Mediterranean Archaeology and Archaeometry, Vol. 15, No 3,(2015), pp. 259-276

DOI: 10.5281/zenodo.32068

THE PRODUCTION OF CHIOS-STYLE AMPHORAE AT A CERAMIC WORKSHOP IN PHOCAEA (FOÇA)

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Received: 23/03/2015
Accepted: 10/11/2015
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ABSTRACT

The third term of archaeological excavations carried out in the township of Foca, in Izmir province, Turkey revealed what appears to be a pottery workshops and dumping grounds that are capable of illuminating the ceramic industry of the city, the pottery forms produced, and the chronologies of both. The discovery of the Hellenistic Period Ceramic Workshop Sector near the Persian Cemetery Monument is particularly significant because amphora production of the ancient city of Phocaea was previously unknown, even though workshops and pottery dumps ranging from the Archaic to the Byzantine periods have been discovered at various locations throughout the city center. During the 2001 excavation season, two rooms (referred to as "Alpha" and "Beta") and a clay basin lying under the old road to Foça revealed numerous amphorae sherds, some with obvious defects, and a piece of a stamped handle. The amphora sherds and several soil samples were subjected to various archaeometric analyses including petrography, and were thus characterized physically and chemically. The Phocaean Chios amphoras have long and cylindrical neck, long and round-section handles, conical body and a pointed base. This form is suitable for the form of Chios amphoras which were produced in 2nd century BC in terms of their typology. The other vessel types which are found in clay pool of the workshop confirm this date. These convergent forms of evidence suggest that this structure was a pottery workshop producing local Chios-style amphorae alongside quotidian wares. Within the archaeometrical investigations, physical, petrographical and chemical properties of the samples were analysed by basic physical tests, thin section optical microscopy, and PED-XRF methods. The samples were groupped by using thin section analysis in their matrix/agregate feature, type/distiribution/size of aggregate, porosity, clay type and structure. The firing temperature of the samples might be the values between the 800 and 950ºC. The clay type of the samples were mainly illite. Most of the samples had the brick particles in their aggregate content. Both petrographical and chemical properties of the samples gave high competibility not only the each other but also to the local rock formation.

KEYWORDS: Chios, Amphora, Phocaea, Hellenistic, Workshop, Persian, XRF

INTRODUCTION

The third term of the archaeological excavations at Phocaea have been proceeding since 1989 under the direction of Prof. Dr. Ömer Özyiğit in various regions of the city with promising results. Among the important areas uncovered, pottery workshops and their waste dumps have provided much of the evidence for the production of ceramics and the variety of their shapes from the city. Most remarkably, the recent discovery of the Hellenistic Period ceramic workshop near the Persian Cemetery Monument is unique in that it illuminates previously unknown aspects of amphorae production of the city.

Phocaea dominated maritime trade of the Western Mediterranean from the end of the 7th century BC until the Persian invasion in 546 BC (Bosch-Gimpera 1944, 53-54)[1]. Phocaea had fallen under the Persian sovereignty after 546 BC, but, nevertheless they took part in Ionian revolt that occured between 499-494 BC and they been able to send only three ships. This situation does not seem to affect their economical prosperity by judging the continuous mintage of the city (Alexandrapoulou 2011).

After the sea battle of Mycale in 479 BC, Persian sovereignty over the city disappeared. From this date, Phocaea joined the First Athenian League by paying low annual tribute in 478/77 BC and had continued being a member until 412 BC (Alexandrapoulou 2011). Phocaea had fallen under the Spartan control until 394 BC when it was liberated by Athenian Admiral Conon, the victor of the sea battle of Cnidus, which was a joint Athenian and Persian operation against the Spartans. Since 386 BC, after the liberation from the Spartan dominance, Phocaea had fallen under Persian control again with the Antalchidas' Peace (Xenop. Hell., IV, 3; 10-11).

Despite the lack of definite historical evidence, Phocaea was liberated after Alexander's victory at the Granicus River in 334 BC. Building of the theater in the city at this time is a reflection of this situation. After the death of Alexander the Great in 323 BC the kingdom was divided by his generals. During this time, Phocaea's economical conditions declined more and more and it has never risen again to its former welfare.

After the battle of Ipsus in 301 BC, Phocaea has fallen under the Lysimachus' Kingdom. After the death of Lysimachus at Corupedium of Lydia in 281 BC, the city was subjugated by the Seleucid Kingdom. In the Roman war made against the Antiochos III the Seleucid King in 191-190 BC, Phocaea supported the Seleucids. Therefore the Romans made an alliance with the Attalids both on land and sea. Finally, the Romans and their alliance won this war and they seized Phocaea. After the Peace of Apamea in 188 BC, Phocaea was recognized as an independent city under the suzerainty of Pergamon Kingdom. This period was ended by the death of Attalos III in 133 BC. He bequeathed his kingdom to Rome. Immediately after, Aristonicus who was alleged descented of the Attalid Dynasty, rebelled against the Roman Hegemony in 132-129 BC. Phocaea also took part in this rebellion which was stifled by the Romans. With the mediation of Massalia, Phocaea managed to avoid the disastrous retaliation of the Roman Legions (Alexandropoulou 2011).

During the Roman time, Phocaea was a small town just dealing with the ceramic production, but its ports never lost their importance. Unfortunately, we have no archaeological evidence to reveal the historical data mentioned above yet, because the ancient city of Phocaea is lying under the modern town of Foça. We have just an evidence showing the battle that took place during the Persian invasion at the city gate (Özyiğit 1993, 17-21).

The pottery workshop and its refuse dump discussed in this paper have an important place not only for the ceramic production of the city but also for the typology and chronological classification of the ceramic forms of the Hellenistic and Roman periods at large. Despite the fact that Phocaea was an important center of ceramic production, until recently there was little information available regarding Hellenistic amphorae production, which has now been somewhat rectified by the discovery of a ceramic workshop near the Persian Cemetery Monument. Chian amphoras found in the archaic (Okan 2011, 39-66) and classical sectors of Phocaea indicate commercial transactions between the two cities, but the workshop in question demonstrates that this interaction continued until the beginning of the Roman period.

POTTERY WORKSHOP IN PHOCAEA (FOÇA)

Modern restoration and landscape works of the Persian Cemetery Monument on behalf of the Yeni Bagarasi Municipality revealed a workshop structure approximately 110 m north-east of the cemetery (Figs 1 and 2) (Özyiğit 2002, 338). Following the discovery of the building walls during the laying of water pipe next to the old Foca road north of the cemetery, attention was shifted towards this area. As the walls extended beyond the original 5x3 m excavation trench, the size of the excavation area was expanded

[1]Phocaea was the greatest naval power and dominated on maritime trade in Western Mediterranean until 540 BC, but its supremacy of 150 years in Mediterranean was ebolished because Phocaea lost the battle of Alalia which was made on the coast of Corsica towards the naval fleet was established by Carthaginian and Etruscian in 540 BC.fleet was established by Carthaginian and Etruscian in 540 BC.

to 3 x 15 m, but was restricted on the southern end because of the road (Fig 2). The main wall, about 11.30 m long and running east to west, is contiguous to two walls descending steeply south that outline two more rooms. The room on the west was designated as "Alpha Room," and the one on the east as "Beta Room" (Özyiğit 2002, 339). The continuation of all walls under the road indicates that the greater part of the structure remains unexcavated towards the lower end of the cemetery.

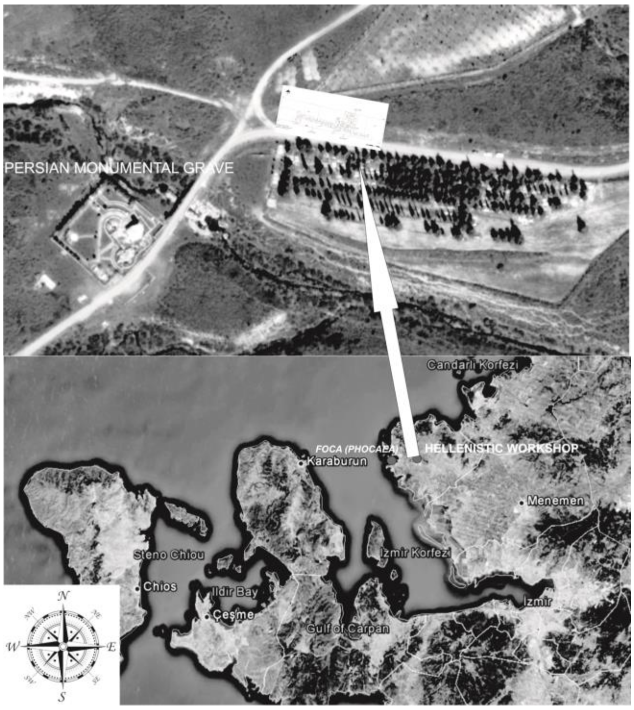

Fig 1. The location of the Hellenistic workshop

Alpha Room

The majority of the room is still under the road, but its visible width measures 4.75 m A scatter of roof tiles uncovered near the floor that continue towards the bottom of the road may indicate that the structure fell out of use due to the collapse of the building (Fig 2).

