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POTTERY PRODUCTION, EXCHANGE AND CONSUMPTION IN LATE BRONZE AGE MAGNESIA (THESSALY): RESULTS OF NEUTRON ACTIVATION ANALYSIS OF POTTERY FROM DIMINI, VOLOS (NEA IONIA, KASTRO/PALAIA), PEFKAKIA AND VELESTINO

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This article presents the results of Neutron Activation Analysis (NAA) of, altogether, 145 pottery and clay samples deriving from five sites located in the Thessalian region of Magnesia: Dimini, Nea Ionia, Kastro/Palaia (Volos), Pefkakia and Velestino. Chronologically, the sampled pottery covers the entire Late Bronze Age (LBA), with a few samples dating to the Middle Bronze Age. Within this broad chronological range, Mycenaean-type pottery dominates, the majority of it being decorated, with an addition of fine unpainted pottery and such used for transport and cooking. Pottery of non-Mycenaean derivation is represented by a variety of types belonging to the early LBA as well as two classes of the early post-palatial period (i.e. after 1200 BC): Handmade Burnished Ware and Grey Ware. Importantly, samples associated with two pottery kilns at Dimini and Velestino were included in the project, although no kiln wasters were identified. Results of the analysis provide important insights into both local Thessalian pottery production and inter- and intra-regional pottery exchange. Local production utilising clay beds around Dimini is best evidenced, with a distribution of its products reaching beyond Thessaly. Two further chemical patterns appear to be associated with Velestino, while an additional two small chemical groups are likely Thessalian as well. In terms of identified imports, the Argolid stands out as the major source of non-local pottery from the beginning of the LBA until the end of the palatial period. Other regions and production localities play a significantly smaller role as sources of supply. On the basis of the study, for the first time the local production as well as importation of pottery in the region of Magnesia is documented by scientific means, opening new research perspectives and strengthening the region's standing as part of the Mycenaean world.

INTRODUCTION

From the late 1970s, the region of Magnesia in Thessaly witnessed a steadily growing amount of fieldwork at important Mycenaean sites (Fig. 1). Of the archaeologists involved in this publication, Anthi Batziou directed excavations at Pefkakia, took part in fieldwork at two other sites – Dimini, Velestino – and studied material from Kastro/Palaia, while Vassiliki Adrymi-Sismani carried out large-scale fieldwork at Dimini. This work has put coastal Thessaly firmly on the map of the Mycenaean world, not simply on its periphery (Batziou-Efstathiou 1994; 1998; 2015a; Adrymi-Sismani 2013; 2014; see also Feuer 2016).

These excavations produced large amounts of pottery, which were used in the first place to provide information on the chronology and function of uncovered contexts. Nevertheless, growing recognition of the differences between local and imported pottery shed a first light on the issue of commercial contacts and made it possible to formulate questions about their extent

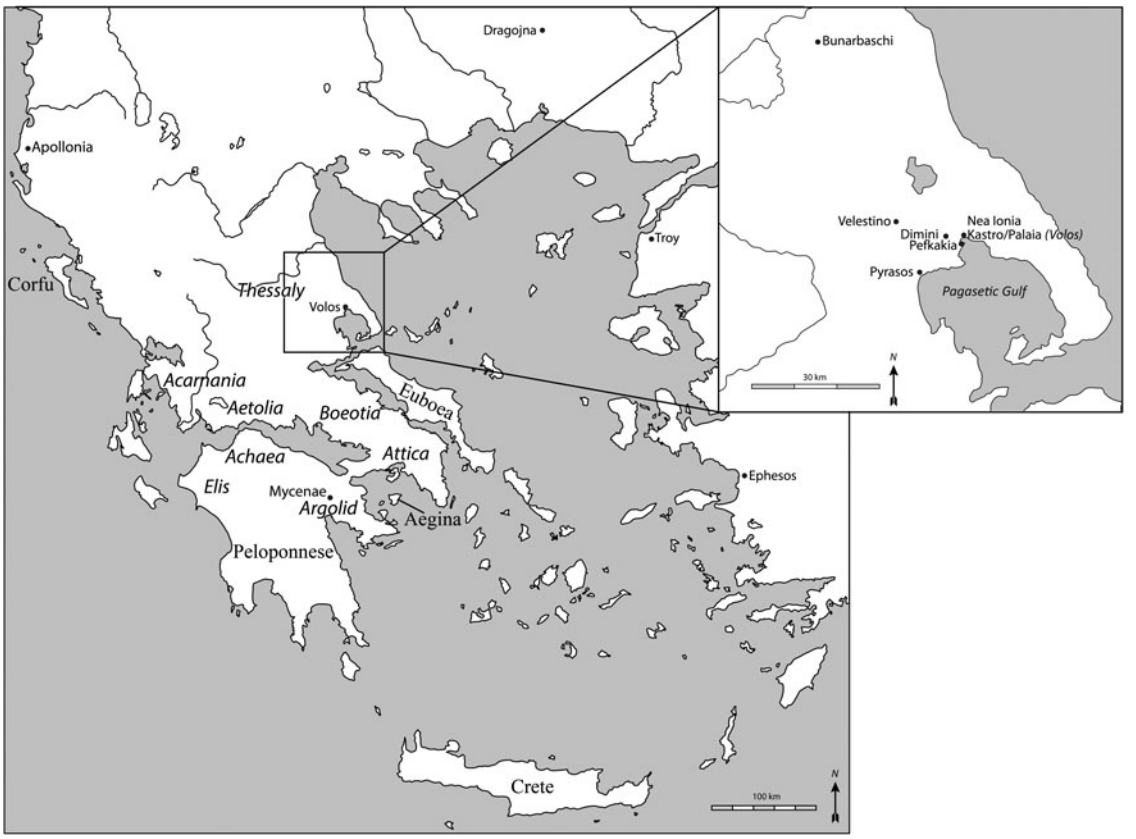

Fig. 1. Map of Greece showing sites and regions mentioned in the text.

and the types of pottery that were being exchanged. Furthermore, the discovery of a large kiln at the site of Dimini raised important questions about the character of local production. Did it cover all functional classes of pottery, including fine tableware and utilitarian coarse vessels? Where was the pottery produced at Dimini exported? Were two important pottery groups of non-Mycenaean derivation, Handmade Burnished Ware and Grey Ware, locally made or imported?

The initial answers to these important questions were based on macroscopic analysis of the fabrics and decoration, but it was clear that only through scientific analyses could such observations be tested. This first led to a collaboration between Anthi Batziou and Richard Jones from the Fitch Laboratory, focused on pottery from the rich tomb at the Nea Ionia cemetery. Unfortunately, the results proved inconclusive (Batziou-Efstathiou 1991). As Batziou was preparing her PhD thesis on Mycenaean pottery from Kastro/Palaia, Nea Ionia, and Pefkakia, and a centre with evidence for both local production and intensive exchange was being uncovered at Dimini, a new opportunity emerged with the large sampling project coordinated by Joseph Maran and Hans Mommsen. This was a perfect coincidence, which made it possible to test a sample of pottery from those sites and verify ideas regarding local production workshops, patterns of exchange within Thessaly, and links between Thessaly and Mycenaean centres located further to the south.

The present research was conducted in the course of a project funded by the German Federal Ministry of Education and Research that was dedicated to characterising Bronze Age regional pottery groups, predominantly of the Mycenaean period, with the help of Neutron Activation Analysis (NAA). Based on this main aim of the project, it was decided to use the available project budget to chemically characterise the Mycenaean pottery production of as many regions as possible, especially of central and southern Greece, by focusing on pottery assemblages from settlements or burials of selected sites in the various regions. The high overall number of regions

and sites to be covered during the three sampling campaigns of the project carried out between 1995 and 1997 and each lasting for only a few weeks required a restriction of the number of samples for each site, which made it impossible to achieve a representative cross-section through the entire pottery production of any of the sites included in the project. Due to time constraints – the sampling for each region had to be carried out within a few days – the vessels and sherds to be sampled had to be pre-selected by the excavators, who were informed of the project's aim to enable a characterisation and differentiation of local and regional Mycenaean pottery production and were explicitly asked for possible wasters related to potter's kilns. If such were not available, they were told to choose examples of what they thought to be characteristic examples of Mycenaean decorated pottery and other Mycenaean pottery classes (fine undecorated wheel-made pottery, cooking pottery) from the respective sites.

The sampling of the pottery from Thessalian sites was carried out in 1996 at the Museum of Volos and focused on Late Bronze Age (LBA) pottery classes and, above all, on Mycenaean decorated pottery from the three settlements (Kastro/Palaia, Dimini and Pefkakia) and one cemetery (Nea Ionia) in the area of the northern Pagasetic Gulf (Fig. 1). In addition, pottery from Velestino at the south-eastern end of the east Thessalian plain was included in the sampling campaign, because the site had also yielded an LBA potter's kiln and was situated in a key position for trade routes linking the interior of Thessaly with the coastal area. The aim of the sampling campaign was primarily to enable the characterisation of the NAA patterns of a variety of pottery classes used during the different stages of the LBA and also, whenever possible, to attribute the sampled pottery to specific workshops. For this purpose, a particular emphasis was given to the sampling and analysis of pottery associated with potter's kilns. In addition to LBA pottery classes, examples of Middle Bronze Age date from Pefkakia were sampled with the aims of characterising them with the help of NAA and pursuing the question of whether any of the chemical patterns that emerged on the basis of the analysis of Middle Bronze Age pottery would continue into the LBA. In total, 137 pottery samples were taken, to which three clay and five modern reference samples were added.

Even though more than 25 years have passed since the sampling took place, this material still represents the best source of primary data for pottery production and exchange during the Late Bronze Age in Thessaly, and as such should be fully published.[1] This article will first present the archaeological context of the samples, and this will then be followed by a concise overview of the pottery groups, leading into a presentation and discussion of the NAA results.

CONTEXTS

Dimini

From 1977 to 1997, several rescue excavations were carried out on various plots at Dimini (Figs 1, 2 and 3), uncovering a total area of 2852 m^2. As a result, remains of 11 Mycenaean houses and an administrative centre with two main megaron complexes (Megaron A and B) were discovered, providing a representative picture of architectural planning during this period (Adrymi-Sismani 2013; 2014).

The Mycenaean settlement at Dimini was established on the alluvial plain to the east of the hill occupied by the Late Neolithic settlement, in the transitional period from the Middle to the beginning of the Late Bronze Age.

Archaeological evidence for the early Mycenaean period is rather scarce, and is mostly of funerary nature. Settlement deposits of Middle Helladic (MH) III date are followed by

[1] Unfortunately, we were unable to locate in the storerooms the majority of pottery from Dimini that was originally sampled to produce photographs for publication. Therefore, only four vessels from that site will be illustrated with a photograph or drawing in the catalogue, published as online-only Supplementary Material.

