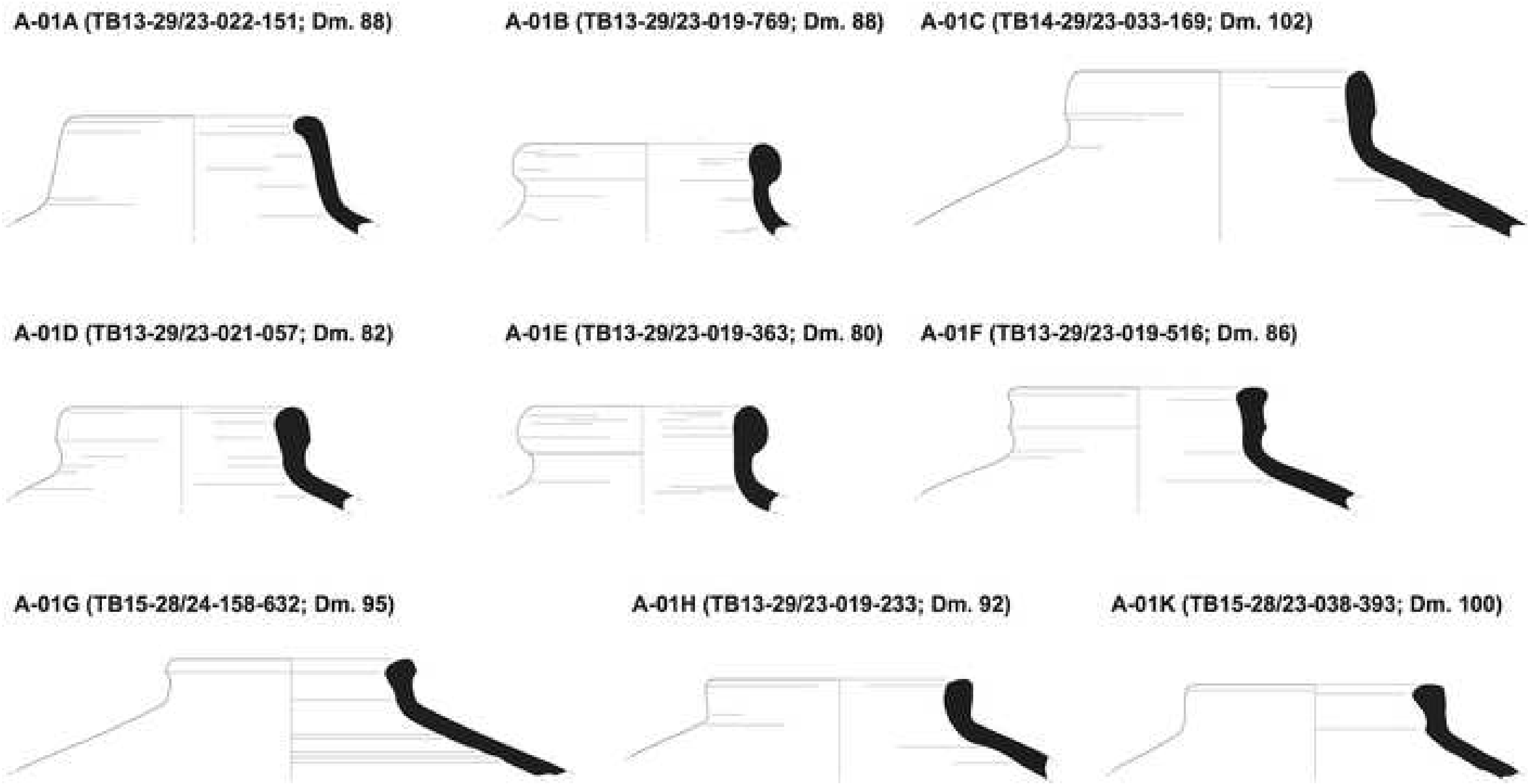

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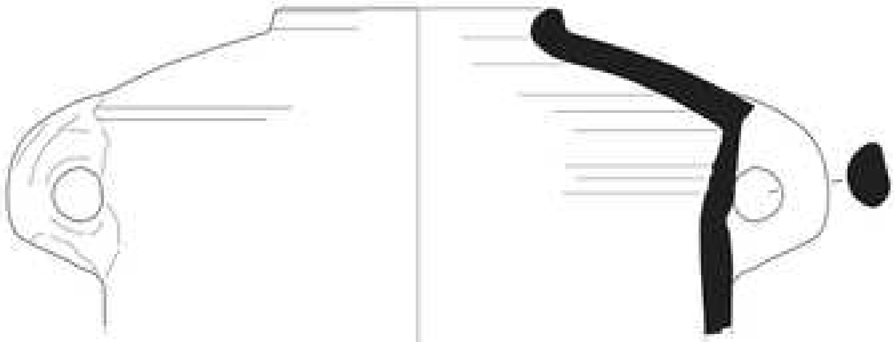

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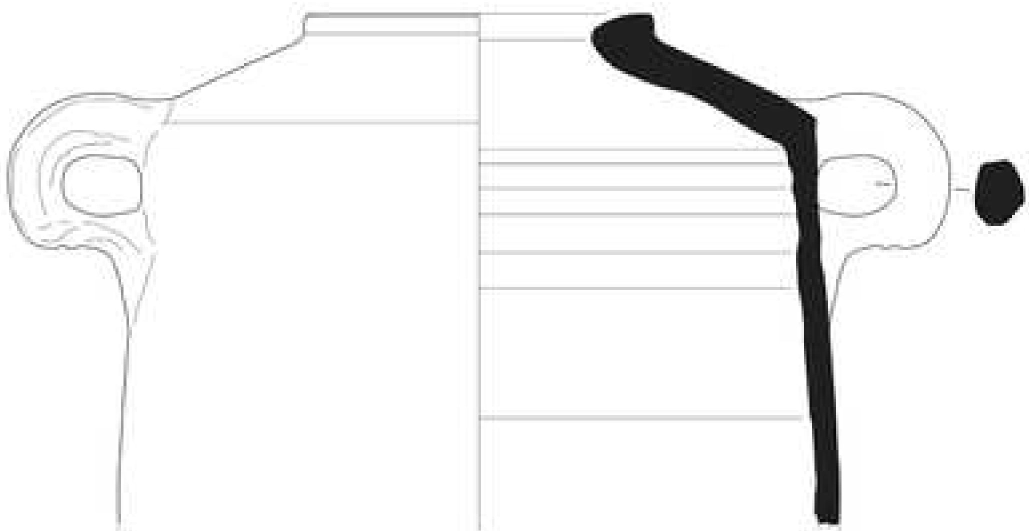
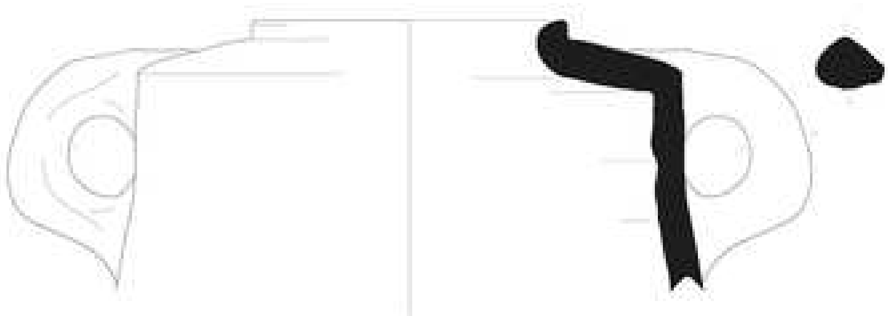