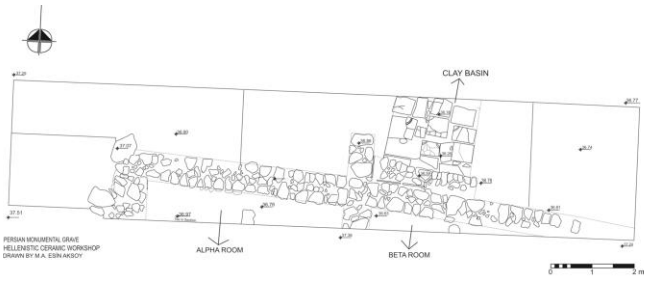

Fig 2. The plan of the Hellenistic workshop

Beta Room

Located on the east side of Alpha Room, presumably of similar dimensions, Beta Room revealed an amphora found buried 40-50 cm in the earth floor adjacent to the wall in the middle of the room (Fig 2).

Clay Basin

Arguably the most telling part of this complex is the clay preparation basin and its contents. This basin, measuring 1.2 x 0.5 m, was dug into the earth and paved with roof tiles (pan tiles) and square floor tiles. It shares its northern wall with the workshop, and the west and south walls are also furnished with pan tiles (Fig 2). The base of the basin slopes about 8 cm in a north-south direction, and the average size of a pan tile is 67 x 55 cm, while the square floor tiles are about 48 cm. The pan tiles which belong to the Hellenistic workshop have two long sides that are perpendicularly rising. One of two narrow sides forms a relief and the other one is bent downwards (Figs 3a-3b). The covering tiles are in the form of gable which is attributed to Corinth and have a thin stage to hold the covering tiles on it. The similar examples of Phocaean tiles were found in an house - *The Rodiakis House* - at Corinth. The scholars who excavated the Rodiakis House stratigraphicly have dated these tiles between the late 3rd century BC and the first half of the 2nd century BC[2] (Σαραντιδης 2009, 552-553).

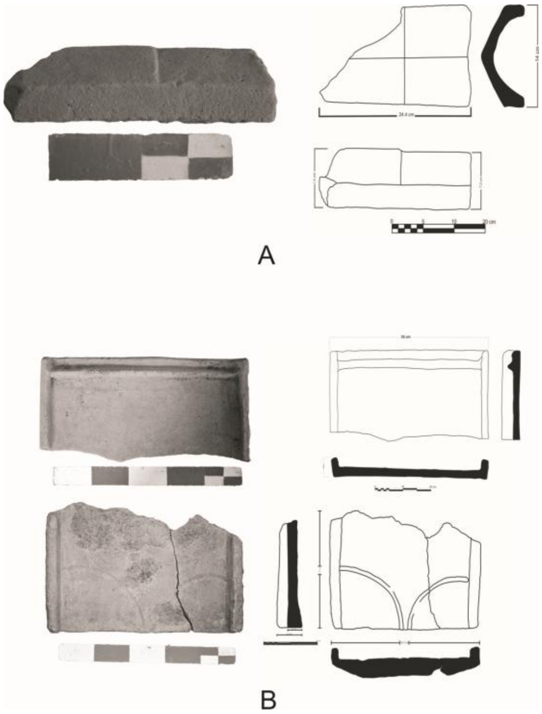

Fig 3. The pan and cover tiles of the workshop

The content of the basin includes numerous pieces of defective pottery and cinder, indicating that it was probably used as a dump for workshop waste at some point late in its life. In addition to amphorae fragments, numerous pieces from bowls and plates were also found. A bronze coin with a female bust

[2] *This date is especially important, it confirms Ozyigit's views which are about to date of the tiles of the workshop to the Middle Hellenistic Period; also see, Ozyigit 2002.*

(Nymphe or Kybele) looking left, opposite a griffin protome has been dated to 300-100 BC[3]. This date is in accordance with the pan tile and floor tile forms, which occur in the Middle Hellenistic period.

DEVELOPMENT OF CHIOS AMPHORAE

The island of Chios, prized for its quality wine in antiquity, began producing amphorae as early as the 7th century BC and continued until around the 1st century BC. During this long period, due to the change of economical conditions, Chios produced different forms of amphoras to avoid losing its economical power in the Mediterranean basin. The appearance of these amphorae throughout that period at various centers in the Mediterranean, Aegean, and Black Seas such as Pergamon, Delos, Athens, and Alexandria, suggests an enduring demand for this product (Alkac 2011, 131).

The earliest form which is produced on the island has distinctive features: cylindrical neck, bobbin shaped body and ring base. It has white and thick coat with painted vertical and horizontal bands. This form had continued until the middle of the 6th century BC. After this time, Chios produced a brand new form with bulbous neck which was shown on didrachm and tetrobol coinages with a Sphinx as a symbol of the city (Mattingly 1981, Pl. 1b). The third quarter of the 5th century BC was a period of changing economical situations. In any event the evolution of the Chios amphoras from bulbous-necked to straight-necked can now be given with some confidence in the late 430's BC (Mattingly 1981, Pl. 1a). This form was predecessor of the canonical amphorae with long straight necked and tapering body which were produced at the beginning of the 4th century BC (Monsieur 1990, 237-238.).

At the beginning of 4th century BC, Chian producers replaced the characteristic swollen-neck configuration of their amphorae with a straight neck. This new form had an outward turned, high rim, a long, cylindrical neck with long, oval-sectioned handles, and a triangular body with a distinctly cone-shaped foot. The production of this form persisted with only minor changes until the 1st century BC (Fig 4). The use of this new form by wine producers of Chios, instead of imitating the amphorae of such cities as Cnidus and Rhodes, both of which produced superior wine, is regarded as a reflection of their confidence in their own production (Şenol 2007, 105; Lawall 2002, 203, Figure 2). While the widest part of the conical-bodied amphora with hollow base that appeared in the 4th century BC was located about midway along the jar's height, by the 3rd century BC the lower part of the body became more elongated (Empereur-Hesnard 1987, 22; Senol 2007, 105.). This asymmetrical form continued in use until the beginning of 3rd century BC when the foot became more narrow and extended.

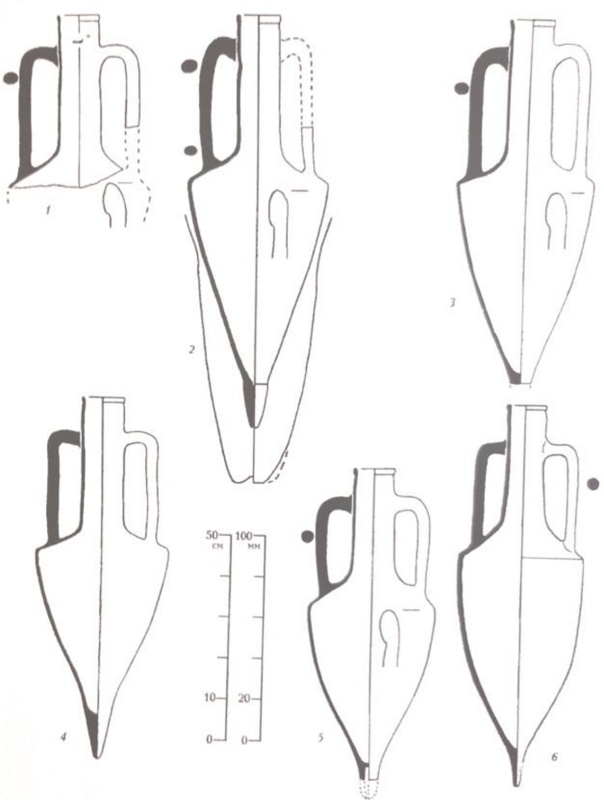

Fig 4. The development of the Chios style amphoras through the Hellenistic period (Monakhov 2003, 243, Tab. 13.)

The interior of the foot remained hollow until the middle of the 3rd century BC, but the rims became thinner compared with the 4th century style. The handles were made in a round in profile from the 4th century BC to the mid-3rd, at which point they evolved into a carinated in profile (Grace 1979, Figure 46-47). During the war between Antiochus III, the King of Seleucia, and the Romans at the beginning of 2nd century BC, Chios hosted the Roman Navy at its home port. At the conclusion of the conflict, which ended with the peace agreement of Apameia/ Kibotos in 188 BC, Chios, enjoying the benefits of being a free city in alliance with the Romans, reclaimed its territories in Asia Minor and was exempt from taxation (Lagos 1998, 32-33). This in turn led to an accelerated wine and amphora production. The Chian amphorae produced during this period have narrower and rounder rims with smaller diameters; the necks became cylindrical and elongated, while

[3] *This coin has not yet been published. Phocaea coins with Hermes or a woman's head on one side and griffin on the other are usually dated to 300-100 BC; see www.forumancientcoins.com/gallery/displayimage.php?album=2599&pos=28; www.numismatics.org/search/results?q=department_facet%3A%22Greek%22%20AND%20region_facet%3A%22Ionia%22AND%20Phocaea&start=40.*

the handles became round in section and carinated in profile. Starting from the middle of the century, the handles became more truncated and their upper ends were attached between the rim and the midpoint of the neck (Şenol 2007, 107). During the same century, as the form of the 4th-century jar begins to lose its sharpness, its hollow and conical base with a delineated toe transforms into a solid, thin, and pointed shape that forms an extension of the body.