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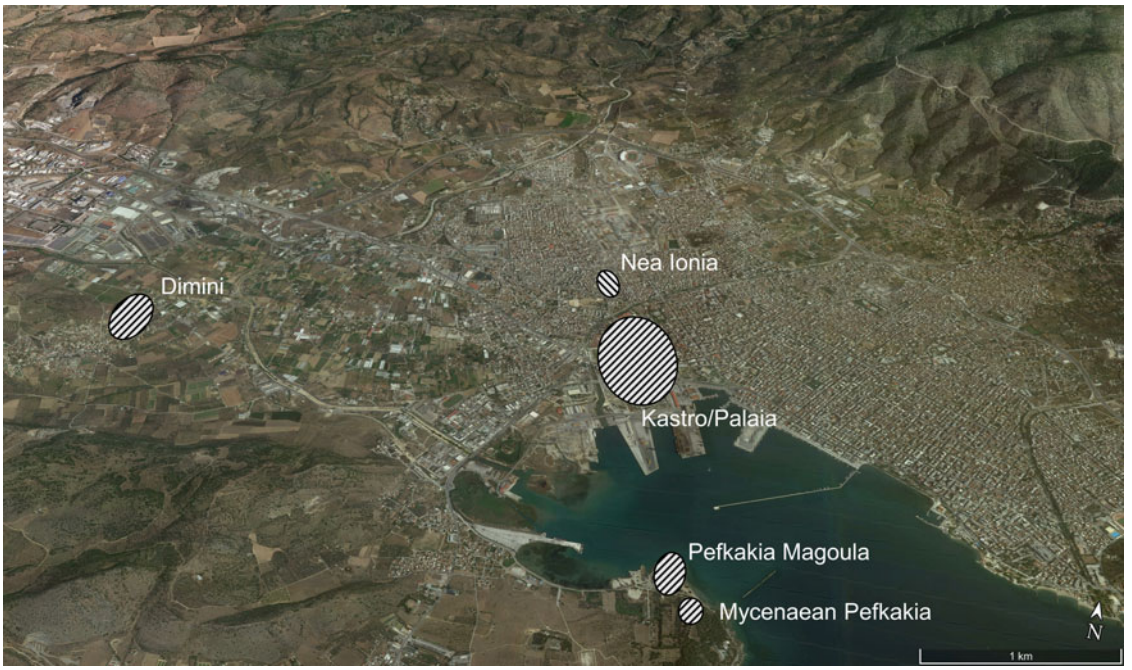

Fig. 2. View of the Bay of Volos with location of sites (except for Velestino) that were included in sampling. Base map: Google Earth.

fragmentary Late Helladic (LH) I–II architectural remains, associated with matt-painted ware of the Middle Helladic style.

A number of new houses were founded at the beginning of LH IIIA. To the same period belongs a large ceramic kiln, discovered in Section IV (see below). A second phase lasting from the beginning of LH IIIB1 to the end of LH IIIB2 was represented by the expansion and renovation of the houses in the same locations. This is the period of greatest development for the settlement. After the destruction of the settlement at the end of LH IIIB2 a short-term third phase of habitation during early LH IIIC is identifiable. This period is characterised by small-scale reconstructions and additions to pre-existing buildings; a lower quality of life might be inferred both from the architecture and the material culture.

Of the 11 houses excavated in Sections I–IV, samples of pottery were taken from deposits deriving from Houses A and K (Section I) and the North House (Section II) as well as from the ceramic kiln and its vicinity (Section IV). These contexts will be described in more detail below.

House A (plot Kariofili)

House A (Adrymi-Sismani 2013, 88–96; Fig. 3) was founded in LH IIIA, but its main period of use is placed in LH IIIB2, when it consisted of three rooms. A short, final phase of partial use of some spaces can be placed at the beginning of early LH IIIC, at the end of which House A was permanently abandoned. It appears that this building formed the residence of an individual family.

Samples **Dimi 012** and **036**[2] were taken from vessels BE 2968 and BE 2969 respectively (Adrymi-Sismani 2006). BE 2969 was found north of House A within an early LH IIIC layer, and BE 2968 in room 1 of House D[3] in an early LH IIIC layer very close to the modern surface.

[2] For detailed information on the samples, see the catalogue published as online-only Supplementary Material.
[3] Only a plan of this house was revealed, without it being completely excavated.

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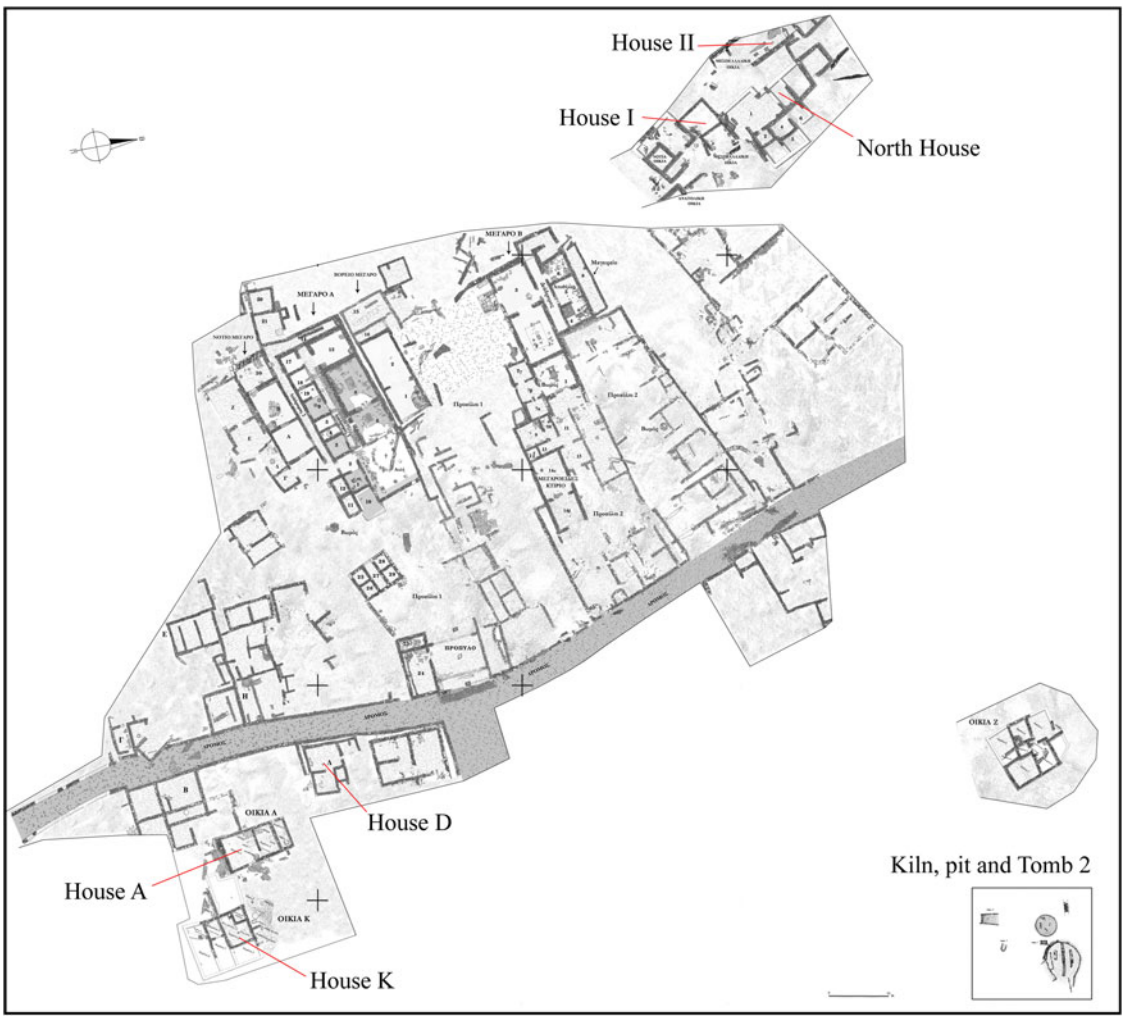

Fig. 3. Plan of Dimini showing contexts from which samples were selected.

House K (plot Kotsali)

House K (Adrymi-Sismani 2013, 96–107; Fig. 3) was only partially excavated, due to limitations resulting from modern habitation, and is of particular interest due to the strong evidence for the existence of a 'house sanctuary' for cult activity. It was founded during LH IIIA, on top of early Mycenaean layers (LH I–II), while its acme is placed at the end of LH IIIB2, when it consisted of six rooms. A brief third phase of use at the beginning of early LH IIIC was also observed. A well (diameter 0.90 m and depth 15 m), situated outside the north side of House K, in an open courtyard shared with House A, functioned until the end of LH IIIB2, when it was filled with rubbish. It contained pottery with a wide chronological range, from MH III to the end of LH IIIB2 (Adrymi-Sismani 2013, 97–100, fig. 20).

Samples **Dimi 014** and **015** were taken from pottery found inside of the well.

Samples **Dimi 029–032** came from pottery fragments found on top of a hard clay floor that sealed the mouth of the well after it went out of use, and date to LH IIIC Early.

North House (plot Katsarou)

The North House (Adrymi-Sismani 2013, 115–21; Fig. 3) is the largest house on the eastern slopes of the hill. Moreover, although it is located at a considerable distance from the main road, it seems that its orientation follows the general spatial plan of the settlement. It is built on top of an earlier building, which was destroyed by fire at the end of LH IIIA2. Layers of the early Mycenaean period (LH I/IIA) were identified at a lower depth.

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In the main phase of use, during LH IIIB2, it consisted of nine rooms that were arranged on three axes. Based on the different levels of foundation of the rooms, it seems that the rooms of the west axis (rooms 1, 7, 8 and 9) were built first, and gradually the other rooms were added.

After the destruction of the North House at the end of LH IIIB2, a short phase of reuse of room 1 only was attested, which is placed in early LH IIIC according to the associated pottery.

Sample **Dimi 035** was taken from a pottery fragment found south of the North House, outside of the north-east corner of room 1, in an LH IIIB2 layer. The almost completely preserved stemmed krater with a bird, from which sample **Dimi 037** was taken, came from an LH IIIB2 context in room 9 of the North House.

House II

Three independent buildings dating to the MH III period were uncovered at the eastern side of the hill, situated to the west of the North House. Samples **Dimi 033** and **034** were taken from pottery found in House II (Adrymi-Sismani 2013, 60, fig. 12; Fig. 3) within a layer of the MH III period. This layer contained wheel-made Grey Minyan and matt-painted pottery.

Kiln, pit, and tombs at Tsakanika plot

The pottery kiln's chamber is roughly circular in shape with a diameter of *c.* 3.40 m (Adrymi-Sismani 1999; 2013, 163–74; Fig. 3). The kiln was preserved to a height of 55 cm and was built on flat ground. The exterior of the chamber was constructed with large stones; the interior was lined with bricks and coated with a thin (0.05 m) layer of clay. The two upper rows of bricks are inclined towards the interior, suggesting that there was a vaulted roof over the chamber.