A-02C (TB14-28/24-006-202; Dm. 112)



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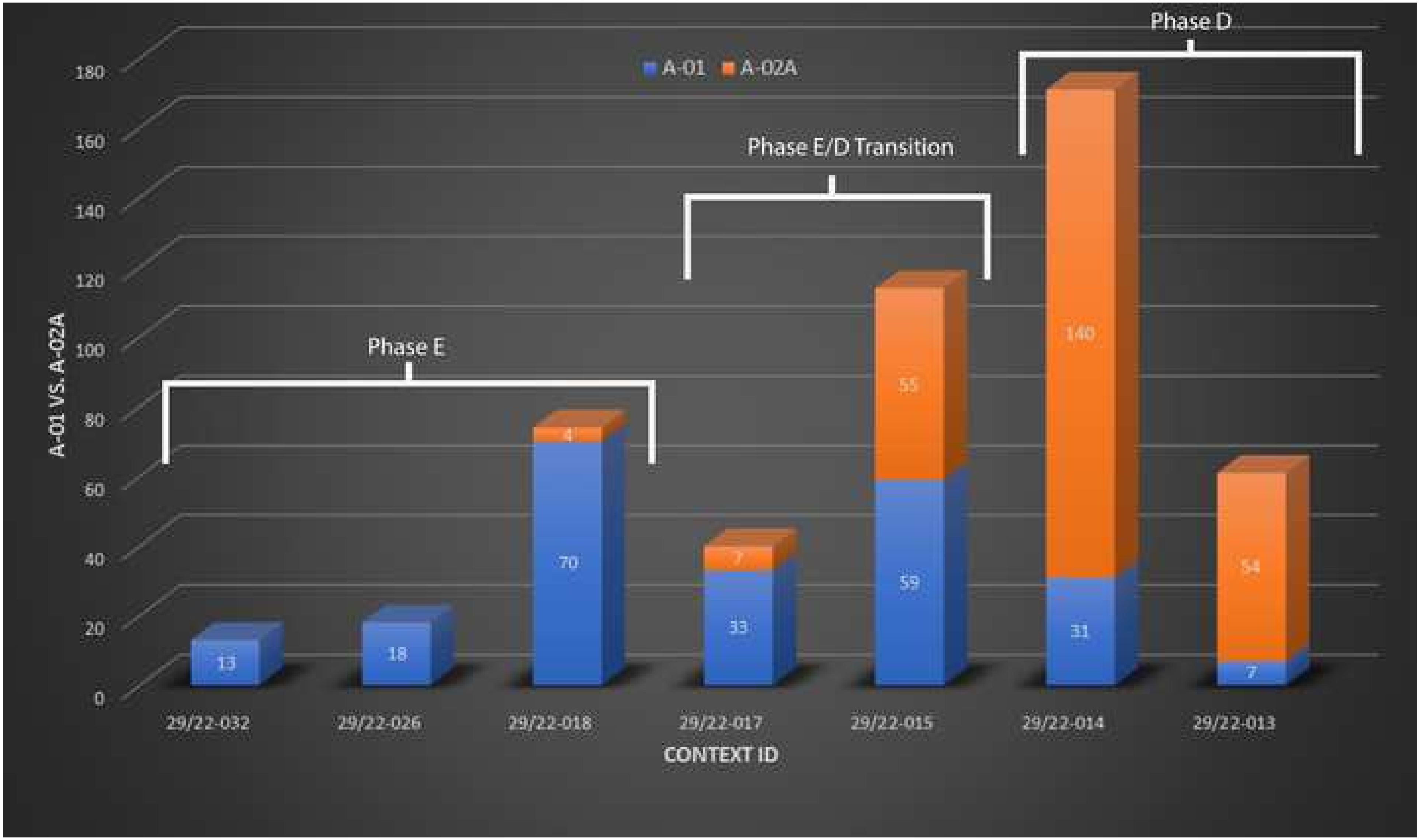
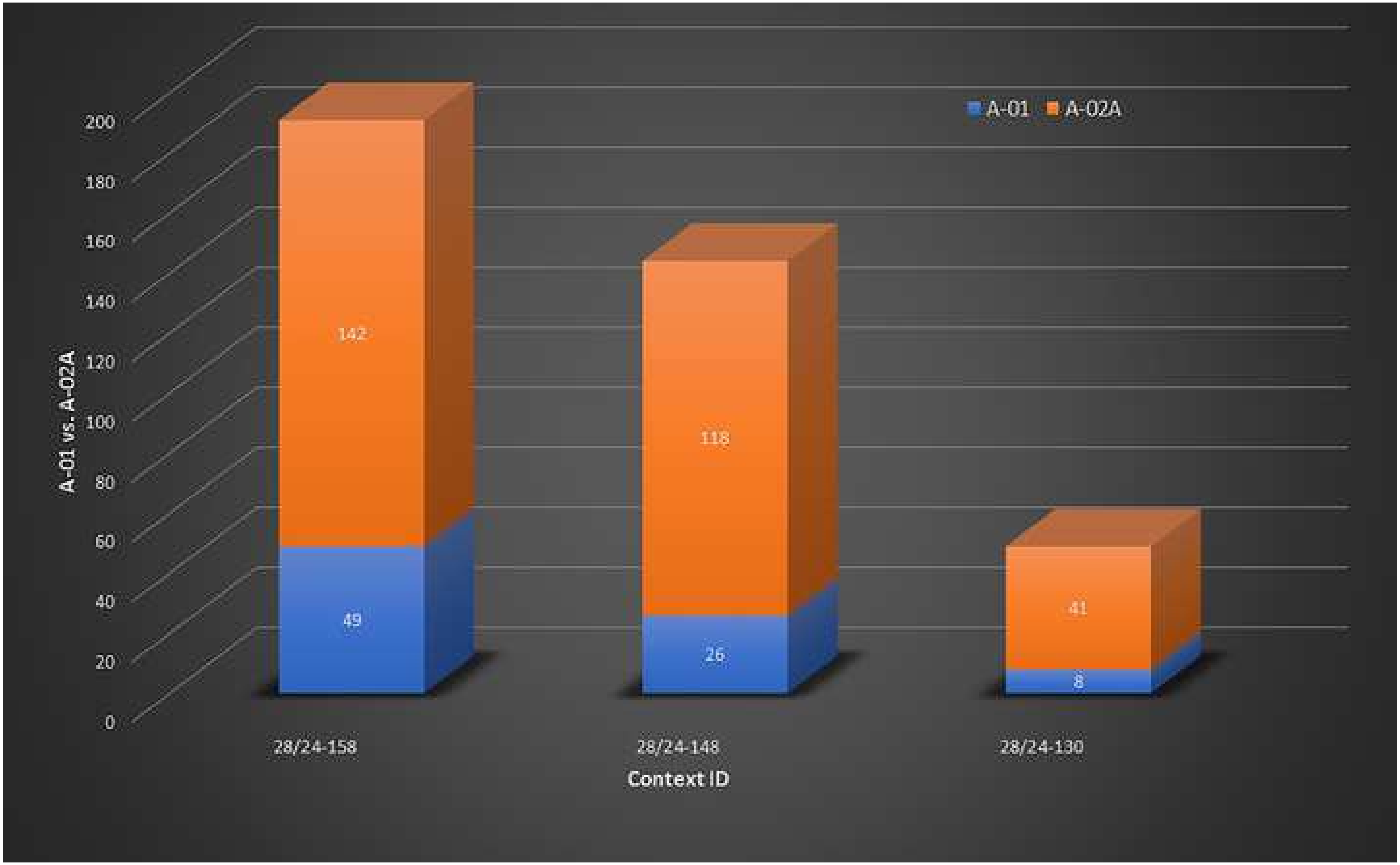
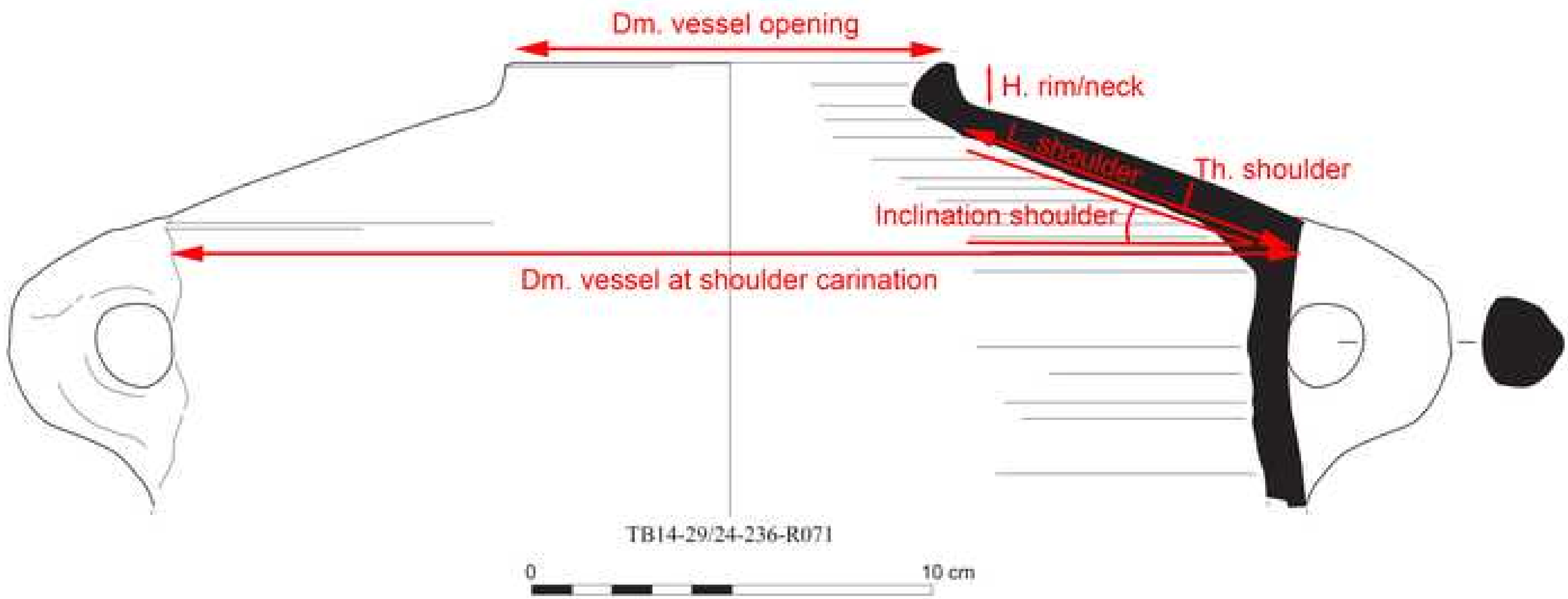