During the 1st century BC, Chios allied with Mithridates VI, the King of Pontos, and was severely punished by Rome for being on the losing side, which led to a decline in amphorae and wine production on the island. Why Chios sided against the Romans is not known, but one view is that the island's inhabitants became agitated by the increased number of Romans claiming the financial resources of the island after the war against Antiochus III (Lagos 1998, 36-38.).

At the beginning of the Hellenistic Period, even though wealthy cities such as Pergamon, Delos, Athens, and Alexandria had preferred Chian wine previously, the extremely limited quantity or complete absence of Chian amphorae in the strata in these cities dated after the middle of 1st century BC corroborates the dwindling Chian wine economy (Alkaç 2011, 131). However, even though the production was interrupted, Chios continued to issue coins with amphorae as a symbol of the city in the 1st century BC (Grace 1979, Figure 51).

By the 1st century BC, Chian amphorae had a very particular form that can be dated precisely using two important contexts. One of these is provided by a stratum dated to 86 BC in the Agora of Athens (Grace 1979, Figure 36, 47), and the other by the La Tradelière Shipwreck of the 1st century BC found off Cannes, France (Fiori-Joncheray 1975, 61). The Chian amphorae recovered in both contexts are very similar to each other in terms of form and dimensions; the short handle extending from the neck; smooth, straight transition from the upper body to the lower body; and a solid, thin, conical foot comprise unmistakable characteristics of this style. These finds indicate that Chios continued its amphora production until the beginning of Augustus' reign; further evidence of continued production comes from a limited number of late Chian amphorae discovered at Lyon and St. Romaine en Gal settlements of France (Lemaître 2002, 217). Moreover, the inland provenance of these Rhone Valley amphorae has implications for changing trade routes (Senol et al. 2009, 112).

Phocaea Production of Chios-Style Amphorae

During the late stage of production in the workshop, the clay basin, originally for levigating and preparing the clay for pottery production, was used to discard large quantities of pottery. Excavators found nearly 250 amphorae fragments within the basin that clearly demonstrate the nature of the Chios-style amphora produced in Phocaea.

From the pieces recovered in the clay basin of the workshop so far, it is deduced that the amphorae produced in this complex have rounded outward-rolled rims, and a long and cylindrical neck that bulges outward slightly just below the rim (Fig 5).

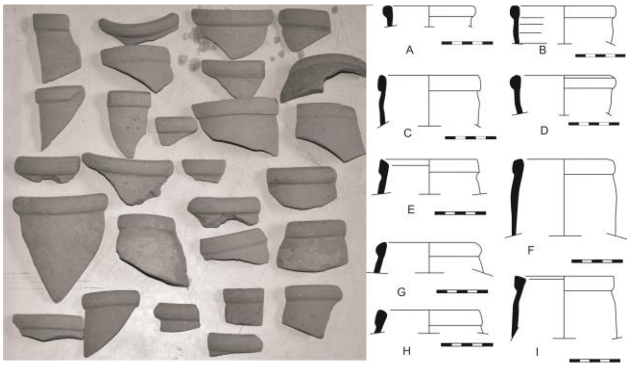

Fig 5. Amphora rim and neck fragments found in clay basin of the workshop

Based on the handle and upper-neck fragments recovered from the clay basin, the handles were not attached near the rim but between the rim and midpoint of the neck, more like the examples produced at the beginning of the 2nd century BC, and protrude upward slightly before turning in a tight angle toward the shoulder (Fig 6).

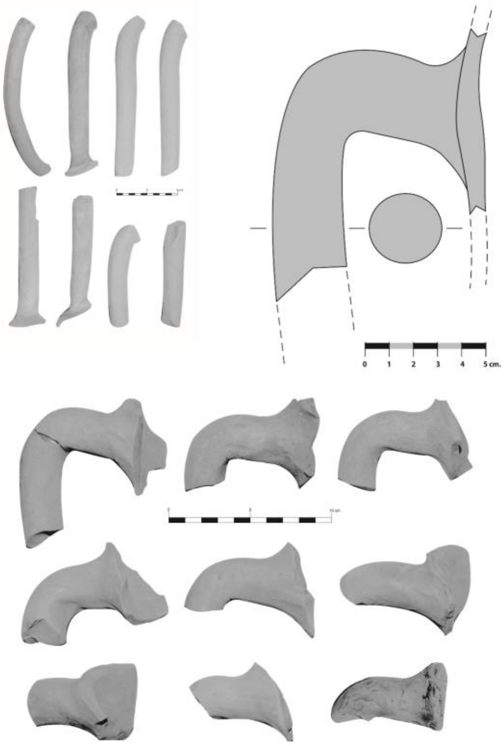

Fig 6. Phocaean handle samples found in clay basin

All handles are round in cross-section (Fig 6), a feature that occurs from the beginning of 2nd century BC (Şenol 2007, 107). Most of the upper body sherds belong to the shoulder junction of the amphora, and their form suggests that Phocaean-Chian amphorae had lost the sharpness of the 4th century BC form and attained a slight ovoid shape (Fig 7).

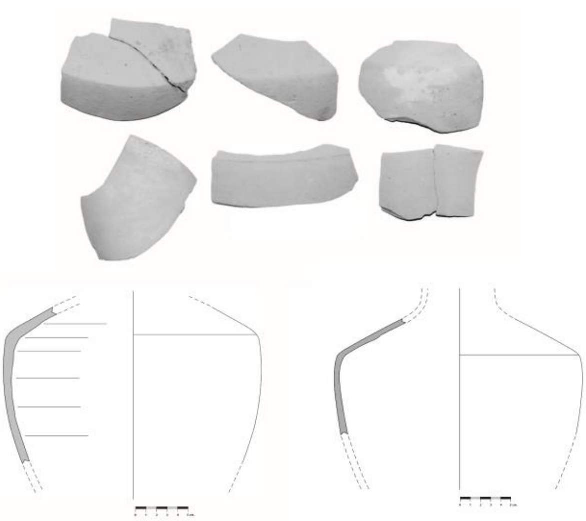

Fig 7. Shoulder fragments and drawings of the Phocaean amphoras

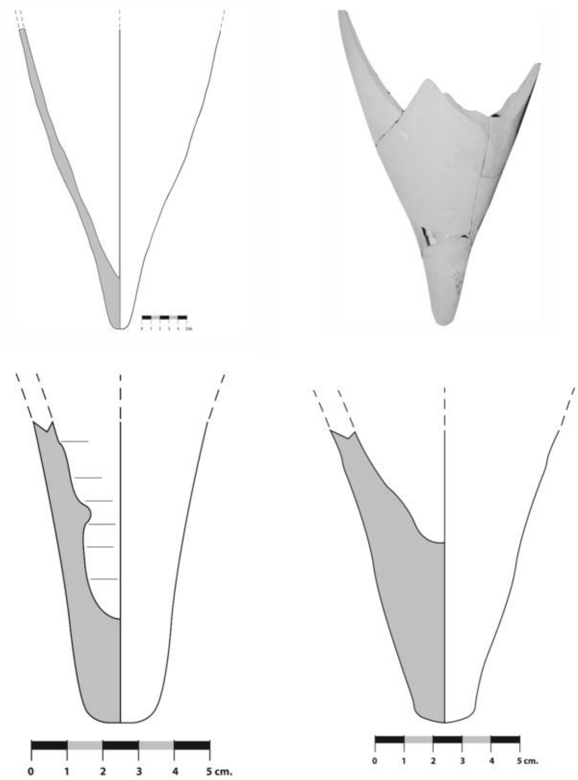

Fig 8. The lower parts of the Phocaean body

Although minimal in number, some mid-body sherds were also found, that suggest a smooth transition from neck to shoulder, but a sharp one from shoulder to body. The base sherds indicate that the foot took one of two forms, either tall and thin, or squat (Fig 8). The transition from the hollow to a solid foot is known to occur in the middle of the 3rd century BC, as outlined above, and by the beginning of 2nd century BC, the base cavity is completely filled and the toe assumes a pointed shape (Şenol 2007, 106-107). Therefore, the Phocaea samples with sharp, solid, and thin conical bases must have been produced between the end of 3rd and the beginning of 2nd century BC.