The interior of the chamber is divided by three parallel walls built of large bricks. Above those divisions was the perforated floor of the chamber, parts of which were still in place. The kiln was used from LH IIB until LH IIIA2.

From the interior of the kiln, more than 1200 pottery fragments were recovered. The vast majority belong to unpainted open and closed shapes, among which short-stemmed goblets and cups were most common. A wide range of decorated shapes, among them alabastra, rhyta, jugs, piriform jars, and kraters, were encountered.

Samples **Dimi 002–008** were taken from pottery and a clay lump found in the entrance/firing chamber. Samples **Dimi 009–011** came from clay fragments found just above the bottom of the kiln. Samples **Dimi 013** and **028** were taken from a lump of clay and a pottery fragment respectively, found in the interior of the kiln**.**

At a distance of only 0.6 m to the west of the kiln, a large pit was found with a diameter of 2 m and a depth of 0.8 m, which contained more than 3600 pottery fragments, again mainly unpainted. Most common were goblets and cups. The pottery dates predominantly to LH IIIA and was the source of samples **Dimi 016–027**.

A cist tomb (Tomb 2) dating to LH IIB was found 5 m south-west from the kiln. An adult was buried inside, accompanied by seven vessels. One of the vessels, the piriform jar BE 10422, was sampled (**Dimi 001**).

Clay and modern reference samples

In addition to pottery, three clay samples from the surroundings of the modern workshop of the potter Kostas Louros at Dimini (location: 39°21′35.2″N 22°54′11.2″E) were taken (**Dimi T1[040]**, location 39°21′23.0″N 22°54′11.0″E, **Dimi T2[041]**, location: 39°21′17″N 22°54′13″E and **Dimi T3[042]**, location: 39°21′23″N 22°54′20″E), while Louros also provided two modern akroteria (**Dimi 038** and **Dimi 039**), two brick fragments (**Dimi 043** and **Dimi 044**, the former made from clay in the sampling location of Dimi T2) as well as a fragment of a kiln's wall from his workshop (**Dimi 045)** that were analysed.

Kastro/Palaia (Volos)

The settlement at Kastro/Palaia is situated on the northern bay of the Pagasetic Gulf in the area of the modern city of Volos (Figs 1 and 2). The first settlement may have been established in an almost

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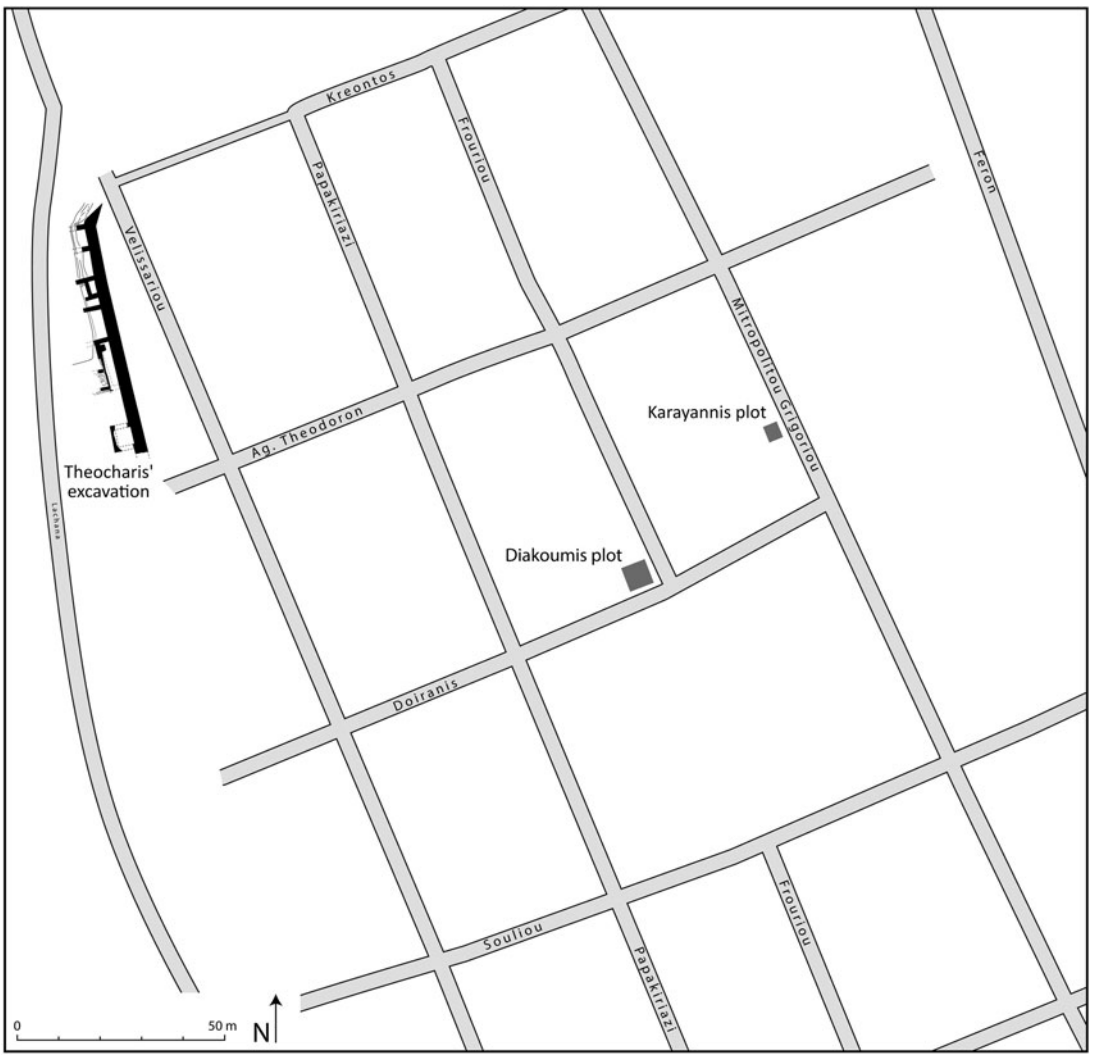

Fig. 4. Plan of Kastro/Palaia showing locations of rescue excavations from which samples were selected, as well as the excavations of Theocharis with substantial Mycenaean structures (© plan by T. Ross).

flat area, as the current low hill was formed by successive habitation layers dating from the Early Bronze Age onwards. The site was densely populated from ancient times until the present and is almost totally covered by modern buildings. In 1956, Demetrios Theocharis (1956a; 1956b) started the systematic excavation on the west slope of the hill of Kastro/Palaia (Fig. 4). His aim was to examine the stratigraphy and find the location of the Mycenaean palace of Iolkos, as from the time of Christos Tsountas' excavations it was taken for granted that Iolkos was to be identified with the site of Kastro/Palaia (Tsountas 1900). Theocharis excavated between the two destroyed towers of the medieval castle, where the richest evidence for the palatial period was revealed. His limited excavations revealed successive buildings with substantial walls, pottery and small finds. He concluded that the remains belonged to two successive 'palaces'.

Evidence from the rescue excavations at Kastro/Palaia

The excavations of Theocharis were followed by several rescue excavations at the site of Kastro/Palaia, carried out in small plots and reaching considerable depths (Fig. 4). Thirty-four samples have been taken from the pottery of the Diakoumis plot (**Iolk 001–Iolk 034**), documenting all

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the archaeological horizons in the centre of the Mycenaean settlement, and three samples of LH IIIC Pictorial style are from the Karayannis plot (**Iolk 035–037**). Overall, these are representative of the evolution of the settlement during the LH period, and of the contacts that could have developed within the region and beyond, including the major Mycenaean centres of the Peloponnese.

The E. Diakoumis plot (Fig. 4), excavated by Zoe Malakasioti in 1990, is situated at the top of the Kastro/Palaia hill, in the middle of the Mycenaean settlement. In this plot no architectural remains dating to the Late Bronze Age were found. Nevertheless, several floor levels with associated pottery and small finds were recorded. Unfortunately, they do not allow us to reach conclusions regarding the use of the excavated area.[4] These floor levels cover a broad chronological sequence, starting with the early Mycenaean period and going through the palatial and post-palatial periods. Despite the lack of complete floor plans of the architectural remains, the early LBA levels are important as they contain a range of non-Mycenaean pottery together with the first Mycenaean-style pottery, documenting the appearance and spread of Mycenaean culture in the area of Volos, as is also illustrated by the LH IIB–IIIA1 cemetery at Nea Ionia (see below).

Starting from the uppermost Mycenaean strata, the layer at the depth of 2.68–3.47 m dates to LH IIIC Late. A single fragment was sampled from there (sample **Iolk 031**). The next layer, from 3.47 to 3.80 m, is dated to LH IIIC Middle, and yielded pottery that was the source of samples **Iolk 029-30**. The following layer dates to LH IIIC Early and extends from the depth of 3.80 to 4.10 m. It produced pottery from which samples **Iolk 026–028** were taken. From 4.10 down to 4.68 m there is a thick layer dated to LH IIIB. Samples **Iolk 001–007** and **033** were taken from pottery found there. No material found in an LH IIIA1 layer (4.69–4.93 m) was sampled. Below the depth of 4.93 m, down to 5.44 m, there is a layer containing Mycenaean and non-Mycenaean pottery, dating to LH I–IIB, from which samples **Iolk 008–025** were taken. Sample **Iolk 021** derives from a jug with a cutaway neck BE 9048, found in a cist tomb (Tomb I) located at a depth of 5.17–5.20 m, built with monolithic schist slabs on the north, south and west sides, while the east side was taken to the required height by the addition of a row of paving stones. The tomb contained the skeleton of a child in contracted position, lying on its right side, with the skull in the south-east. Single samples were taken from pottery found at the lowest excavated layer, reaching down to 5.80 m (sample **Iolk 034**) and dated to the MH period, and from an LH IIIC Middle pit stretching from a depth of 4.12 to 4.85 m (sample **Iolk 032**).

The E. Karayannis plot (Fig. 4), excavated in 1973 by Evangelia Deilaki (1977), is situated very close to the Diakoumis plot, and to the west of the church Ay. Theodoroi. In spite of the missing diaries, an effort was made to establish the sequence of the archaeological horizons (Batziou-Efstathiou 1998, 76–87). A floor deposit excavated at a depth of 3.85 m contained three interesting sherds with Pictorial style, among the usual LH IIIC Middle pottery (samples **Iolk 035–037**).[5] They were included in the NAA project in order to gain information about the production centre(s) of this kind of pottery.