A-01
A-02A
A-01 vs. A-02A
200
180
160
140
120
100
80
60
40
20
0
142
49
118
26
41
8
28/24-158
28/24-148
28/24-130
Context ID

Colour figure (print: author charge applies - please contact the Editor for cost details)

Click here to access/download;Colour figure (print: author charge applies - please contact the Editor for cost details);SchmittFigure07.tif



Non-colour figure

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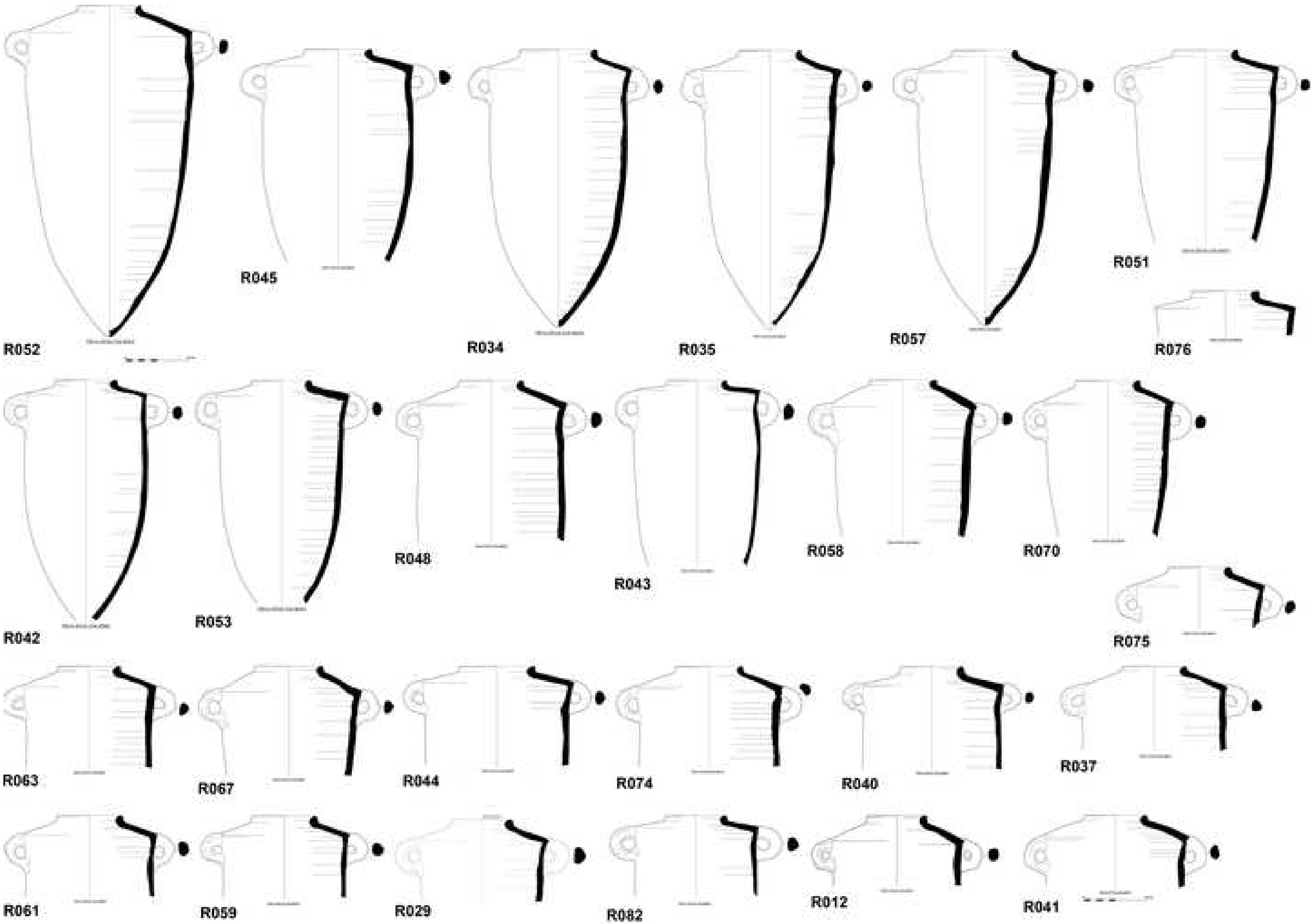
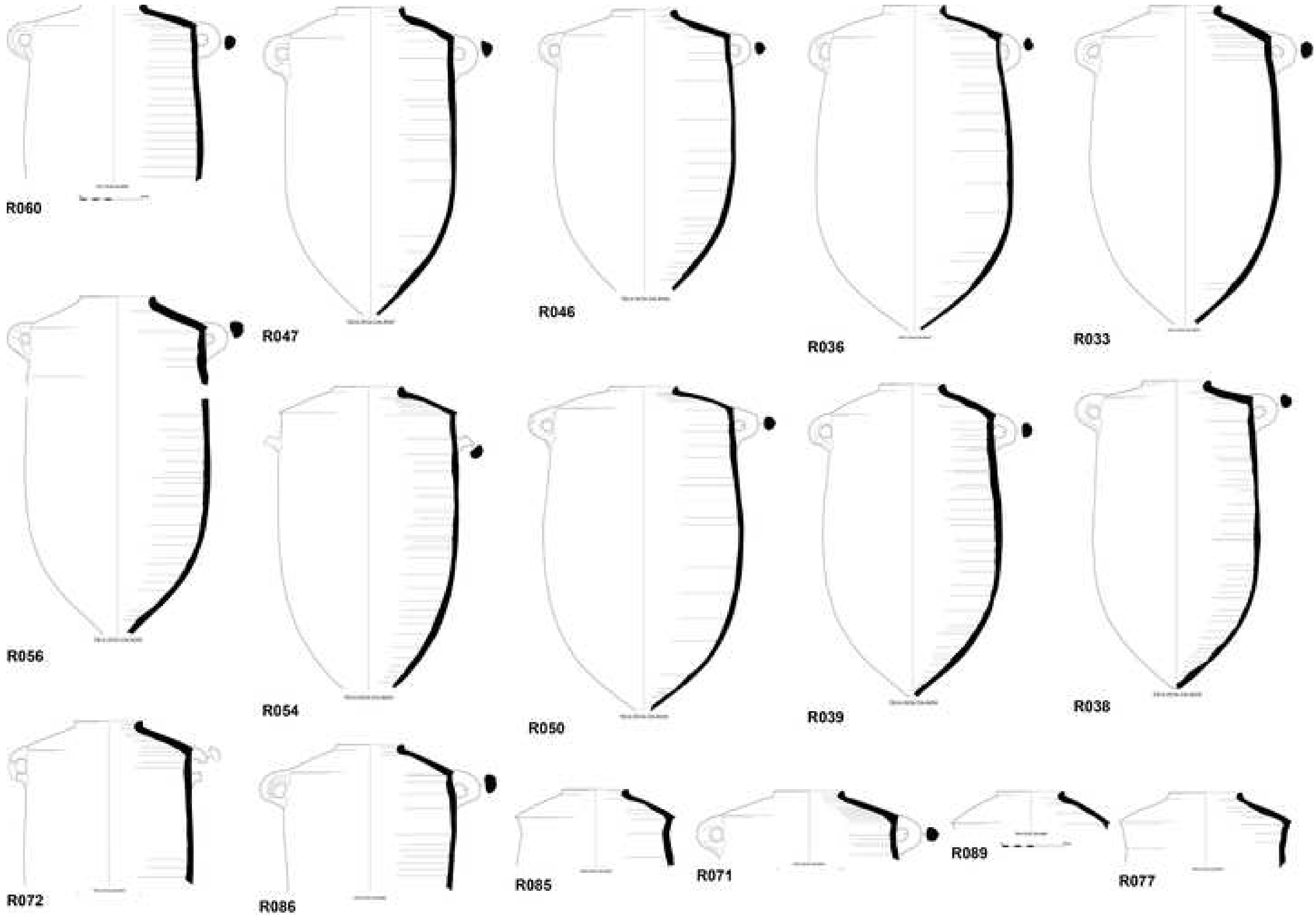
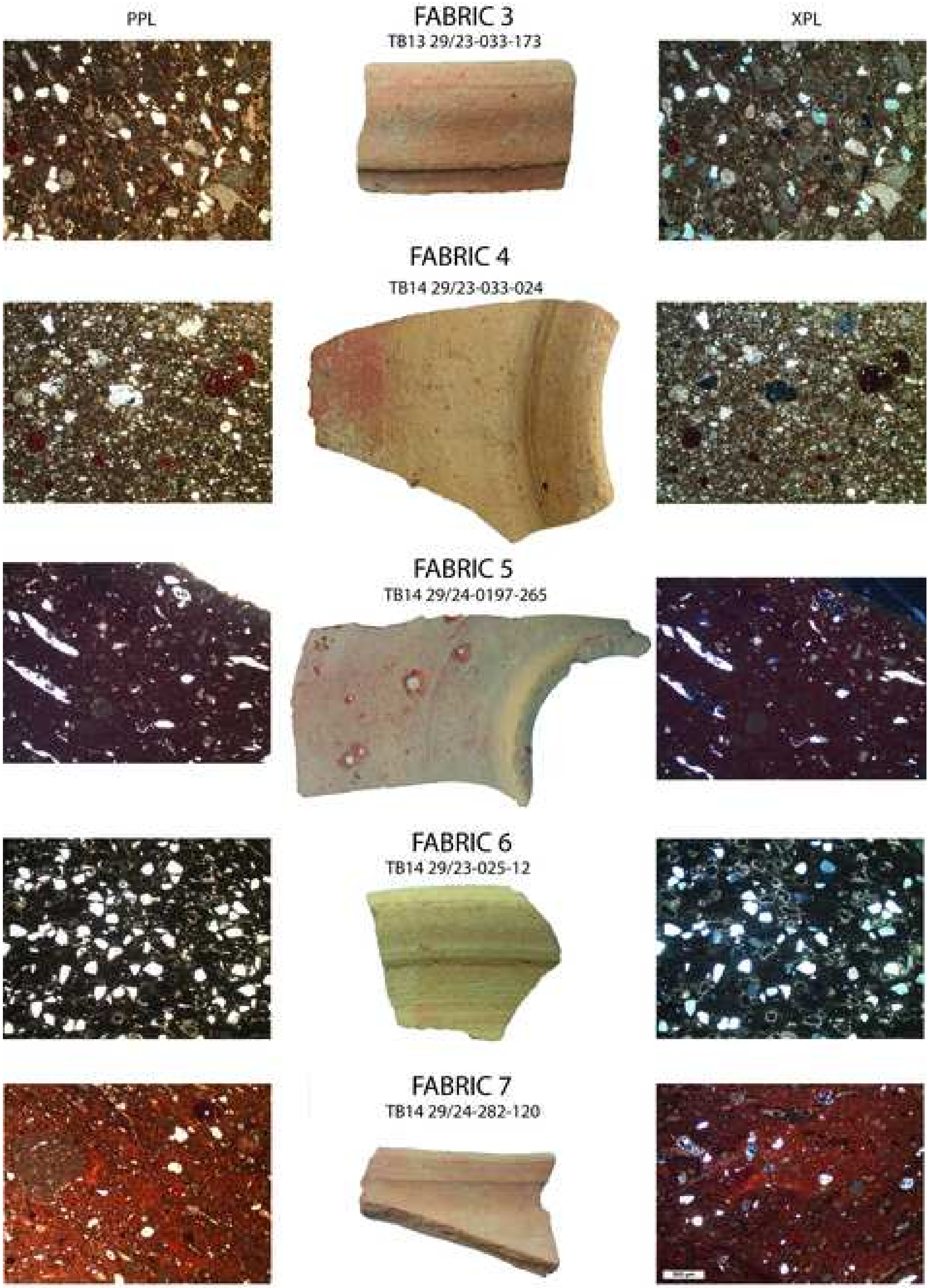