Other Vessel Types Found in the Clay Basin in the Hellenistic Workshop

Besides amphoras, many different vessel types were uncovered from the clay basin of the Hellenistic pottery workshop at Phocaea. These vessels help us to date the workshop as well as showing its production potential. The form of the vessels found in the basin are as follows:

Chytrae

In the Hellenistic Period, especially in the Roman Period, the Chytrae were one of the most commonly used kitchen wares. The Chytrae that are similar to the modern stewpots usually have globular bodies, and, in the meanwhile it has been used for a long time in the Ancient Greek World (Rotroff 2006, 165). As chytrae is produced in many different forms, it is difficult to provide a satisfactory classification scheme. The chytrae found in the Athenian Agora were divided into four groups by Rotroff according to their characteristics (Rotroff 2006). These groups are:

Form 1- one handled, lipless
Form 2/3- one and ornamented handle
Form 5/6- double handles, with lip.
Form 10- Double handled, lipless.

When we examine the chytra examples found in the clay basin of the workshop at Phocaea, we can say that the single and double handled examples were produced together. The cythra form in Fig 9a is attributed to the Rotroff's Form1. In Fig 9a, a part of its handle can be seen. A similar example found in the Athenian Agora G 5:3 deposit was dated between 170-130 BC (Rotroff 2006, Figure 72, pl. 61).

The other ctyhra in Fig 9b is attributed to the Rotroff's form 10 due to the large rim diameter (19.2 cm). Some of the similar examples were found in the contexts in Athenian Agora dated between 200-150 BC(Rotroff 2006, Cat. Nr. 626-627, Figure 80, pl. 66; cat. Nr. 628-629, Figure 81, pl. 67.). Fig 9c is a further example that could be included in Form 10. It dates between 160-130 BC according to a similar example found in the Athenian Agora H 16:4 (Group D) deposit.

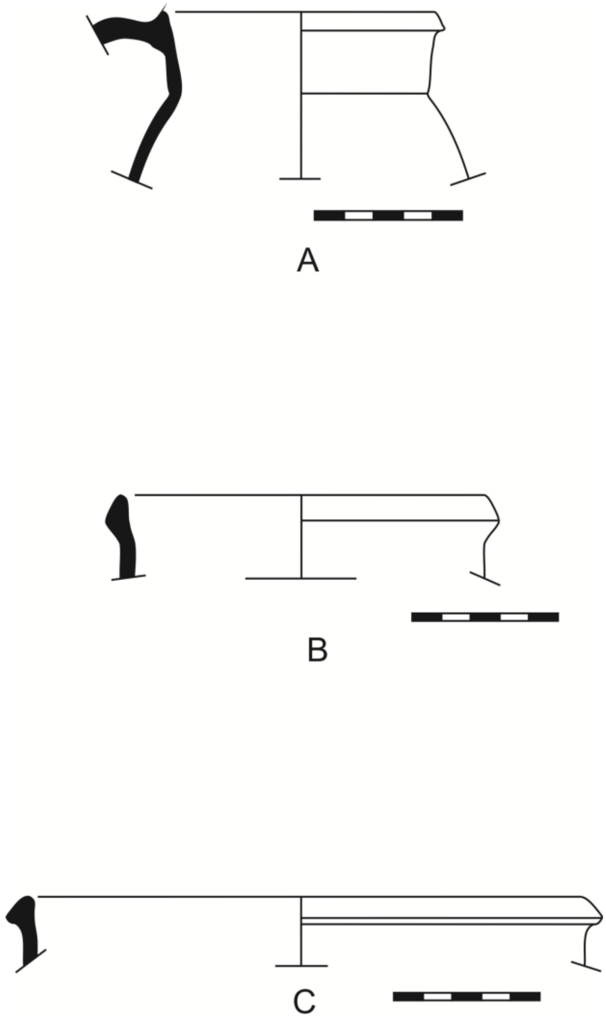

Fig 9. Chytrai forms that are found with amphora from the clay basin

Lopades

The lopades that are shallow version of the Chytrae were produced from second half of the 5th century BC (Sparkes-Talcott 1970, 227). Lopades were more commonly used than the chytrae in the Hellenistic Period (Rotroff 2006, 179.). The lopades that are uncovered in the Athenian Agora were divided into 5 forms by Rotroff (Rotroff 2006, 178-186). These forms are:

Form 1- Upturned handles-rounded bottom
Form 2- Upturned handles-flat bottom
Form 3- Engaged handles-flat bottom
Form 4- Straight sided-two handles
Form 5- Straight-sided, no handles

In the clay basin at Phocaea, a single sample with a solid profile should have belong to the Form 5 of Athenian Agora due to the similarity in their forms (Fig 10). On the other hand, Form 4 contains the handled examples, but there is no trace about handles on Fig 10, so that, Fig 10 will be appropriate to Form 5. This group was dated between 150-110 BCE with the help of the contexts in the Athenian Agora (Rotroff 2006, 669-671, Figure 85, pl. 69). But, the Phocaean example, when compared with the other vessel types in terms of their dates, must not be later than 150 BC.

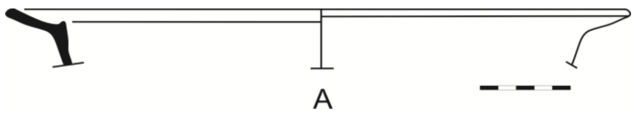

Fig 10. Lopas form which is found with amphora sherds in clay basin

Echinus Bowls

The name of this type comes from the echinus part of the Doric capitals (Edwards 1975, 29). Rim diameters of such a vessel ranging from 10 cm to 28 cm and it stands on a ring base with a shallow hollow. Echinus bowl samples are found in the basin at Phocaea have the same profile but a different diameter (Fig 11). The similar examples that are found in Corinth (Edwards 1975, 17-18) and Metropolis (Gürler 2003, 14-15, pl. XIV.) are dated between first half of the second century BC. But Phocaean echinus bowls must be dated to the second half of the 2nd century BC due to their context.

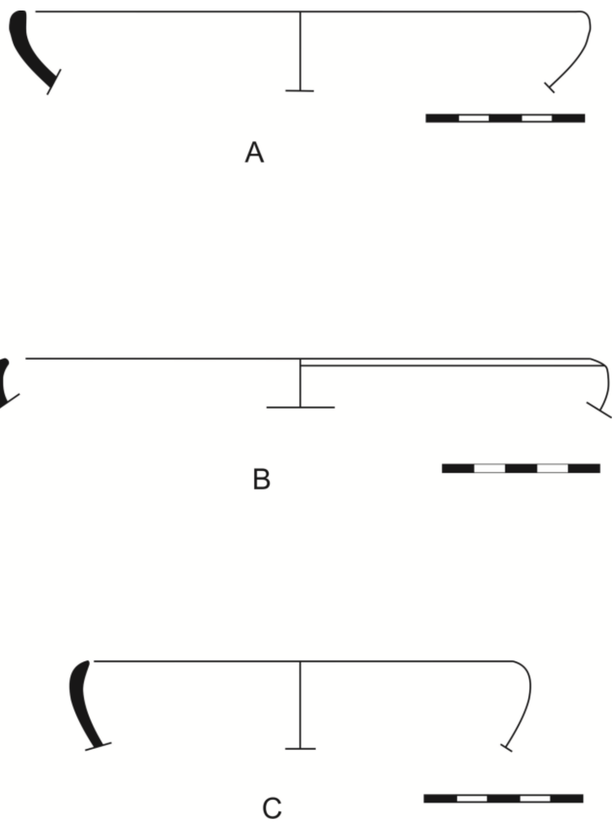

Fig 11. Echinus bowls that are found with amphora sherds in clay basin

MATERIAL CHARACTERISTICS OF THE AMPHORAE

Archaeometric analyses of the fabric of these amphorae, provides additional important information about the raw material sources, types of production, the firing technologies, and workshop characteristics (Akyol et al. 2013 (a), 251-269; Akyol et al. 2013 (b), 163-177; Akyol et al. 2007, 99-114; Aygün et al. 2010, 411-429; Demirci et al. 1999, 141-148; Tekkök et al. 2009, 101-121.). Distinctive local or regional qualities of individual ceramic workshops arise from a variety of processes from the procurement of clay to the firing of the final product. Sherds and clay samples whose physical, petrographic, and chemical characteristics are investigated, are taken from a stream bed about 50 m to the west of the workshop (Fig 12).