Nea Ionia

The cemetery at Nea Ionia (Fig. 2) is dated to the prepalatial period, LH IIB–IIIA1, and is located to the north-west of Kastro/Palaia. The majority of the cemetery's tombs belong to cist and built types, and three out of 50 in total possibly held burials of Mycenaean warriors. The number and the quality of the grave goods indicate that not only the military but also other social classes acquired wealth and prestigious goods, including imported items from Crete and southern Greece. Although hundreds of tombs were excavated to the west of the settlement, dating to all

[4] The initial dimensions of the excavation were 5.85 x 5.95 m. The excavation's dimensions were restricted to the eastern half of the plot, dimensions 3.00 x 5.80 m, from the depth 3.35 down to 5.80 m, where it stopped.

[5] Pictorial style pottery is known from three other excavations at Kastro/Palaia: three examples from the Stratigraphical Trench to the west of the settlement (Theocharis 1960, figs 4–5), one from the Diakoumis plot and one from the Kokotsika plot (Batziou-Efstathiou 1998, figs 53*a* and 53*e*).

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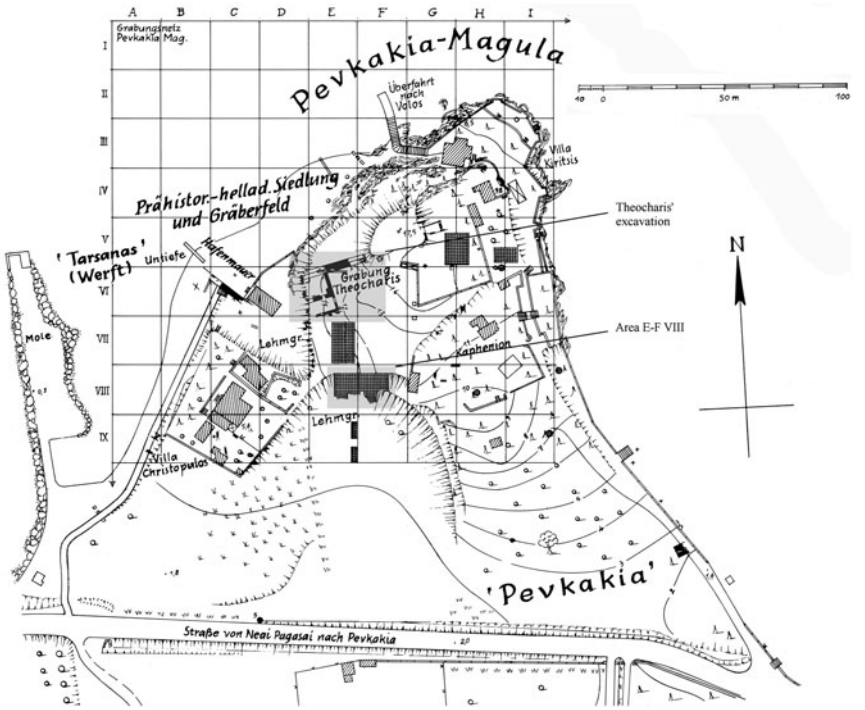

Fig. 5. Plan of Pefkakia Magoula with highlighted contexts from which samples were selected. Modified after Maran 1992, plan I.

periods from LH IIB to Byzantine times, only one or two of them belong to LH IIIA2, even though on the hill of Kastro/Palaia continuity of habitation is attested throughout the LH period (Batziou-Efstathiou 1991; 1999; 2003). Fourteen pottery samples from the tombs of the early Mycenaean cemetery of Nea Ionia were selected, dating predominantly to LH IIB–IIIA1 and thus representing some of the earliest Mycenaean pottery in the area (Graves 6, 17, 18, 52, 194, 1/95 and 3/95; samples **NIon 001, 003, 005, 006, 008–012, 014–017**). Only one sampled vessel dates to LH IIIA2 (Grave 9, sample **NIon 007**), and one to LH IIIC Late/Submycenaean (Grave 57, sample **NIon 013**).

Pefkakia

Pefkakia is one of the three major Mycenaean sites in the Volos area, the other two being Dimini and Kastro/Palaia (Figs 1 and 2). Pefkakia dominates the entrance to the inner Pagasetic Gulf (i.e. the Gulf of Volos) and was the harbour involved in trade between Iolkos and the Mycenaean world.

The site consists of a tell (Magoula), where Demetrios Theocharis (1957, 66) and Vladimir Milojčić (1974) excavated settlement remains dating from the Neolithic to the Late Bronze Age periods. The excavations in the flat area to the south-east of the tell have demonstrated that the settled area in the Mycenaean period extended beyond the Magoula. The excavations of the last 14 years have uncovered part of a multi-phased architectural complex of the Mycenaean period (Batziou-Efstathiou 2012; 2015a; 2015b). The subsequent study of the finds by a collaborative team helps to reveal the character of the settlement, its commercial connections, its role and possible administrative links with the other two Mycenaean sites, as well as relations with other regions to the south.

Samples **Pefk 002–003, 006, 008** come from contexts dating to Middle Bronze Age phases 5 and 6 of Milojčić's excavation on the tell (Fig. 5). They date to the MH II period in southern Greece.[6]

[6] For a discussion of the other MH samples from Pefkakia see already Maran (2007).

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Fig. 6. Photograph of excavations at the site of Mycenaean Pefkakia, south of Magoula, with highlighted context (Room 1) from which samples were selected. North at the bottom of the photograph. Modified after Batziou-Efstathiou 2015a, fig. 6.

Samples **Pefk 013–015** derive from Theocharis' excavations in rooms B and Γ in trench II (Theocharis 1957, 63, fig. 4; Fig. 5). They date to LH IIIA2–B1.

Samples **Pefk 016–017** were taken from complete vessels from the Apostolides Collection. According to the available information, the vases derive from a tomb in an uncertain location, either on the south slopes of Pefkakia Magoula or to the east of it (Apostolidis 1912, 33–6, fig. 2, pl. VII; Wolters 1889, 262). They date to LH IIB.

The samples **Pefk 018–036** come from excavations in 1987 in the flat area ('Mycenaean Pefkakia' on Fig. 2), in Room 1 (Fig. 6).[7] The context dates to LH IIIA2–B.

Velestino

A Mycenaean pottery kiln was excavated in 1986 by A. Intzesiloglou (1992) in Velestino (Figs 1 and 7), to the south-west of 'Magoula Bakali', a settlement of the Bronze Age, Archaic and Classical periods.

The pear-shaped kiln with a diameter of 1.60 m was revealed below the depth of 4.80 m, covered by charcoals and stones of the collapsed dome (Batziou-Efstathiou 1994). Only a small part of the dome (l. 0.80 m, w. 0.20 m, h. 0.40 m) to the south-west of the kiln (Batziou-Efstathiou 1994, fig. 2), with the heating chamber, part of the grid and the opening (l. 0.80 m, w. 0.60 m) for supplying combustibles were found to be preserved. The opening had inclined sides. The interior of the kiln was coated with clay and divided by a mud-brick wall into two equal parts. The clay floor had holes (diameter 0.10–0.12 m), which allowed the circulation of hot air. The painted Mycenaean pottery found within the area of the kiln includes closed shapes (hydrias, amphoras, jugs, feeding bottles, straight-sided alabastra), but open shapes (kraters, deep bowls, kylikes, kalathos, basins, cups) constitute the majority. Apart from the linear decoration found on both categories, the closed vases are decorated with Furumark Motif (FM) 72 tassel pattern, and FM 50 antithetic loops, and the open shapes mainly with triglyph patterns and FM 46

[7] Batziou-Efstathiou 1992; for the location of Room 1 in relation to other architectural spaces, see Batziou-Efstathiou 2015a, fig. 6.

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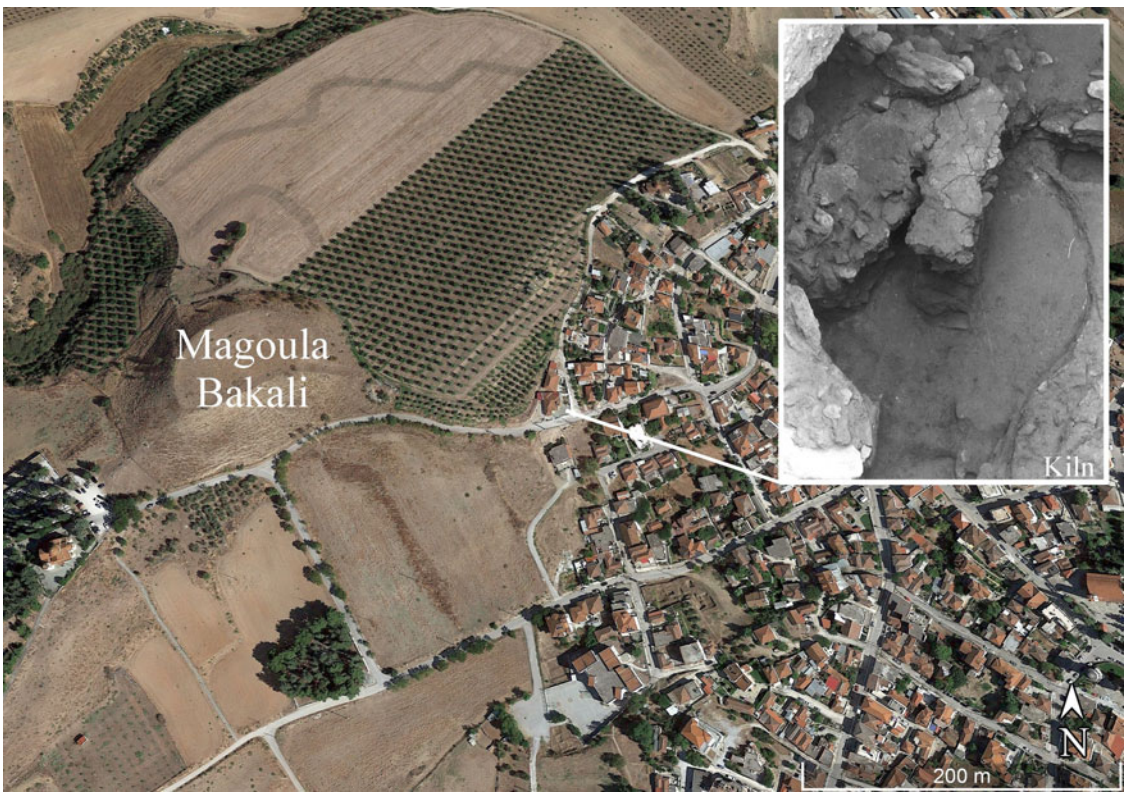

Fig. 7. View of Velestino with location of kiln in relation to the site of Magoula Bakali. Base map: Google Earth, photograph of the kiln after Batziou-Efstathiou 1994, fig. 2.

running spiral, and a single pictorial motif, FM 7 bird. Some deep bowls are monochrome. In general the pottery seems to date to LH IIIC Middle. Twenty fragments were selected for analysis (samples **Vele 001–020**), among them predominantly open shapes, and a few closed forms. None of the pottery found within the kiln area qualifies as production waste.