R060
R047
R046
R036
R033
R056
R054
R050
R039
R038
R072
R086
R085
R071
R089
R077


PPL
FABRIC 1A
XPL
TB13 29/23-019-718
FABRIC 1B
TB14 28/24-002-043
FABRIC 1C
TB14 29/23-019-363
FABRIC 2
TB14 29/23-019-1088


PPL
FABRIC 3
TB13 29/23-033-173
XPL
FABRIC 4
TB14 29/23-033-024
FABRIC 5
TB14 29/24-0197-265
FABRIC 6
TB14 29/23-025-12
FABRIC 7
TB14 29/24-282-120

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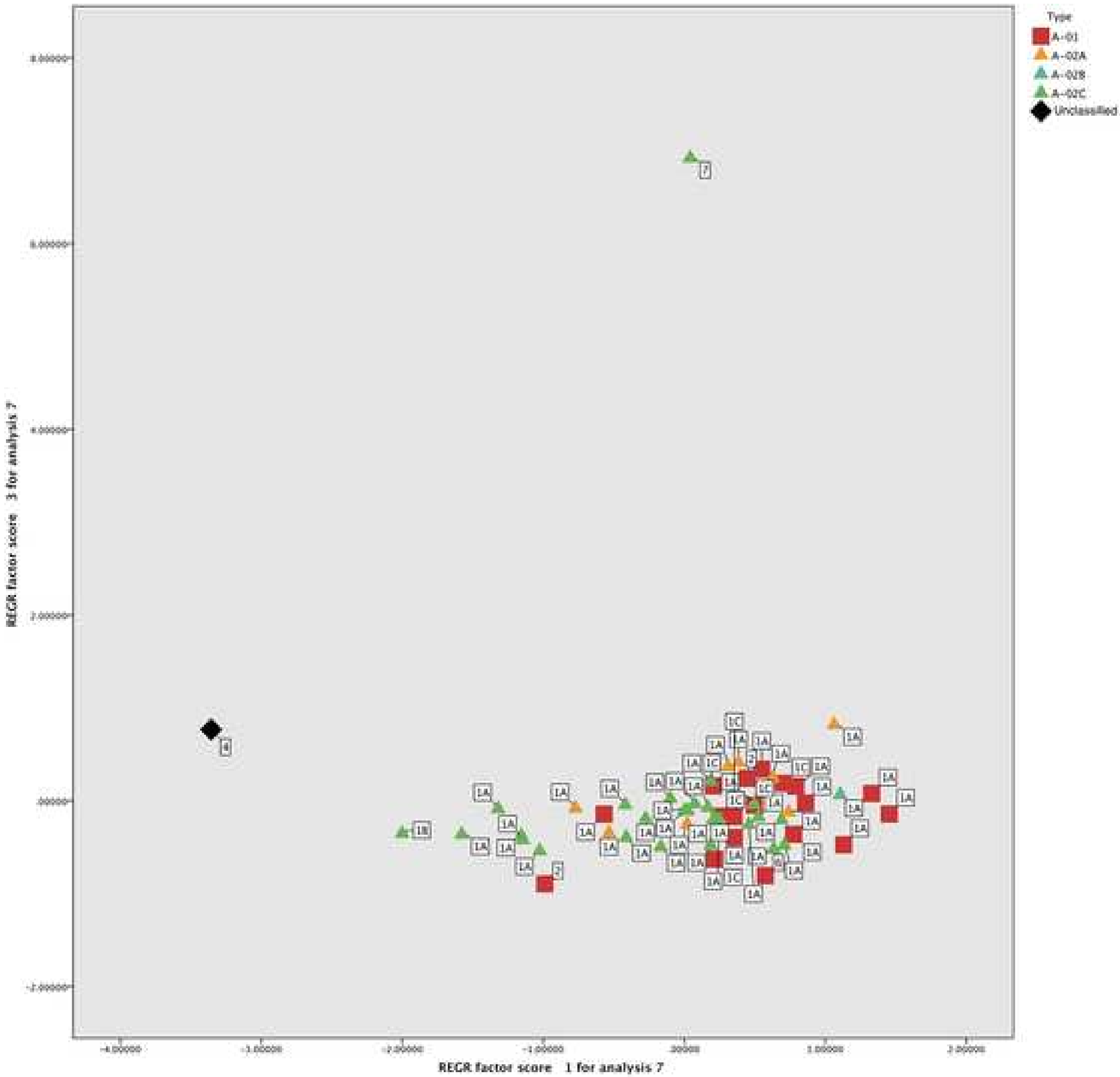