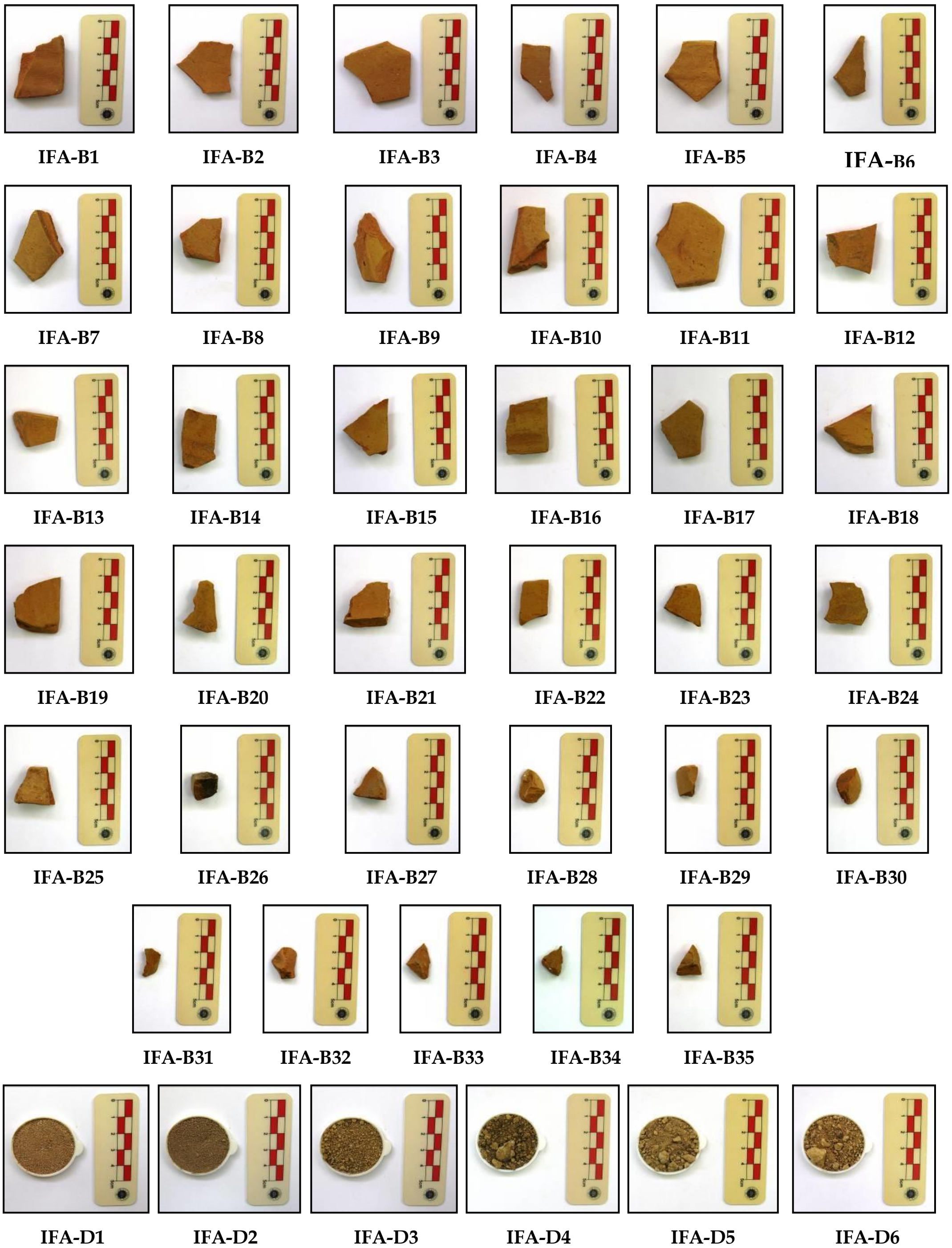

Fig 12. Amphora and soil samples analised from Phocaea from the Hellenistic workshop clay reservoir

First, the samples were visually evaluated and classified based on their physical characteristics, color, and thickness (Table 1). The fabric and soil texture of the amphora sherds were defined with a portable colorimeter (Chroma Meter) using ColorQA Pro System III program. The CEI L*a*b* (Commission Internationale de L'Eclairage) color coding system is one of the most detailed and universal standard color systems for documentation (Ohno 2007). The values are as follows: (L) represents the lightness/darkness value of the color; (+a) the intensity of red in the color; (-a) the intensity of green in the color; (+b) the intensity of yellow in the color; and (-b) the intensity of blue in the color (Table 1 and Fig 13).

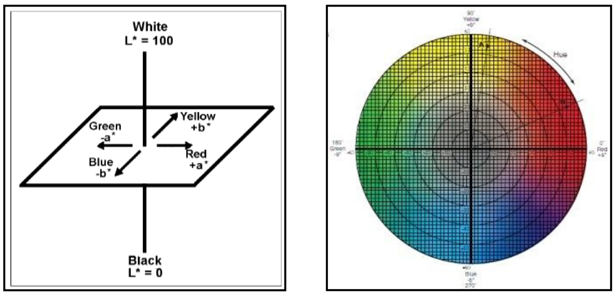

Fig 13. CEI L*a*b color system

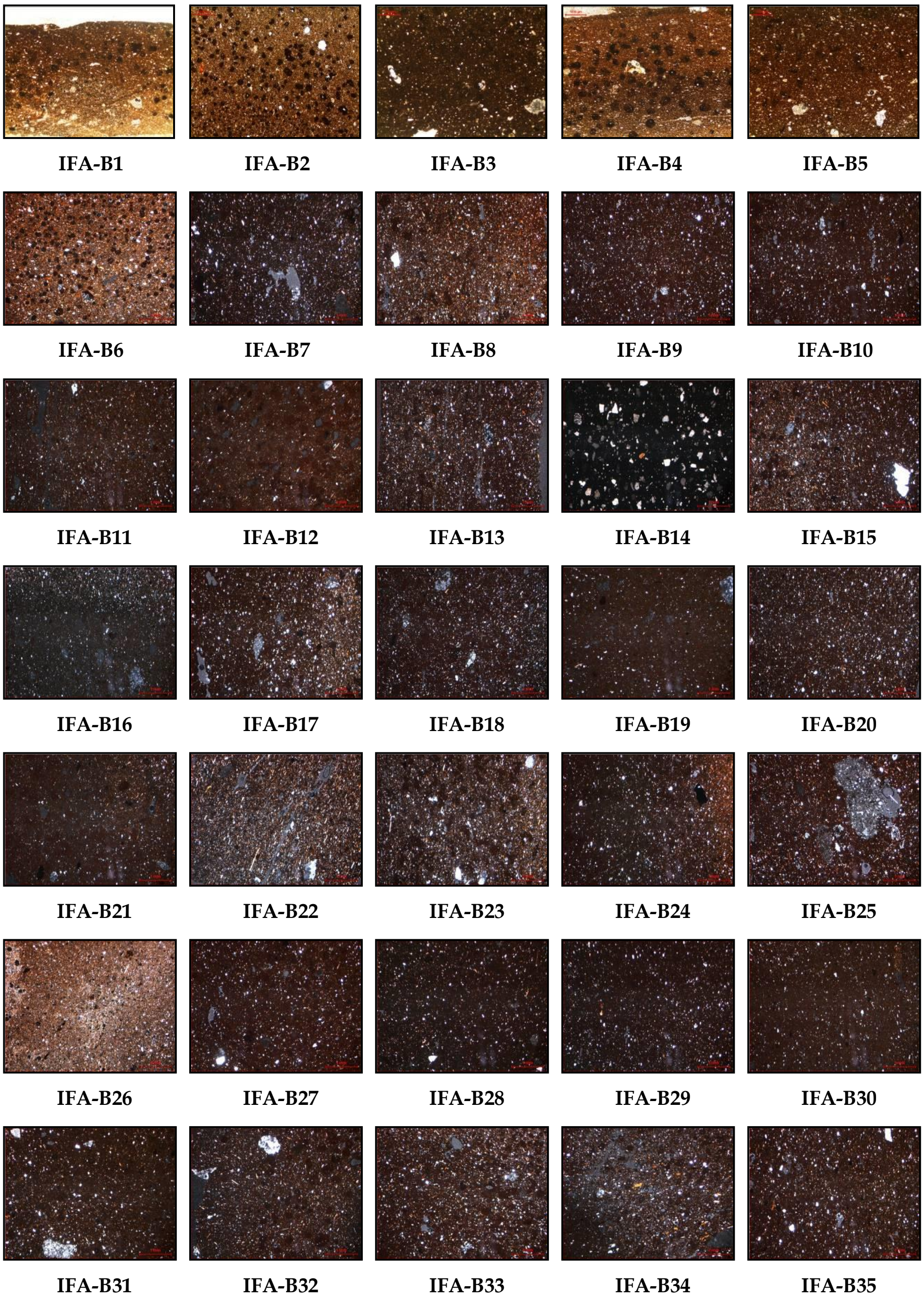

Fig 14. Thin section optical microscope microphotographs of the Phocean amphora samples.

In the examination of mineral phases and textural structure of the samples, thin section play an important role. Observations on thin sections are always most meaningful when correlated with other analyses. There are two mutually supporting aspects of the thin sections, namely, identification of the constituents and observation of morphology. Morphological investigations can stand alone, but they are strengthened greatly as more minerals and other substances are identified. The petrographic (matrix) and aggregate (rock fragment and mineral content) characteristics of the ceramic and soil samples were determined by thin section optical microscopy (Figs 14 and 15).