OVERVIEW OF SAMPLED MATERIAL

The pottery[8] sampled within this project from the five Thessalian sites just described represents a broad chronological as well as typological range, covering the time between the MH period and the very end of the LBA. The majority belongs to the Mycenaean repertoire of shapes and decorative motifs, yet several pre-Mycenaean and LBA non-Mycenaean pottery fragments and vessels were sampled as well.

The few MH fragments include two examples of Grey Minyan pottery and one dark burnished closed shape, as well as a few polychrome and matt-painted examples.

Contexts dated to LH I–IIB/IIIA1 yielded a mix of non-Mycenaean and Mycenaean pottery, a selection of which was chosen for analysis. Among the former, there are closed and open shapes with matt-painted and bichrome decoration, as well as undecorated and burnished open shapes. The earliest sampled Mycenaean pottery includes Vapheio cups, goblets, and a range of closed shapes, deriving mostly from tombs and consisting predominantly of piriform jars but also jugs.

[8] See the catalogue published as online-only Supplementary Material.

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This Mycenaean pottery dates chiefly to LH IIB–IIIA1, but a few earlier fragments (LH IIA and even LH I) were included too.

Sampled pottery of the palatial period (LH IIIA2–B) consists predominantly of open shapes, decorated and plain. These include kylikes, kraters, deep bowls, mugs and stemmed bowls. A single alabastron derives from an LH IIIA2 cist tomb. Other decorated closed shapes from settlement contexts include stirrup jars, another alabastron, fragments of unclassifiable jars, and a rare example of a flask. A few linear medium-coarse closed fragments most likely belong to transport stirrup jars.

Post-palatial pottery included in this project is again dominated by open shapes such as kraters, deep bowls, cups and basins. Closed shapes comprise a hydria and fragments of linear and unpainted jars. The LH IIIC Early contexts at Dimini yielded two vessels belonging to Handmade Burnished Ware and a fragment of Grey Ware. The latest sampled vessel is a stirrup jar deriving from a cist tomb at Nea Ionia, dating to LH IIIC Late or Submycenaean.

The pottery included in this sampling project cannot be considered as fully representative of the range of shapes, decorative treatments, functional classes and fabrics used in the respective sites during the various stages of the Late Bronze Age. This is a result of a relatively small sample size, especially in the case of multi-period sites such as Dimini or Kastro/Palaia, considerable chronological variation across the parameters listed above, as well as the fact that in the mid-1990s the study of pottery at several of the sites included here was far from completion. These constraining factors, however, do not invalidate the fact that this study documents, for the first time, the extent and character of local pottery production in Thessaly as well as the range of contacts with the exterior world.

NAA METHOD AND RESULTS

Neutron Activation Analysis has been successfully used since the late 1960s to determine the production places of archaeologically discovered pottery, and is today a widely accepted method for this task. In Bonn, NAA measurements of pottery samples were begun more than 30 years ago, and the procedure has been described already several times at length (Mommsen et al. 1991; Mommsen 2007; Mommsen and Japp 2014; Lis et al. 2020b). Most important facts regarding the Bonn NAA procedure are as follows:

- sample size about 80 mg obtained by drilling with a corundum pointed drill bit.
- irradiation at the Research Reactor Geesthacht for 90 minutes at a flux of $5 \cdot 10^{13}$ neutrons/(cm^2 s).[9]
- standard: Bonn pottery standard calibrated with the Berkeley pottery standard (Berkeley standard composition: Perlman and Asaro 1969, 29, table 3; Bonn standard composition: Mommsen and Sjöberg 2007, 360, table 1).
- measurement of each sample four times in the period of one to four weeks after the irradiation, determining up to 30 minor and trace element concentrations in each sample, many of them several times.

For the comparison of the data and the forming of groups of vessels of the same origin, more precisely made with the same clay paste, the statistical 'filter method' developed in Bonn is applied that takes experimental uncertainties and also possible dilutions (adding any material not seen by NAA) or elutriations (removal of coarser fractions) of the clay paste into account. This has also been described at length in a number of publications (Mommsen, Kreuser and Weber 1988; Beier and Mommsen 1994; Mommsen et al. 2002; Mommsen and Sjöberg 2007; Lis et al. 2020b, 6).

The raw concentration data of the 145 samples of clays and pottery from Thessaly are stored online at https://mommsen.hiskp.uni-bonn.de, and are also included in this publication as

[9] The help of the staff of the research reactor in Geesthacht irradiating the samples is thankfully acknowledged.

online-only Supplementary Material. This dataset was found to have a large number of statistically different concentration patterns. All the group patterns that are archaeometrically not assignable to either a certain workshop(s), a definite site or a limited region are for some time now named with the letters U or X and a number, e.g. X148. If a member of a group is a good and obvious reference piece, like a clay sample or a waster, we rename the group indicating this site, e.g. DimI to point to Dimini as origin.

The largest group of 27 members, called DimI (Table 1), was made locally at Dimini, as clay samples from the surroundings of the modern workshop of the potter Kostas Louros and other reference material like sherds from the firing chamber of the kiln at the Tsakanika plot prove. The clay samples were taken from the visible clay layer at the *c.* 1 m high step between the fields near the workshop, which separates fields where the clay had already been quarried from those with yet unexploited clay beds. Included in this group of 27 vessels are seven from Kastro/Palaia and one each from Nea Ionia, Pefkakia and Velestino (Table 2). A group of other vessels exported from the workshop(s) using paste DimI has been identified at Dragojna, Bulgaria (Bozhinova, Jung and Mommsen 2010), and a few more pieces were exported to other sites like Troy or Ephesos (Fig. 1).

A second local pattern, DimE, of only four members has now been defined, comprising samples of unfired and fired clays from the kiln at the Tsakanika plot.

Two further new patterns can be ascribed with high probability to a workshop(s) at Velestino, group X119 of six samples, among them a hydria from the area of the kiln there, and group X032 of seven samples: four from Velestino, one from Dimini and two modern akroteria given to us by the potter Louros.

Presumably also local to Thessaly are two small groups X148 and X149 that characterise workshops of a still unknown location. X148 has four members from Bunarbaschi (north-east Thessaly) and one from Velestino, and X149 has eight members from Pyrasos (south-east Thessaly, within the modern city of Nea Anchialos, Fig. 1) and six more deriving from this project (Table 2).

In Fig. 8 the result of a discriminant analysis (DA) supports the statistical group forming procedure and shows the good separability of the six groups mentioned before. Three additional well-known groups, assigned to the north-eastern Peloponnese (MYBE), Euboea (EuA) and, by distribution arguments, Thebes (TheB) have been added in a second DA calculation, the result of which is depicted in Fig. 9. The pieces imported form these locations to Thessaly (see below) are good members of these groups and well distinguished from the six probably regional groups.

To summarise, from the 145 samples deriving from the sites studied here, about a third, i.e. 52 samples, are members of the previously mentioned groups, and can be ascribed with high probability to regional centres of production. The average concentration patterns of these groups are given in Table 1. A further third, 47 samples, are chemical singletons (39) or single pairs (8 samples belonging to 5 different pairs). Nothing can be concluded about these samples, as they might belong to so far unknown patterns or have been contaminated in antiquity or in modern times, or they might have been measured erroneously.

The final third of the samples has concentration patterns that were known to us already, some assigned to particular workshops and some known only as paste patterns of workshops with unknown locations. The large number of different patterns and therefore imports from workshops at different sites in this group is astonishing and may point to extended trade networks during Mycenaean times (for more discussion see below), further emphasised by a sampling strategy partly directed towards macroscopically non-local pieces. This is also confirmed by the high number of singletons.

The largest group of samples, 21 pieces, is thought to originate in the north-eastern Peloponnese and to be imports from there. They belong to the well-known cluster of groups around the core group called MYBE (MBCs, MYCE, MBKR, MBKK; see Mommsen et al. 1988; Demakopoulou et al. 2017). A conspicuous feature that needs further study is that the members of the groups MBCs and MYCE, whose date is known, seem to belong predominantly to the phases before LH III (see also EMBP in Mommsen et al. 2002). Other groups with a smaller number of samples and also single pieces of known groups were imported from regions near to

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Table 1. Average concentration values M in μg/g (ppm), if not indicated otherwise, of groups of samples in the Thessaly dataset of this project. σ is the standard deviation (root mean square deviation) in %. All member samples of the groups in the Bonn databank are shown. The individual samples have been corrected with a best relative factor with respect to the grouping values (given in Table 2).

	DimI 38 samples		DimE 4 samples		X119 6 samples		X032 7 samples		X148 5 samples		X149 15 samples	
	M	σ(%)	M	σ(%)	M	σ(%)	M	σ(%)	M	σ(%)	M	σ(%)
As	19.7	(49.)	26.1	(39.)	10.5	(49.)	9.02	(21.)	17.4	(83.)	5.02	(84.)
Ba	557.	(26.)	375.	(26.)	483.	(14.)	404.	(31.)	510.	(9.1)	427.	(9.5)
Ca\%	3.16	(41.)	2.78	(22.)	6.22	(20.)	7.04	(49.)	4.79	(56.)	13.0	(17.)
Ce	66.5	(3.3)	57.0	(4.3)	59.7	(2.4)	50.2	(3.7)	67.4	(2.7)	62.4	(3.0)
Co	23.4	(4.9)	27.3	(3.6)	25.0	(3.0)	32.7	(7.8)	32.2	(5.9)	24.9	(7.8)
Cr	210.	(5.8)	245.	(6.9)	245.	(4.6)	348.	(13.)	290.	(6.7)	234.	(7.9)
Cs	6.28	(7.1)	5.59	(7.7)	5.18	(6.7)	3.99	(7.5)	5.33	(6.8)	4.40	(6.6)
Eu	1.27	(3.7)	1.38	(4.1)	1.21	(4.2)	1.10	(3.1)	1.34	(2.6)	1.17	(3.5)
Fe\%	4.53	(2.9)	5.67	(4.6)	4.62	(1.8)	5.76	(4.6)	5.62	(2.2)	4.90	(4.5)
Hf	4.71	(7.9)	4.44	(3.7)	4.93	(6.8)	4.08	(5.2)	5.13	(8.7)	3.76	(4.6)
K\%	2.66	(9.4)	1.67	(9.6)	2.10	(9.4)	1.79	(16.)	2.68	(2.8)	1.83	(9.2)
La	31.7	(3.3)	27.8	(6.7)	28.5	(1.8)	23.4	(3.1)	32.5	(3.1)	28.8	(5.5)
Lu	0.44	(8.9)	0.54	(5.1)	0.44	(4.6)	0.47	(7.4)	0.51	(3.5)	0.45	(4.1)
Na\%	1.49	(20.)	0.93	(12.)	1.69	(20.)	1.17	(12.)	1.38	(6.9)	0.47	(11.)
Nd	28.3	(9.8)	25.6	(15.)	25.4	(14.)	22.2	(16.)	30.2	(3.6)	25.8	(5.3)
Ni	143.	(14.)	144.	(9.1)	179.	(7.9)	254.	(13.)	295.	(18.)	205.	(12.)
Rb	138.	(8.3)	95.1	(13.)	104.	(16.)	92.5	(4.6)	127.	(4.9)	109.	(5.7)
Sb	0.90	(15.)	0.88	(21.)	0.75	(12.)	0.59	(10.)	0.70	(19.)	0.56	(22.)
Sc	19.5	(2.5)	26.8	(7.8)	20.7	(2.4)	25.3	(8.4)	23.7	(3.9)	20.5	(3.2)
Sm	5.33	(7.9)	5.30	(8.2)	5.34	(4.0)	4.57	(2.5)	5.91	(3.3)	4.86	(5.8)
Ta	1.06	(5.5)	0.76	(7.8)	0.88	(4.7)	0.66	(4.6)	0.97	(3.3)	0.88	(3.8)
Tb	0.80	(5.7)	0.86	(6.1)	0.81	(5.6)	0.75	(8.1)	0.92	(5.7)	0.74	(5.9)
Th	13.8	(5.7)	11.4	(5.0)	10.9	(2.4)	8.52	(5.2)	12.1	(2.2)	10.4	(3.2)
Ti\%	0.43	(15.)	0.46	(16.)	0.40	(6.8)	0.42	(9.5)	0.47	(4.0)	0.45	(42.)
U	2.41	(12.)	3.66	(10.)	2.65	(6.8)	1.97	(9.9)	2.52	(5.7)	2.42	(24.)
W	3.04	(13.)	3.31	(11.)	2.63	(17.)	1.97	(8.7)	2.32	(13.)	2.27	(15.)
Yb	2.95	(4.3)	3.28	(3.4)	2.88	(1.8)	2.84	(5.3)	3.55	(6.3)	2.80	(4.8)
Zn	101.	(15.)	98.6	(5.0)	92.8	(9.1)	104.	(8.0)	136.	(19.)	99.2	(9.2)
Zr	204.	(17.)	214.	(20.)	229.	(14.)	189.	(14.)	229.	(13.)	153.	(21.)