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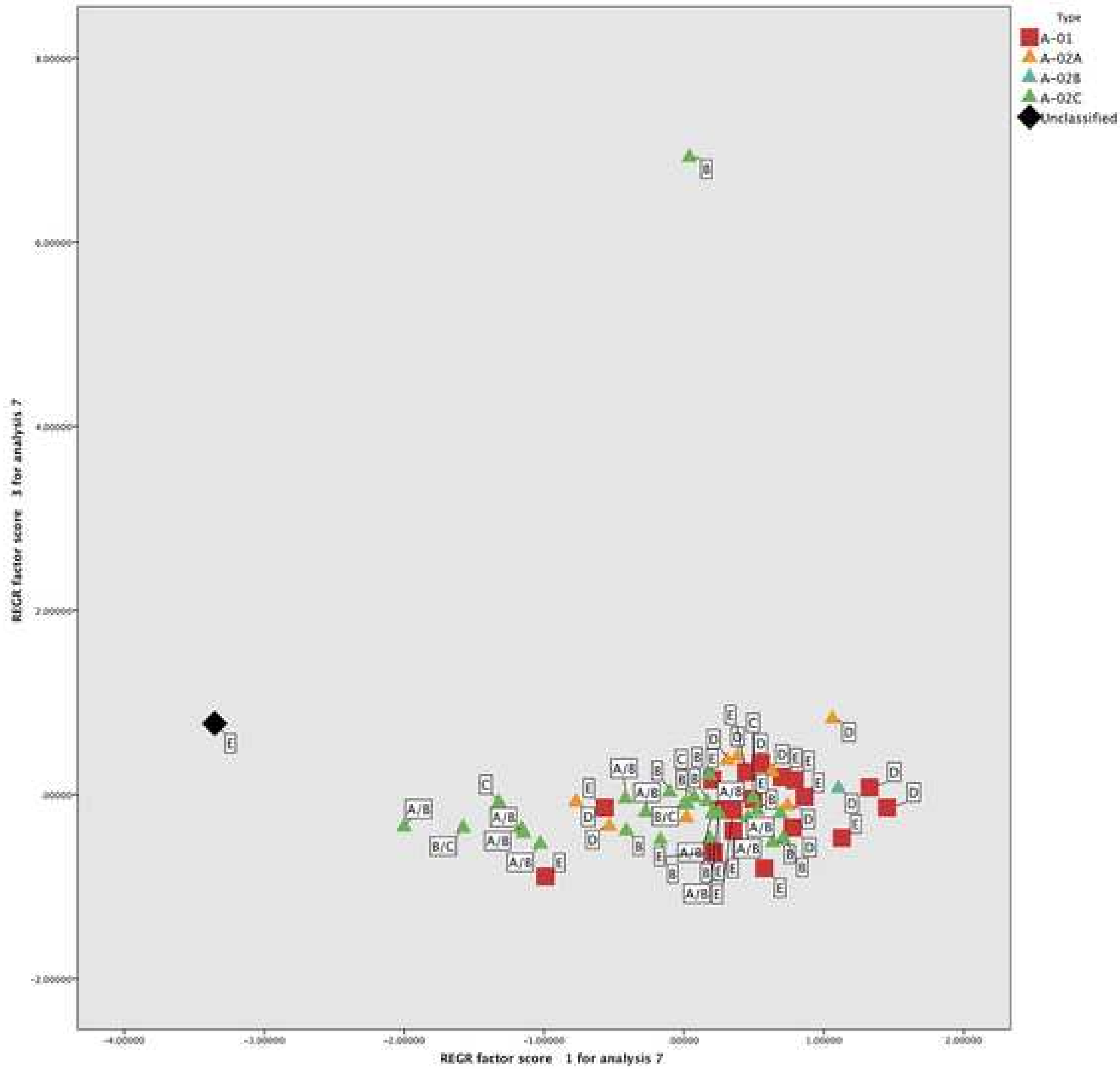