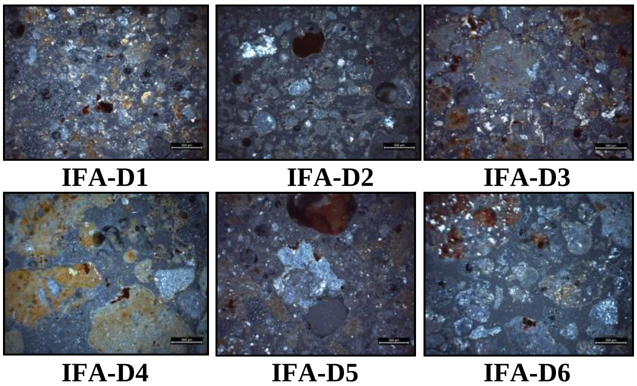

Fig 15. Thin section optical microscope micro-photographs of the soil samples

In these analyses, the samples were prepared by cutting with a suitable cutter, and transferred to glass slides where they were thinned (about 20 - 30 μm thick) by grinding for analyzing with a LEICA Research Polarizing Microscope DMLP Model optical microscope (Withbread 1995, 365). Photographs of the samples were taken with a Leica DFC280 digital camera attached to the microscope and using the "Leica Qwin Digital Screening Program". The matrix and the clay, and the rock and mineral components forming the matrix were defined using the "Particle Counting Method". Observation of the thin sections was carried out by using reflected and transmitted light. Examinations of thin sections should proceed from lower to higher power in both plain and cross polarised light (Kerr 1977; Rapp 2002).

The chemical constituents of all samples were analyzed by X-Ray Fluorescence Spectroscopy (XRF) (Table 3 and Fig 16), using a SPECTRO X-Lab 2000 PEDX spectrometer in conjunction with a Polarized Energy Dispersive (PED-XRF) system (Shackley 2011, 7-44). For this analysis, the surface impurities must be removed from the samples primarily. The powderised samples were analysed using the SPECTRO XLAB 2000 Model PED-XRF device. The device had a liquid nitrogen-cooled Si(Li) detector. The resolution values were <150 eV Mn Kα, 5000 cps. The analysis used the USGS (United States Geological Survey) standards and referred to GEOL, GBW-7109 and GBW-7309. The precision limit of the device is 0.5 ppm for heavy elements and 10 ppm for light elements.

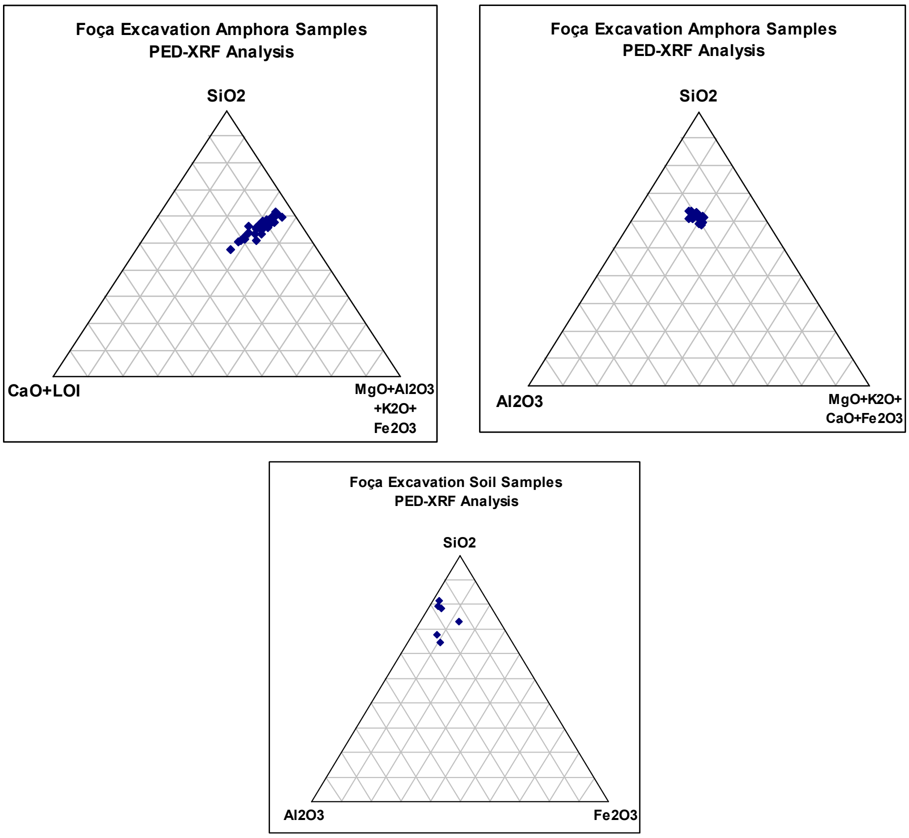

Fig 16. Grouping of the amphora (a), (b) and (c) soil samples by triangular plotting using PED-XRF analysis data

The amphora sherds found in the clay basin exhibit a homogeneous clay structure. The sherds have similar fabrics but vary in thickness from 3.80 – 14.01 mm (avg. 7.93). When the colors of the sherd samples are evaluated according to the CEI L*a*b* color coding system, the (L) value of the pieces range from 4.96 - 33.62 (avg. 27.04); the (+a) value from 5.27 - 20.27 (avg. 13.58); and the (+b) value from 7.53 - 36.25 (avg. 29.18) (Table 1). Clearly, the color values of the samples (except sample IFA-D4) are very close to each other, and the same can be said for the soil/clay samples (Table 1). The sherds and soil colours are very similar in terms of average values of (L), and (+b) values except (+a). A yellowish-red colored slip is applied to the surface of the jars. The fabric has uneven inclusions of sand, dense granules of rock, and a fine micaceous structure resulting from ordinary and mass production. The bases of the amphorae are made of a noticeably different clay, which is rougher and with larger inclusions, probably because they carry the full weight of the jar and were often handled at that end.

From the samples analyzed by thin section optical microscopy, the three factors—porosity varying between 3% and 9%, a matrix devoid of carbonates, and an undeformed clay structure (illite)—point to the possibility of firing temperatures varying between 800°C and 950°C (Table 2). It is known that the presence and amount of carbonate relict and the degree of clay deformation within the matrix may give idea about the firing temperature. If they are high, the firing temperature shold be low (such as 800°C or less), if they are low firing temperature shold be realtively high (higher than 800°C). The samples from Phocaea (IFA-B3, IFA-B14, IFA-B16, IFA-B25 and IFA-B26) have different structure to its clay matrix, thereby suggesting a different production method or, perhaps, of a standard product resulting from a different tradition. Additionally, the aggregate content of all the samples matches the composition of the local clay sources (Table 2); and, brick particle fragments subjected to the same analysis are seen to contain ratios of 0.5% to 3.5% of the total aggregate (Table 2).

The results of chemical analysis of pottery and clay samples as defined through PED-XRF analysis substantiate the results of the petrographic analysis (Fig 16). Generally speaking, the amphora samples exhibit rather similar chemical compositions regarding both the major (>%1) and minor/trace (<%1) element contents. The proportions of SiO_2 (avg. 55.17%), Al_2O_3 (avg. 17.99%), Fe_2O_3 (avg. 7.46%), K_2O (avg. 3.10%), CaO (avg. 2.89%), MgO (avg. 2.78%), which comprise the main elemental composition of the samples, are very close (Table 3). This result indicates that the jars were produced in the same workshop, or under traditional production conditions. There is a further similarity in terms of the chemical compositions of the clay samples taken from the stream bed near the pottery-production complex. When the amphora samples and the clay samples are evaluated from the viewpoint of raw-material sources, clay samples (except sample IFA-D1) are observed to have similar concentrations in terms of main element compositions. The aforementioned relationship can clearly be observed also in the minor/trace element contents of the same samples, and thus suggest that the amphorae are made from local clay sources.

The trace elements Strontium (Sr) and Zirconium (Zr) observed in the amphora and clay samples are the most informative, in terms of determining whether the source of the raw material used in amphora production is marine or terrestrial in origin. Strontium (Sr) is similar to Calcium (Ca) geochemically and exists within carbonate-structured marine formations such as seashell and limestone. When the level of Sr is more than 400 ppm, it usually is an indication that the raw material originates in a marine environment, and when it is less than 150 ppm, it can be assumed that the material is of terrestrial origin, containing limestone. If indeed raw material of terrestrial origin is used in production, then the Zr level should be higher than 160 ppm (Freestone et al. 2003, 19-32). In the samples from Phocaea, the Sr content of all amphora and clay samples are less than 400 ppm, and the Zr content is above 160 ppm (Table 3), thus indicating that terrestrial raw material sources were used in the production of amphorae.