Table 2. Dilution or elutriation factors of the individual samples of the groups applied to the raw NAA concentration data forming the groups (w = repetition measurement).

DimI	38 samples, 27 here (Dimi 41, 42, 44, 45 are clays)
	Vrom 15(0.99), Dimi 3(1.01), 4(0.95), 5(1.00), 6(0.97), 8(1.03), 19(0.98), 22(1.04) 28(0.99), 29(0.97), Dimi 32(1.08), 33(1.07), 35(1.03), 37(1.01), 41(1.13), 42(0.99), 44(0.94), 45(1.13), Iolk 21(1.00), 29(1.00), Iolk 30(0.95), 31(1.06), 34(1.05), 35(1.01), 37(1.03), NIon 8(0.99), Pefk 33(0.93), Vele 4(1.02), Pole 1(0.98), Drage 1(0.92), Drage 2(0.92), 2w(0.92), 3(0.94), 4(0.97), 6(0.94), Troia 67(0.96), 261(1.10), Ephe 144 (0.94)
DimE	4 samples, only here
	Dimi 2(0.99), 9(1.01), 10(1.02), 11(0.98)
X119	6 samples, only here
	Vele 1(1.06), 8(0.93), 11(1.01), 12(0.99), 16(1.04), 19(0.98)
X032	7 samples, only here
	Dimi 15(1.04), 38(0.88), 39(0.87), Vele 3(0.98), 9(1.10), 13(1.13), 15(1.03)
X148	5 samples, 1 here
	Vele 18(1.22), BUBA 14(0.92), 21(1.01), 23(0.97), 25(0.94)
X149	14 samples, 6 here
	Dimi 7(1.03), Iolk 2(1.01), 3(1.07), 26(1.05), Pefk 23(0.99), 34(1.13), Thes 8(0.92), 10(0.97), 11(0.95), 11w(0.99), Thes 15(1.04), 17(0.95), 18(0.95), 19(1.00), Troia 243(0.97)

Thessaly like Boeotia (TheA, TheB,[10] X066[11]), the northern Aegean (X010, Stockhammer et al. 2020) or Euboea (EuA, Mommsen 2014). Imported pieces are detectable also from production sites further away, such as Attica (KroP, Mommsen 2003), Aegina (AegA, Mommsen et al.

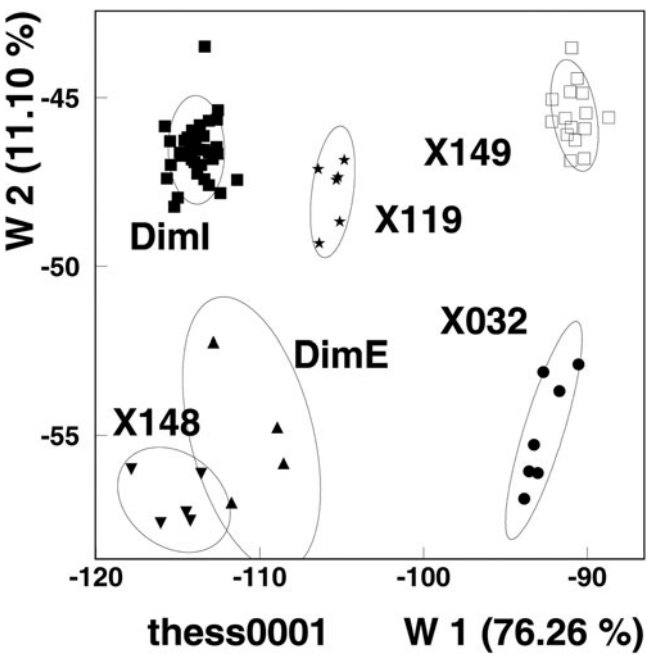

Fig. 8. Result of a discriminant analysis (DA) of 74 samples, corrected for dilution, assuming the six clusters given in Table 1 using all elements shown there except As, Ba, Ca, Na, Ti. Plotted are the discriminant functions W1 and W2, which cover 76.3% and 11.1% of the between-group variance. The ellipses drawn are the 2σ boundaries of the groups.

[10] Schwedt et al. 2006, A = TheA, B = TheB.

[11] Villing and Mommsen 2017, 128–9. This group contains samples from at least two production centres, one on Rhodes, the other in Boeotia/East Lokris.

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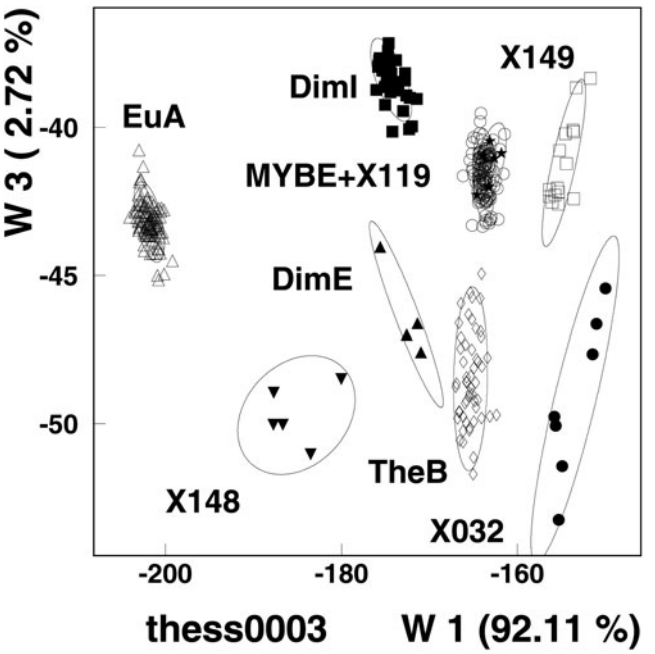

Fig. 9. Result of a discriminant analysis (DA) as in Fig. 8, including now three additional clusters (MYBE, EuA, TheB). Plotted are the discriminant functions W1 and W3, which cover 92.1% and 2.7% of the between-group variance. The groups MYBE and X119 overlap here, but are resolved in other projections (group centres of MYBE: W1 = -163.8, W2 = 1.48, W3 = -41.6 and of X119: W1 = -163.2, W2 = -7.2, W3 = -41.2): all groups are well separated in the multidimensional concentration space.

2001a; and possibly also X093, unpublished, with five additional members, all from Aegina), Achaia/Elis (OlyA, Mommsen, Bentz and Boix 2016; and also possibly X160, unpublished), and Aetolo-Acarnania (AkaR, Jung, Mommsen and Pacciarelli 2015), and even from as far as Crete (subgroup of KnoL, Gilboa et al. 2017), Corfu (Kofu, unpublished) or Apollonia in Albania (ApoA, unpublished).

DISCUSSION

Archaeological investigations at the sites included in this project revealed the existence of two kilns belonging to the Mycenaean period, at Dimini and Velestino. The results of NAA correlate well with this evidence, as several of the revealed chemical patterns can be tied to these production centres with high probability, despite the lack of production waste that represents prime reference material. In the case of Dimini, the association is stronger, as it is confirmed by clay samples, while at Velestino it is based only on the distribution of group members.[12]

The DimI pattern is found in samples of Mycenaean-style pottery dated from LH IIB to LH IIIC Middle deriving from all investigated sites (Table 3). At least two bichrome pottery fragments (**Dimi 033**, **Iolk 034**) show this pattern as well, and as such extend its chronological range to the beginning of the Late Bronze Age, if not earlier. In addition, examples of a cooking pot (**Dimi 003**) and of an Italian-type Grey Ware piece (**Dimi 029**) provide further evidence that this pattern is attested among various wares and pottery types. The result for the Grey Ware sample shows for the first time that such pottery, despite its relatively low numbers, was locally

[12] It is planned to conduct analyses of clay samples from Velestino in order to provide additional evidence for pottery production there.

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Table 3. Provenance as determined by NAA of different pottery groups analysed in the project.