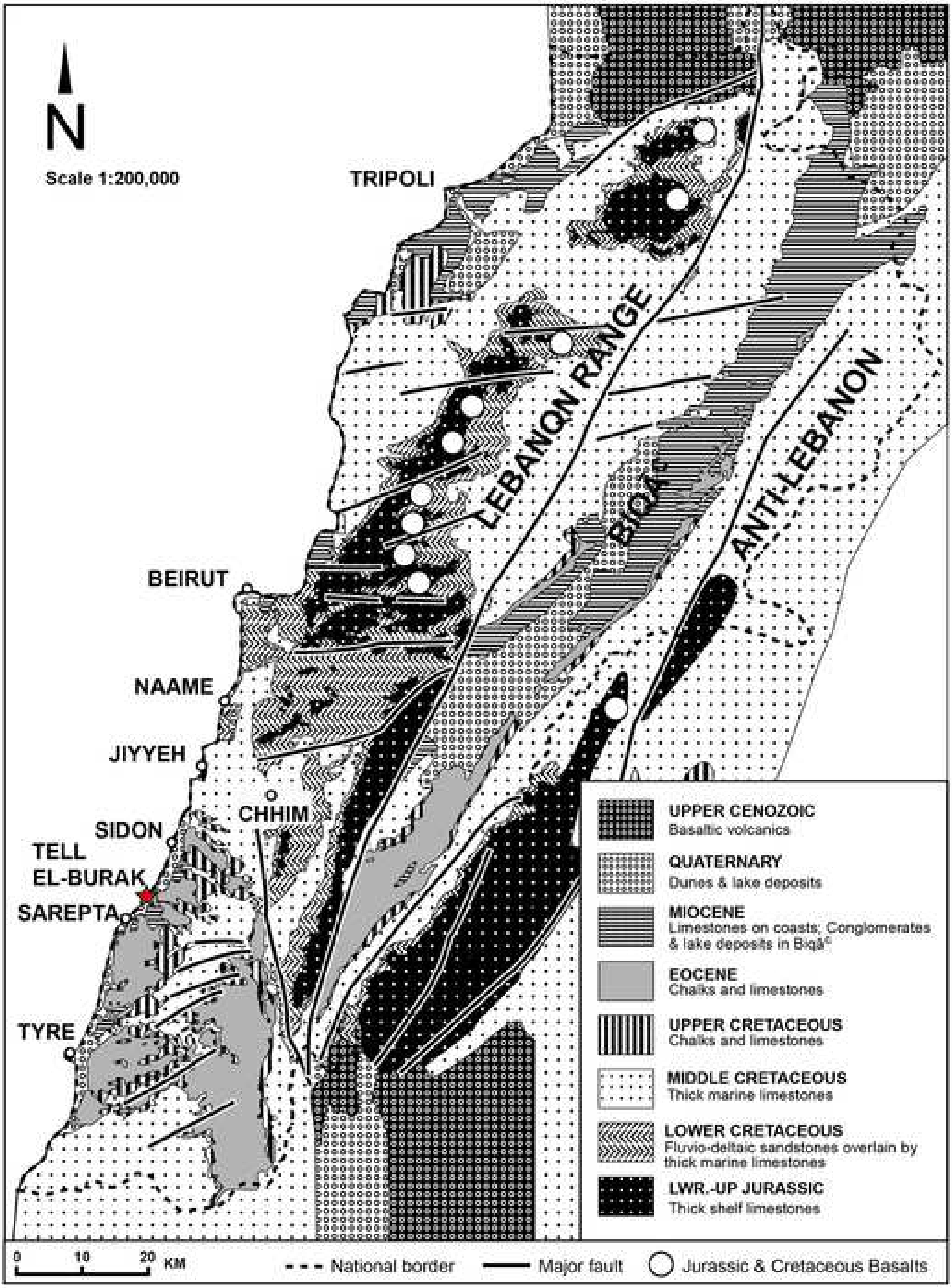
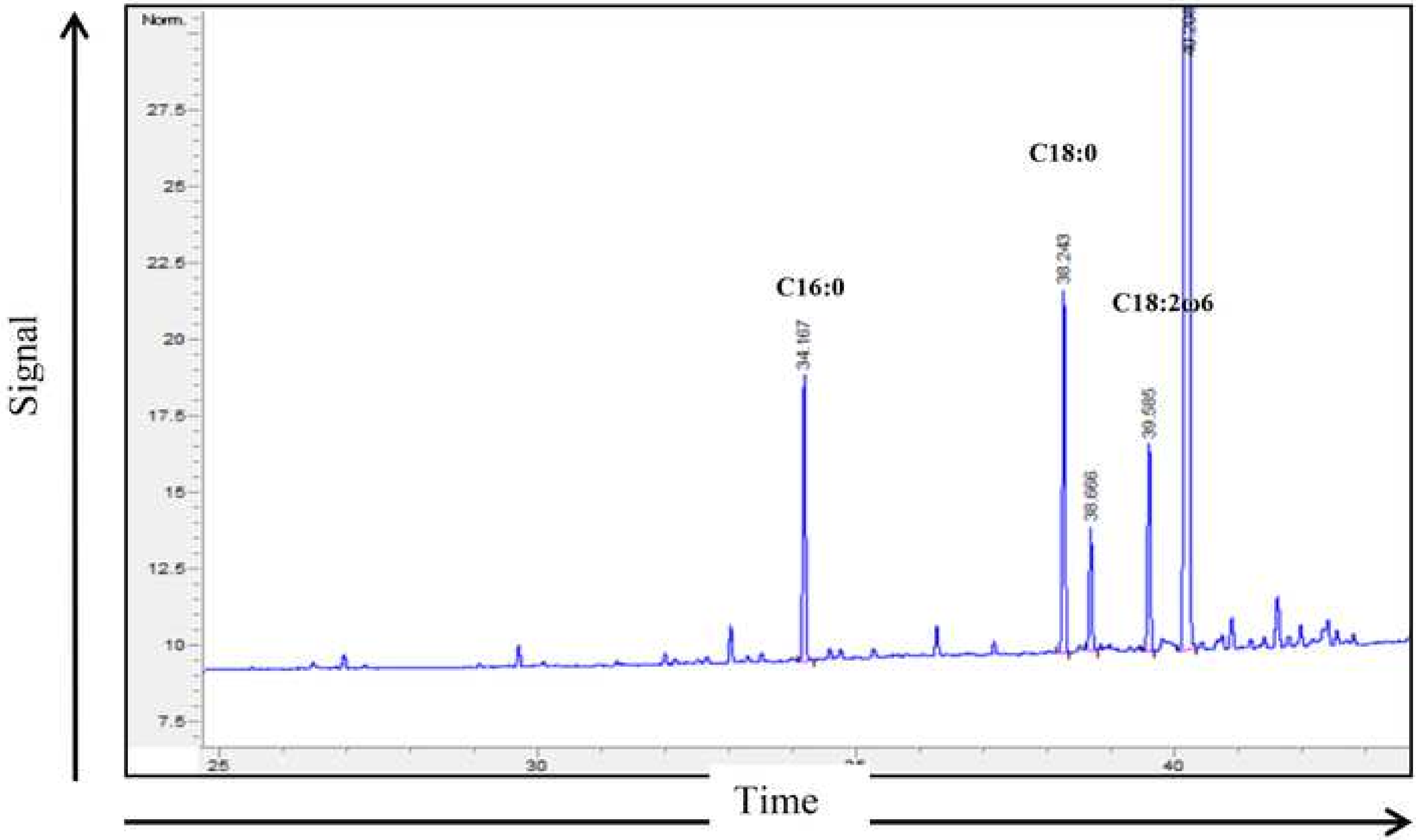