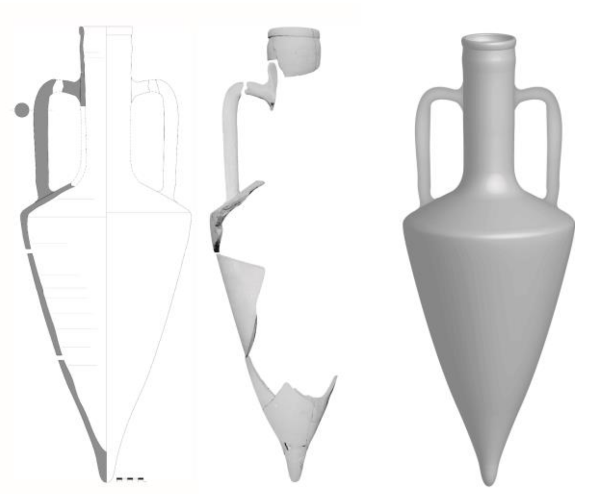

Fig 17. A tentative reconstruction of Phocaean Chios-Style amphoras based on amphora pieces

RESULTS AND DISCUSSIONS

Examination of the recovered amphorae reveals that they resemble the late versions produced at Chios. Fig 17 shows a tentative reconstruction based on amphora pieces recovered from the workshop. Such a dense concentration of broken and defective pottery dumped in a limited area is usually indicative of an area of production; the presence of defective fragments is highly suggestive. Imperfections such as cracks and fractures, traces of burning inside some handles, handles split in half, and a defective foot piece are manifestations of errors in production (Fig 18).

Fig 18. The manifestations of errors in production

Another indication to the function of the building complex is the discovery of a stamped handle. While stamped Chian amphorae are widespread but seem rather unsystematic (Empereur-Hesnard, 1987, 22), excavations at Eretria reveal that stamping in Chios started at the beginning of the 2nd century BC., at which time private names appear on the stamps (Şenol 2007, 107, footnote 33; Lawall 1999). In the Chios example that was found in Phocaea, even though the stamp is not readily legible, the existence of a private name written in a single line is unmistakable (Fig 19).

The name, executed from right to left[4], reads "Νικι(ου" and most probably a name of a wine producer or workshop owner named "Νικιας" like contemporary producers Hegesias and Hikesios. The name of Nikias is rarely seen on the Chios amphora handles. One of them is Phocaea example and the other was uncovered in Assos necropole in 1991. The name is genetive but the first letter N and genitive suffix at the end of the name was written inversely on Assos example. It is difficult to understand whether this was done intentionally or accidentally (Kramer 1993, 196, no. 20, taf. 25, 3). Five examples of these stamps were found on the Delos Island. All of these has been published on the website of "Amphoralex". All of the Delian Nikias stamps have inversely written N letters like Assos sample. However, unlike the other stamps, on Phocaea example, ehole Nikias name was written inversely. In this case, Phocaea example comes to an exceptional position in terms of both name and stamp shape. This may be a Phocaean version. Delos examples were dated to the 2nd-1st centuries BC[5]. This date range is suitable for both Phocaean workshop and its amphora chronology.

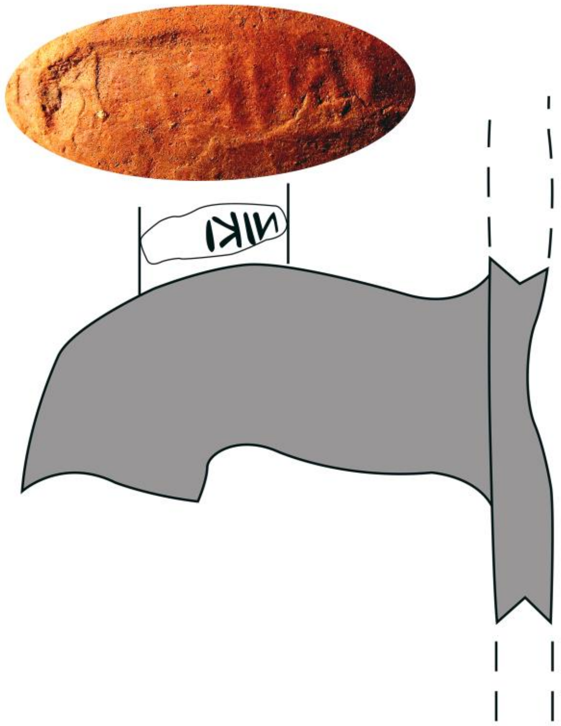

Fig 19. Stamp sample with the name of NIKIAS

The amphorae produced in Phocaea, take the form of those produced on Chios from the beginning of the 2nd century. The closest example to this form comes from the Necropolis at Olbia. The study of Olbia amphora was published by Monakhov and dated to the 2nd century BC. (Monakhov 2003, 23, footnote 108, Figure 13.4). Two instances of amphorae produced in Chios can be dated precisely to the 1st century BC and are important for confirming the form and the style of late period Chian amphorae. These examples differ from Phocaea-produced Chi-

[4]Assoc. Prof. Gonca Şenol, who examined the stamped handle, states that the name is in retrograde written from right to left and that the name "NIKIAS" was written on the stamp; furthermore the letter sigma was written in the form of a crescent.

[5] http://www.amphoralex.org/timbres_delos/affiche_liste_delos_chios.php

os-style amphorae in terms of handle and body shape. Therefore, the Chios-style amphorae from Phocaea were probably produced before the beginning of 1st century BC. The style of the floor and roof tiles found at Phocaea (Özyigit 2002, 339), in conjunction with a coin dated between the 3rd and the end of the 2nd century BC., support such an assumption.

35 amphorae samples revealed from the near Persian Cemetery Monument of Phocaea archaeological area and six soil/clay samples nearby area were analised archaeometrically. The samples were primarily groupped in terms of their material type and sampling regions. The physical properties (thickness, colours and their structural homogenity) of the cataloged and photographically documented samples were then determined. Petrographical properties of the samples were analysed by thin section optical microscopy, and XRF method was used to determine their chemical structures. The sherds were classified into six groups by using thin section analysis due to their matrix/agregate feature, their aggregate type/distiribution/size, porosity, clay types and structures. The firing temperature of the samples might be values between the 800 and 950ºC. The clay type of the amphorae samples were mainly illite. The brick particles are mainly determined within their aggregate compositions in some. Both petrographical and chemical properties of the amphorae samples gave high competibility not only the each other but also to the local rock formation. The production of the amphorae was most probably by using terrestrial originated local type clays due to their Sr and Zr contents.

Having conducted extensive analyses on the ceramics recovered from what is most likely a workshop near the Persian Cemetery Monument, it may be concluded that Phocaea was producing amphorae along with quotidian pottery in the Late Hellenistic and Early Roman Periods. The amphora form that was reconstructed from fragments of rim, handle, body and base closely resembles the style of jars that were produced at Chios at the beginning of the 2nd century BC. The results of archaeometric analysis dictate that this Phocaean-pottery tradition was based on local clay sources of terrestrial origin, most likely from a nearby stream bed. Another conclusion about the workshop is related with the Nikias stamp. During the excavations which are conducted in the amphora workshops on Delos Island, totally five stamps with the name of Nikias were found and these stamps are dated generally between 2nd-1st centuries BC[6]. But, we can precisely date this stamp to the first half of the 2nd c. BC. As a result of this research, Chios type amphora production in Phocaea has been revealed. At least for Hellenistic period, it can be claimed that Chios amphora production is not particular for the island, but indeed, is a part of a regional production including Phocaea.

ACKNOWLEDGEMENTS

The authors wish to thank to the Phocaea Excavation director Prof. Dr. Ömer ÖZYİĞİT for giving permission to work on the amphorae of the workshop at Phocaea, Prof. Dr. Ahmet Kaan ŞENOL and Assoc. Prof. Dr. Gonca ŞENOL for giving valuable information about the archaeological contexts from their libraries. Thanks are due to Prof. Dr. Yusuf Kağan KADIOĞLU and Kıymet DENIZ for their help in the archaeometrical analyses at Earth Sciences Application & Research Center of Ankara University, and Gülşen ALBUZ for her help in the sampling and laboratorial works for archaeometrical analyses at Historical Material Research and Conservation Laboratory (MAKLAB) of Gazi University.

[6]These stamps which are found on Delos were made by two different matrices. Phocaean example is different from them in terms of its form and being retrograde.