	Local/regional						Local/ regional total	North-east Peloponnese	Central Greece							Western Greece						Other					Imports total			Grand total
	DimE	DimI	X032	X119	X148	X149		MYBE and subgroups	AegA	EuA	KroC / KroP / KroP U +	TheA	TheB	TheB - (gen. Boeotian)	Other (TheB or KnoL, X066)	AkaR	ApoA	ApoA or AkaR	Kofu	OlyA Cs +	KnoQ	X010	X093	X160	X160 or X011		Pairs	Singles	
Matt-painted																												2	2
Bichrome		2					2						1													1		3	6
Δ1β-Ware																												1	1
Grey Minyan										2																2			2
MH Dark burnished											1															1			1
Early LBA handmade and burnished																2		1								3		4	7
Mycenaean style, painted		9*	5	3	1	5	23	20*		1	1	1	1		1	2		1		2	1	1	1	1	1	1	36	7	21	86
Mycenaean style, pictorial		4					4			1																1			5
Mycenaean style, unpainted		6		3		1	10	1		1																2			12
Italian Grey Ware		1					1																						1
Handmade Burnished Ware																												2	2
Transport stirrup jar																											1	2	3
Cooking pottery		1					1																					2	3
Kiln construction/clay lumps	4						4																					1	5
Clays		2					2																					1	3
Modern reference material		2	2				4																					1	5
Total	**4**	**27**	**7**	**6**	**1**	**6**	**51**	**21**	**2**	**4**	**2**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**46**	**8**	**40**	**145**

*Includes two samples deriving from the same vessel

Table 4. Share of samples with particular/without provenance determined by NAA at the sites included in the project

Site	Total samples	Local/regional	Singles and pairs	North-east Peloponnese	Other samples (supra-regional imports)
Pefkakia (LBA) [Pefk]	24	3	8	6	7
%	100%	13%	33%	25%	29%
Dimini [Dimi]	32	15	9	4	4
%	100%	47%	28%	13%	13%
Nea Ionia [NIon]	14	1	6	5	2
%	100%	7%	43%	36%	14%
Kastro/Palaia [Iolk]	36	9	15	5	7
%	100%	25%	42%	14%	19%
Velestino [Vele]	20	12	4	0	4
%	100%	60%	20%	0%	20%

produced in the Aegean.[13] This has been shown before for another group of Italian-derived pottery – Handmade Burnished Ware – that reproduces shapes of *impasto* pottery (Whitbread 1992; D'Agata, Boileau and De Angelis 2012; Mommsen et al. 2002). Within this project, samples taken from Handmade Burnished Ware (**Dimi 012**, **036**) turned out to be chemical singles.

The combined chronology of those samples clearly exceeds the period of use of the substantial kiln found at Dimini. Therefore, other production units/workshops must have existed that manufactured pottery using ceramic paste that shows this pattern. One of them was surely a small kiln dated to LH IIIC Early found at Dimini (Adrymi-Sismani 2020, 29). Nevertheless, sampled pottery from Kastro/Palaia dating to LH IIIC Middle provides evidence of a different phenomenon. Since it post-dates the latest habitation attested at Dimini (LH IIIC Early), Dimini clay beds must have been used more widely than by the local settlement. As Kastro/Palaia is the only site in the area that produced archaeological levels of that date, we may suggest that it could have been the place where pottery production, including of pictorial kraters, took place, using clays from the area of Dimini. The distance between the two sites is less than 3 km as the crow flies (Fig. 1), and thus within the range typically reported in ethnographic records related to pottery production (Rice 1987, 116, tab. 5.1). Furthermore, modern potters from Volos and at least one major tile- and brick-producing company in Volos (Tsalapatas) exploited clays from Dimini until recently.

Dimini itself, as could be expected, has the highest share of samples with this pattern, a number of which came from within the kiln (Table 4). In contrast, samples from Pefkakia and Velestino feature just a single piece each that belongs to this pattern. In the former case, this is probably related to the character of the site involved in maritime trade (see below) and to the focus of the sample choice on possible imports. In the latter, it is probably a combination of three factors – greater distance from Dimini, local production at the site, and chronology.

At Kastro/Palaia, although the DimI pattern is well attested, it is restricted to chronological extremes of the sampled material. It includes a fragment of bichrome pottery and one of the earliest pieces of locally made Mycenaean pottery, as well as four examples of LH IIIC Middle pictorial pottery. The restricted sample from the site does not allow us to say whether this chronological pattern is meaningful, i.e. whether the site of Kastro/Palaia was actually not supplied by the workshop(s) operating at Dimini during the palatial period (LH IIIA2–B). At the nearby Nea Ionia cemetery, only a single piriform jar has been assigned to the DimI group.

Pattern X119 is restricted to LH IIIC and was found only among the samples from Velestino. This, together with the presence of a kiln, makes us fairly confident in assigning it to that site. We

[13] The only other chemical analysis of Grey Ware of Italian type has been performed on a carinated bowl fragment from Tell Kazel (Syria), but no provenance was suggested for the pair formed by this bowl and a fragment of a Grey Ware deep bowl of Mycenaean style (Badre et al. 2006).

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have to admit, however, that the number of fragments dating to LH IIIC sampled from the coastal sites is very limited, and it cannot be excluded that products of the Velestino workshop(s) were present also in the coastal area. Another pattern that is probably associated with Velestino is X032, with four members from Velestino and one member from Dimini, in addition to two modern akroteria manufactured with clay from the area. The workshop that used this paste may have operated over a longer period, as the sample from Dimini (**Dimi 015**) dates to LH IIIA.

Another most probably Thessalian pattern is X149, represented by six samples from three different sites. It was first identified in a group of sherds presumably deriving from Pyrasos, a site within modern Nea Anchialos, 10 km south-west from Volos, likewise located on the coast (Fig. 1). More research on Mycenaean pottery from sites located within the plain of Almyros is needed to confirm this possible provenance. This pattern definitely has a limited presence within the Pagasetic Gulf, and it currently appears to be restricted to the LH IIIA–C Early phases. Pottery displaying this chemical signature is of high quality, both in terms of manufacture as well as decoration.

It is worth mentioning at this point that the very likely Thessalian pattern PfkA, known from MH matt-painted pottery (Maran 2007), was not detected among the Late Bronze Age samples.

Regarding pottery exchange within Thessaly, one additional piece of evidence emerges from this project. One of the fragments from Velestino (sample **Vele 018**) belongs to group X148. Three other members of this group derive from Bunarbaschi, a site in inland northern Thessaly (Fig. 1), and thus the Velestino sample possibly represents an import from one of the inland Thessalian plains.

Moving beyond Thessaly, the major source of imports is the north-east Peloponnese and workshop(s) associated with the well-known pattern MYBE. This pattern is very well represented among pottery from the earliest Mycenaean burials at Nea Ionia, making up slightly less than 40 per cent of the samples (Table 4), and the proportion is similar if LH II/IIIA1 pottery from settlement levels is taken into account. Moreover, thanks to this programme of analysis, the earliest Mycenaean import in Thessaly could be identified. Until now, it was believed that a pyxis from Kastro/Palaia, dated on stylistic grounds to LH IIA (Mountjoy 1999, 827, fig. 329), constitutes the earliest Mycenaean vessel found in coastal Thessaly. Yet the manufacture (handmade) and decoration of a Vapheio cup from the same site (sample **Iolk 010**) strongly suggest an LH I date,[14] providing the earliest evidence for contact between those distant areas.

Samples from Pefkakia show that the importance of the north-east Peloponnese as a source of imported pottery carries on into the palatial period (Table 4), as there are six samples dated to LH IIIA2/B showing this chemical pattern. Interestingly, five of them belong (or most likely belong) to kylikes. Two samples from Kastro/Palaia, this time deriving from small closed shapes, demonstrate a persistence of this connection late into LH IIIB. The pattern is not found among samples post-dating the transition around 1200 BC.

Other groups that are localised beyond Thessaly have fewer members among the sampled material. One of these small groups, with four members, is associated with Central Euboea (EuA). It is an interesting collection, as it comprises chronological extremes. There are two Grey Minyan fragments, both deriving from later contexts but most likely dating to the MH period, an LH IIIC pictorial krater, and an LH IIIC Late or even Submycenaean stirrup jar from one of the tombs at Nea Ionia.

Another important island connection is that with Aegina. Two matt-painted closed shape fragments derive from early Mycenaean levels at Kastro/Palaia. They constitute the first confirmed early Mycenaean imports from Aegina in Thessaly. In fact, these are also the first Bronze Age imports from this island to Thessaly confirmed by scientific means.[15] This connection continues

[14] The best parallels for the decoration can be found among matt-painted panel cups of LH I date, such as examples from Lerna (Caskey 1955, pl. 16*a*). For an LH I Vapheio cup with a similar spiral, see Mountjoy 1986, 15, fig. 8:5.

[15] For the possibility of a local emulation of MH Aeginetan pottery, in spite of the lack of Aeginetan imports in the extensive MH layers at Pefkakia, and of possible Aeginetan imports at Velestino, see Maran 2007. For possible Aeginetan pottery at the site of Kastraki, see Batziou-Efstathiou 2010.

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into the palatial period, during which large quantities of cooking pots produced on Aegina reach the Pagasetic Gulf (Lis et al. 2020a). These were not sampled in this project, but an unpainted kylix from Pefkakia Magoula (sample **Pefk 013**) shows pattern AegA. The phenomenon of fine Mycenaean pottery produced on Aegina is now also confirmed scientifically (Gilstrap 2014), but examples of exports far beyond the Saronic Gulf were unknown until now.

Boeotia is the source of a similarly small group of imports. Three out of four samples cluster in LH IIIA, perhaps suggesting that this was the period when ties between the two regions were closest. The fourth import is a fragment of a bichrome vessel from a Middle Helladic layer (sample **Pefk 003**) and belongs to pattern TheB, suggesting a Boeotian origin. Another sample (**Iolk 014**) belongs to pattern X066, associated with Boeotia/East Locris.

Although separated from the Thessalian plains by a barrier of mountain ranges, Western Greek regions, the Ionian islands, and even areas further to the north (Albania) are sources of a handful of imports associated with patterns such as AkaR, ApoA, Kofu or ZakA. Although attested already in the early LBA, they seem to be most prominent in LH IIIC, in the material from Velestino. In this context one can mention also two samples from group X160, and a single sample from group OlyA, pointing to a source in the north-west Peloponnese. Again, two out of three samples came from Velestino.

Only two sampled fragments derive from Attica according to NAA, while a single sample from Pefkakia provides evidence for the furthest connection traced within this programme – with central Crete. Nevertheless, three transport stirrup jar samples from the same site, considered singles according to the NAA, might also derive from Crete.

Looking at particular sites and their samples (Table 4), a few interesting patterns can be singled out, some already mentioned in the discussion above. They seem to be related to the chronological range of the samples, the position of the site within the regional and supra-regional networks, and the identified locations of pottery production. The limitations resulting from a limited sample size should be taken into account when interpreting these patterns.

The sites of Dimini and Velestino stand out as having the highest share of the local/regional sources in the sampled material, which is clearly correlated with the fact that they are both production sites. Nevertheless, half of the local samples from Dimini derive from just a single context – the kiln – showing that the assemblages sampled from other contexts are much more varied in terms of their provenance. At Velestino, this is combined with a relatively significant share of supra-regional imports, suggesting that even during the twelfth century BC sites in interior Thessaly took part in a lively exchange of pottery.

With respect to the share of local/regional sources of pottery supply, the cemetery at Nea Ionia is at the other extreme. Here, besides a high share of singles/pairs, the MYBE pattern associated with the north-east Peloponnese has the most dominant position, which is not matched by any other site within this project. This highlights the role of contacts with this region for the incipient Mycenaeanisation of Magnesia.