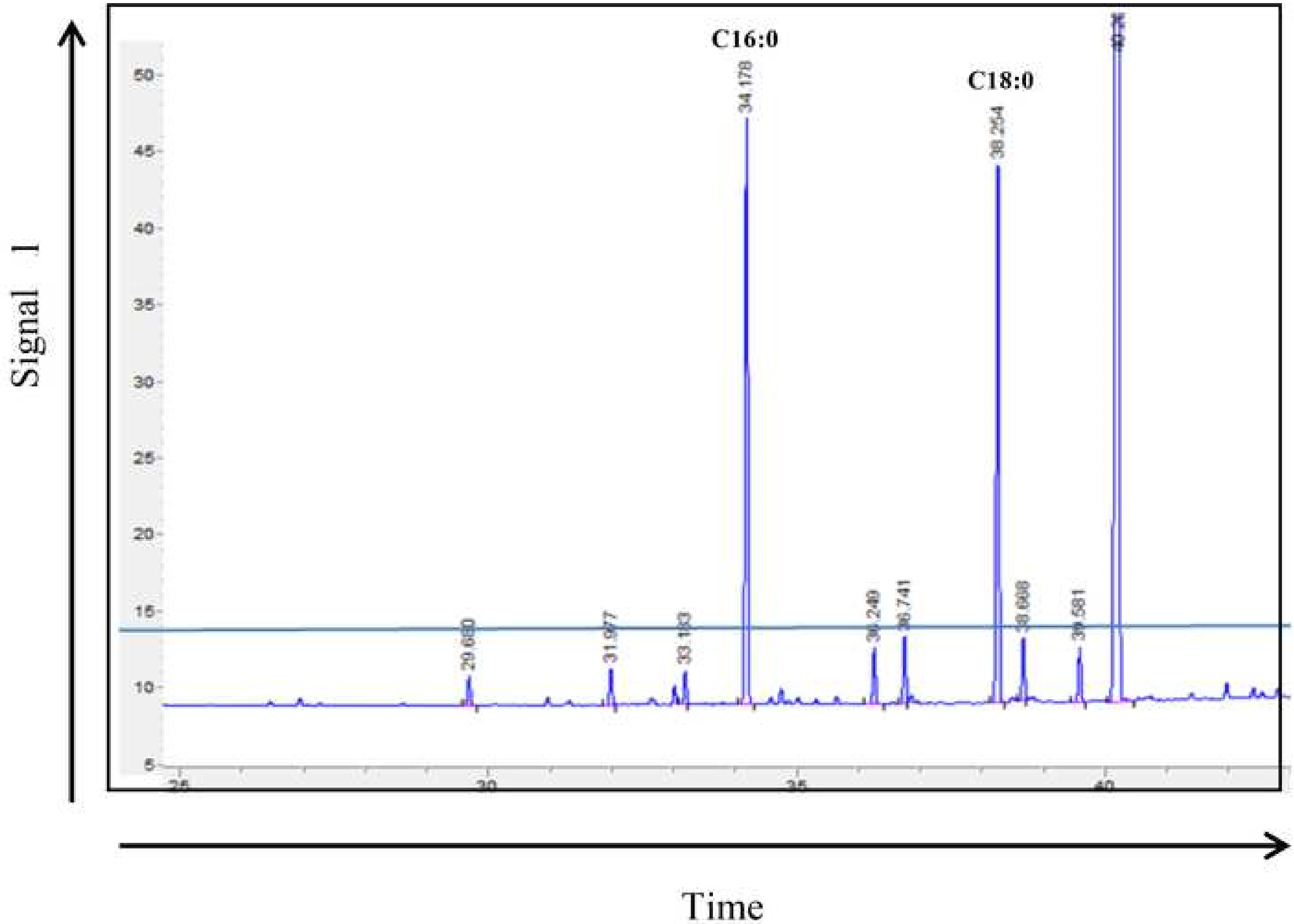
Non-colour figure

Click here to access/download;Non-colour figure;SchmittFigure14.tif




Signal
Norm.
27.5
25
22.5
20
17.5
15
12.5
10
7.5
C16:0
34.167
C18:0
38.243
38.666
C18:2ω6
39.585
25
30
40
Time

Colour figure (print: author charge applies - please contact the Editor for cost details) Click here to access/download;Colour figure (print: author charge applies - please contact the Editor for cost details);SchmittFigure17.tif



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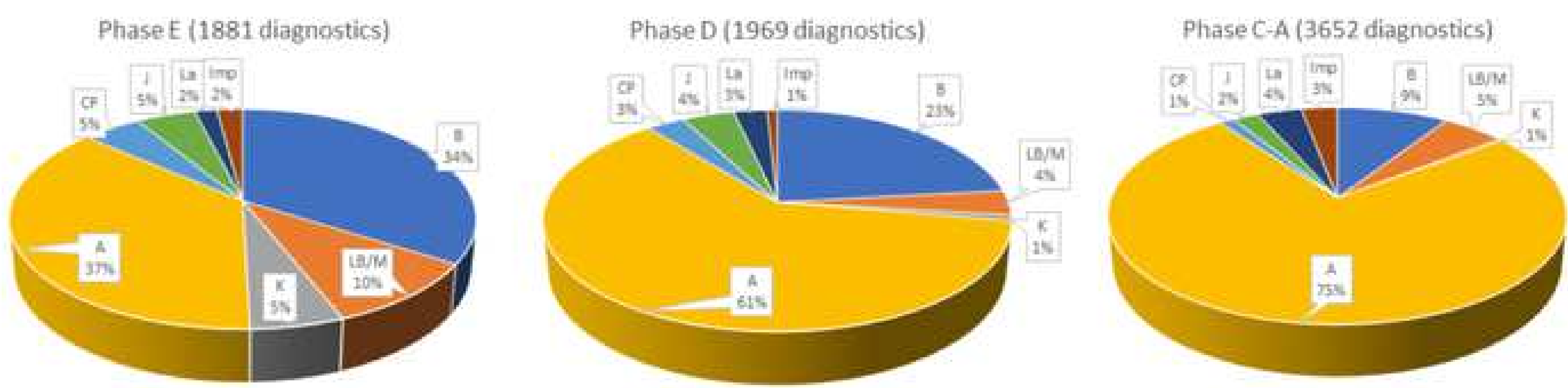

<table>
<tr><th colspan="2">Lehmann 1996 –
Assemblage</th><th>TB Phases</th><th>Sarepta</th><th>Tyre (al-Bass)</th></tr>
<tr><td>until 720</td><td>1</td><td rowspan="4">E
– – – –
D</td><td rowspan="4">(D1)
C2
C1
B</td><td rowspan="4">III (IV)
II–I (V)</td></tr>
<tr><td>720–700</td><td>2</td></tr>
<tr><td>700–650</td><td>3</td></tr>
<tr><td>650–580</td><td>4</td></tr>
<tr><td>580–540</td><td>5</td><td rowspan="4">C
– – – –
B
– – – –
A</td><td rowspan="4">A</td><td rowspan="4"></td></tr>
<tr><td>540–440</td><td>6</td></tr>
<tr><td>440–360</td><td>7</td></tr>
<tr><td>360–330</td><td>8</td></tr>
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