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Table 1. Descriptions of amphora sherds and soils

Samples	Thickness (mm)	Colour Codes			Sample & Location Descriptions
		L	a	b	
IFA-B1*	9.64	30.52	19.03	29.82	Amphora sherd from body, Hellenistic Period Workshop
IFA-B2	3.80 (min) 4.69 (max)	29.91	17.17	29.00	
IFA-B3	5.19	30.95	14.73	30.09	
IFA-B4	5.31	26.91	20.27	25.50	
IFA-B5	6.89	33.62	11.76	33.05	
IFA-B6	5.88	22.09	16.48	31.69	
IFA-B7	10.43	26.77	5.70	36.25	
IFA-B8	10.91	25.33	8.89	34.94	
IFA-B9	10.34	24.77	10.17	34.40	
IFA-B10	6.35 (min) 14.01 (max)	21.76	9.37	30.92	
IFA-B11	5.41	30.20	12.10	31.17	
IFA-B12	9.86	26.86	20.05	27.74	
IFA-B13	5.53 (min) 11.33 (max)	28.56	12.64	29.32	
IFA-B14	6.82	26.22	18.19	26.87	
IFA-B15	9.71 (min) 13.23 (max)	27.50	15.12	28.21	
IFA-B16	10.27	27.09	15.26	27.74	
IFA-B17	6.01	27.91	14.99	28.69	
IFA-B18	5.73	30.90	8.14	31.75	
IFA-B19	6.12 (min) 9.00 (max)	27.39	16.22	28.15	
IFA-B20	8.24	28.97	12.50	29.78	
IFA-B21	9.31	28.17	14.37	28.96	
IFA-B22	5.47	27.66	15.60	28.42	
IFA-B23	6.67	27.13	16.83	27.88	
IFA-B24	7.09	29.52	11.26	30.34	
IFA-B25	9.04 (min) 11.53 (max)	31.47	6.90	32.32	
IFA-B26	12.41	4.96	5.27	7.53	Amphora handle, Hellenistic Period Workshop
IFA-B27	11.63	25.60	16.30	26.01	
IFA-B28	9.33	27.18	12.56	27.70	
IFA-B29	10.02	28.42	12.15	29.13	
IFA-B30	10.38	29.52	9.65	30.26	
IFA-B31	4.55	27.35	14.64	28.01	
IFA-B32	6.98	26.32	17.11	26.92	
IFA-B33	7.08	27.35	14.64	28.01	
IFA-B34	11.04	23.51	15.28	30.00	
IFA-B35	8.19	28.07	13.83	34.83	
IFA-D1	-	36.83	10.74	36.61	Soil from northern slope of the stream (c. 50m)
IFA-D2	-	25.49	9.86	25.56	Soil from southeastern slope of the stream (c. 50m)
IFA-D3	-	30.77	7.64	31.58	Soil from southern region (c. 300m) from ceramic workshop, northern slope of dam reservoir
IFA-D4	-	9.86	3.24	14.80	
IFA-D5	-	29.98	5.02	20.96	Soil from eastern region (50m) from the ceramic workshop
IFA-D6	-	29.86	4.19	26.07	Soil from northern slope of the stream (c. 50m)
Ave. Amp.	**7.93 (min)**	**27.04**	**13.58**	**29.18**	
Ave. Soil.	**-**	**27.13**	**6.78**	**25.93**	

Notations: IFA-B1 = İzmir **F**oça Excavation **A**mphorae

Table 2. Petrographical thin section analysis by optical microscope

Samples	T (°C)	P (%)	MTA (%)	Clay Type	Rocks & Minerals*	Descriptions
Group 1	~850	3-5	15-23	illite	Q,Pl,By,Ç, Ms,S,TK (3.5%)	Matrix contains mostly metamorphic rock fragments formed by weathering of local rocks
Group 2	800-850	4-6	8-14	illite	Q,S,Op,Ms,Ç	Aggregates in matrix are silt sized and having homogeneous aggregate distributions
Group 3	900-950	5	15	illite	Q,Pl,By,Op, Ms,Ç,TK (0.5%)	Matrix aggregates content are similar but firing technology and periods might be different
Group 4	~850	5	15	illite	Q,Pl,Op,Py,Ms,Ç	Aggregates in matrix are coarse sized and having heterogeneous aggregate distributions
Group 5	800-850	6	15	illite	Q,Pl,Ms,Ç,Sr	Matrix contains mostly metamorphic rock fragments formed by weathering of local rocks
Group 6	900-950	9	18	illite	Q,Pl,By,Op,Kt, Ft, Ms,S,Ç	Aggregates in matrix are coarse sized

(*) Notations: By: Biotite, **Ç:** Chert, **Ft:** Fillite, **Kt:** Sandstone, **Ms:** Muscovite, **MTA:** Matrix total aggregate ratio by point counting method, **Op:** Opaque Minerals, **P:** Porosity, **Pl:** Plagioglase, **Py:** Pyroxenes, **Q:** Quartz, **S:** Serpantinite, **Sr:** Sericite, **T:** Estimated Firing Temprerature, **TK:** Brick Particles

Grouping;
Group 1: IFA-B1, IFA-B2, IFA-B4, IFA-B5, IFA-B6, IFA-B8, IFA-B12, IFA-B17, IFA-B23, IFA-B27
Group 2: IFA-B7, IFA-B9, IFA-B10, IFA-B11, IFA-B13, IFA-B15, IFA-B18, IFA-B19, IFA-B20, IFA-B21, IFA-B22, IFA-B24, IFA-B28, IFA-B29, IFA-B30, IFA-B31, IFA-B33, IFA-B34, IFA-B35
Group 3: IFA-B3
Group 4: IFA-B14
Group 5: IFA-B16, IFA-B26
Group 6: IFA-B25

Table 3. Chemical composition of the amphora and soil samples

Composition		Amphora Samples			Soil Samples		
Element	Conc.	min	max	Average	min	max	Average
Na_2O	%	0.079	0.810	0.287	0.070	0.360	0.163
MgO	%	1.86	4.33	2.78	0.505	2.37	0.955
Al_2O_3	%	14.74	20.82	17.99	6.38	18.25	12.97
SiO_2	%	46.96	60.69	55.17	34.22	71.30	51.43
P_2O_5	%	0.077	0.582	0.262	0.001	0.376	0.124
SO_3	%	0.0002	0.052	0.007	0.001	0.215	0.079
Cl	%	0.004	0.095	0.029	0.0002	0.052	0.018
K_2O	%	2.34	3.61	3.10	1.62	4.12	3.20
CaO	%	1.07	4.81	2.89	0.391	25.82	6.26
TiO_2	%	0.653	0.831	0.722	0.311	0.777	0.426
V_2O_5	%	0.013	0.023	0.018	0.009	0.027	0.015
Cr_2O_3	%	0.014	0.035	0.020	0.002	0.040	0.011
MnO	%	0.084	0.123	0.100	0.025	0.226	0.115
Fe_2O_3	%	6.12	8.86	7.46	2.13	6.47	4.35
LOI*	%	1.84	22.58	9.37	6.84	33.46	19.85
Co	ppm	22.5	71.4	46.9	15.7	47.3	28.0
Ni	ppm	60.8	263.3	131.5	7.3	132	32.0
Cu	ppm	22.2	87	30.8	5.4	37.9	20.2
Zn	ppm	82	126.4	96.0	31.7	89.3	59.5
Ga	ppm	20.1	29.5	24.6	12.8	21.7	16.6
Ge	ppm	0.8	3	1.7	0.6	1,4	1.0
As	ppm	11.6	35.6	22.6	4	173.3	61.8
Se	ppm	0.4	0.6	0.5	0.4	0.5	0.5
Br	ppm	0.9	4.1	2.4	0.5	5.2	2.4
Rb	ppm	115.1	180.8	146.2	38,7	207.6	154.5
Sr	ppm	190	303.6	230.5	54.8	353.5	154.9
Zr	ppm	183.7	255.1	212.2	140.7	318.3	225.5
Nb	ppm	14	25.3	20.5	15	23	19.8
Mo	ppm	2.4	7.5	4.5	2.5	28.7	11.0
Cd	ppm	0.5	3.6	1.2	0.7	1	0.9
In	ppm	0.6	1.9	1.1	0.8	0.9	0.9
Sn	ppm	1.3	6.4	4.1	1	4.3	2.8
Sb	ppm	0.9	4.1	2.2	1	3.6	1.8
Te	ppm	1.4	3.1	1.7	1.2	1.4	1.3
I	ppm	2.5	5.8	3.2	1.6	2.7	2.3
Cs	ppm	7.8	29.5	16.3	4	22.8	10.1
Ba	ppm	710.8	1999	1116.6	382.4	1300	735.9
La	ppm	31.7	66.2	48.3	24.6	58.6	39.3
Ce	ppm	71.5	123.7	91.2	38.2	95.9	69.0
Hf	ppm	4.3	11.3	6.0	4.1	6.9	5.5
Ta	ppm	5.5	9	6.7	3.5	7.4	5.0
W	ppm	4.7	7.2	5.7	2.4	5.7	4.1
Hg	ppm	1.2	1.6	1.4	1	2.3	1.4
Tl	ppm	0.8	2.1	1.4	1	3.2	2.0
Pb	ppm	32.7	48.2	38.0	6.6	47.8	39.2
Bi	ppm	0.5	1.6	1.1	0.7	1.7	1.2
Th	ppm	14.9	24	21.1	5.4	35.3	25.5
U	ppm	5.3	23.8	10.2	7.9	15.4	10.8

(*) LOI: Loss on Ignition at 950°C