Pefkakia shows a similarly low share of local/regional sources of supply, with a high frequency of imports from the north-east Peloponnese, and a significant share of other supra-regional imports. To this we can add that among the singles/pairs there are the three transport stirrup jars referred to above, also most likely imported from further afield. All this provides a very clear testimony of the role of Pefkakia as the main harbour in the area (Batziou-Efstathiou 2015a).

Kastro/Palaia presents a most balanced assemblage of samples in terms of their provenance. Nevertheless, a considerable quantity of singles/pairs significantly blurs the picture, while the wide chronological range of samples may conceal some trends that could only be identified if more samples were analysed.

Finally, the high number of singles/pairs should receive a comment, although as already mentioned a number of different factors may have contributed to this situation. Chemical singles and pairs are frequent (Table 3) among coarser and underrepresented fabrics of Handmade Burnished Ware (two out of two examples), transport stirrup jars (three out of three), cooking pots (two out of three) and matt-painted wares (four out of six), as well as early LBA handmade burnished unpainted shapes (four out of seven). Still, the total number of 22 singles and seven pairs among the Mycenaean-style pottery is rather unexpected. Interestingly, singles and pairs are not present among the pictorial or the unpainted Mycenaean-style pottery. The distribution of singles in terms

of date, site or context does not indicate any pattern that could point to a systematic error or an issue pertaining to a certain site or period. Future research will clarify whether this is only due to the choice of samples, or other yet unrecognised factors, or if the reason is more due to the higher number of workshops operating in Thessaly and the variability in raw materials and paste recipes.

CONCLUDING REMARKS

The publication of this group of NAA samples marks an important step towards placing the coastal part of Thessaly firmly within the network of pottery production and exchange of Middle and Late Bronze Age Greece. By providing answers to a number of research questions posed both by archaeologists working in the area and those responsible for the entire sampling project, it paves the way for further similar studies and makes the data available for interpretations by other scholars.

Probably the single most important contribution is the characterisation of local production that took advantage of clay beds around the site of Dimini, involving a range of functional classes produced by potters working in pre-Mycenaean, Mycenaean and non-Mycenaean potting traditions. LH IIIC Middle/Late samples from Kastro/Palaia showing the DimI pattern confirm that the use of these resources was not restricted to a single site, a phenomenon that can be traced up to modern times.

The definition of that particular pattern also made it possible to locate exports from the area of Magnesia (Table 2, pattern DimI). Their distribution is intriguing, as they include LH IIIA1 pottery (goblets and an alabastron) from Dragojna, a site located in southern Bulgaria, and an LH IIB–IIIA1 alabastron and an LH IIIC monochrome deep bowl from Troy (Fig. 1).[16] There are two samples from the area of central Greece south of Thessaly. One is an LH IIB alabastron from the cemetery at Golemi in East Lokris; the other is a fragment of a linear closed shape from the cemetery of Vromousa at Chalkis on Euboea, dated generally to the Late Bronze Age. These exports are few in number but bear witness to existing networks of exchange with the areas to the north, north-east and south of Thessaly, predominantly at the transition between LH II and IIIA.

Chemical patterns associated with other production workshops/sites have also been defined within this programme of analysis, yet their significance appears mostly local/regional at the moment.

Finally, in line with the other archaeological evidence, coastal Thessaly appears to have been closely connected with the other regions where Mycenaean culture developed, providing yet another argument for its inclusion within the core rather than the periphery of the Mycenaean world. Among the variety of regions that proved to be the sources of imported pottery found in Thessaly, the Argolid (or more generally north-east Peloponnese) stands out most prominently and seems to maintain this dominant position from the early Mycenaean period until the end of the palatial period. Even though comparative data with similar chronological resolution and level of published detail is limited, it seems that such a situation is typical for other regions as well.[17]

SUPPLEMENTARY MATERIAL

Online-only Supplementary Material, consisting of (a) the catalogue and (b) raw NAA data of the samples, is published as part of this article.

To view supplementary material for this article, please visit https://doi.org/10.1017/S0068245423000047.

[16] Another import from Thessaly to Troy is a framgent of an LH IIIB/C Early deep bowl, sample Troia 243, belonging to NAA group X149 (Table 2).

[17] See for example East Lokris (Mommsen et al. 2001b, table 2) or Rhodes (Marketou et al. 2006).

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REFERENCES

Adrymi-Sismani, V. 1999. "Μυκηναϊκός κεραμικός κλίβανος στο Διμήνι", in E. Froussou (ed.), *Η Περιφέρεια του Μυκηναϊκού Κόσμου* (Lamia), 131–42.

Adrymi-Sismani, V. 2006. "Η γκρίζα ψευδομινύεια και η στιλβωμένη χειροποίητη κεραμική από τον μυκηναϊκό οικισμό Διμηνίου", in A. Mazarakis Ainian (ed.), *Αρχαιολογικό Έργο Θεσσαλίας και Στερεάς Ελλάδας: Πρακτικά Επιστημονικής Συνάντησης Βόλος 27.2–2.3.2003* (Volos), 85–110.

Adrymi-Sismani, V. 2013. *Ο μυκηναϊκός οικισμός Διμηνίου: 1977–1997. 20 χρόνια ανασκαφών* (Volos).

Adrymi-Sismani, V. 2014. *Ιωλκός: η εϋκτιμένη πόλη του Ομήρου. Ένα αστικό κέντρο στον μύχο του Παγασητικού Κόλπου. Το διοικητικό κέντρο, οι οικίες και το νεκροταφείο* (Volos).

Adrymi-Sismani, V. 2020. 'The destruction of Mycenaean centres in Thessaly', in G.D. Middleton (ed.), *Collapse and Transformation: The Late Bronze Age to Early Iron Age in the Aegean* (Philadelphia, PA), 23–33.

Apostolidis, P. 1912. *Αί Παγασαί Ἐξεταζόμεναι Διά των Αιώνων: Τά Παγασαία Ἀρχαιολογικά Ευρήματα* (Athens).

Badre, L., Boileau, M.-C., Jung, R. and Mommsen, H. 2006. 'The provenance of Aegean- and Syrian-type pottery found at Tell Kazel (Syria), with an appendix by M. Kerschner', *Ägypten und Levante / Egypt and the Levant* 15, 15–48.

Batziou-Efstathiou, A. 1991. "Μυκηναϊκά από τη Νέα Ιωνία Βόλου", *ArchDelt* 40 (Α΄), 17–71.

Batziou-Efstathiou, A. 1992. "Νεότερες ανασκαφικές έρευνες στην ευρύτερη περιοχή της Μαγούλας Πευκάκια", in *Διεθνές Συνέδριο για την αρχαία Θεσσαλία στη μνήμη του Δημήτρη Ρ. Θεοχάρη, Βόλος 1987* (Athens), 279–85.

Batziou-Efstathiou, A. 1994. "Μυκηναϊκός κεραμεικός κλίβανος", in *Θεσσαλία: Δεκαπέντε χρόνια Αρχαιολογικής έρευνας, 1975–1990, αποτελέσματα και προοπτικές: Πρακτικά Διεθνούς Συνεδρίου, Λυών, 17–22 Απριλίου 1990 = La Thessalie: quinze années de recherches archéologiques, 1975–1990; bilans et perspectives; actes du colloque international, Lyon, 17–22 avril 1990* (Athens), 215–24.

Batziou-Efstathiou, A. 1998. "Η Ύστερη εποχή του Χαλκού στην περιοχή της Μαγνησίας, το Κάστρο (Παλιά) και τα Πευκάκια" (unpublished PhD thesis, Aristotle University of Thessaloniki).

Batziou-Efstathiou, A. 1999. "Το νεκροταφείο της Νέας Ιωνίας Βόλου κατά τη μετάβαση από την ΥΕ ΙΙΙΓ στην ΠΓ εποχή", in E. Froussou (ed.), *Η Περιφέρεια του Μυκηναϊκού Κόσμου* (Lamia), 117–30.

Batziou-Efstathiou, A. 2003. "Η Υστεροελλαδική ΙΙΙΓ στο Κάστρο του Βόλου", in N. Kyparissi-Apostolika and M. Papakonstantinou (eds), *2nd Interdisciplinary Colloquium, The Periphery of the Mycenaean World* (Athens), 253–62.

Batziou-Efstathiou, A. 2010. 'Kastraki. A new Bronze Age settlement in Achaea Phthiotis', in A. Philippa-Touchais, G. Touchais, S. Voutsaki and J.C. Wright (eds), *Mesohelladika: la Grèce continentale au Bronze Moyen. The Greek Mainland in the Middle Bronze Age. Η ηπειρωτική Ελλάδα στη Μέση Εποχή του Χαλκού. Actes du Colloque international, organisé par l'Ecole française d'Athènes, en collaboration avec l'American School of Classical Studies at Athens et le Netherlands Institute in Athens, Athènes, 8–12 mars 2006* (Athens), 291–300.

Batziou-Efstathiou, A. 2012. "Ανασκαφή μυκηναϊκού οικισμού στα Πευκάκια, 2006–2008", in A. Mazarakis Ainian (ed.), *Αρχαιολογικό έργο Θεσσαλίας και Στερεάς Ελλάδας, 3. Proceedings of the 3rd Archaeological Meeting of Thessaly and Central Greece 2006–2008. From Prehistory to the Contemporary Period* (Volos), 177–92.

Batziou-Efstathiou, A. 2015a. 'The Mycenaean settlement at Pefkakia: the harbour of Iolkos?', in J. Weilhartner and F. Ruppenstein (eds), *Tradition and Innovation in the Mycenaean Palatial Polities* (Vienna), 51–85.

Batziou-Efstathiou, A. 2015b. "Η τελική φάση κατοίκησης του μυκηναϊκού οικισμού στα Πευκάκια", in A. Mazarakis Ainian (ed.), *Αρχαιολογικό έργο Θεσσαλίας και Στερεάς Ελλάδας, 4. 2012. Πρακτικά επιστημονικής συνάντησης Βόλος 15.3–18.3.2012* (Volos), 133–44.

Beier, T. and Mommsen, H. 1994. 'Modified Mahalanobis filters for grouping pottery by chemical composition', *Archaeometry* 36, 287–306.

Bozhinova, E., Jung, R. and Mommsen, H. 2010. 'Dragojna: eine spätbronzezeitliche Höhensiedlung

in den bulgarischen Rhodopen mit importierter mykenischer Keramik', *AM* 125, 45–97.
Caskey, J.L. 1955. 'Excavations at Lerna, 1954', *Hesperia* 24, 25–49.
D'Agata, A.L., Boileau, M.-C. and De Angelis, S. 2012. 'Handmade Burnished Ware from the island of Crete: a view from the inside', *Rivista di Scienze Preistoriche* 62, 295–330.
Deilaki, E. 1977. "Οδός Αγίων Θεοδώρων", *ArchDelt* 28 (B′ 2), 546–7.
Demakopoulou, K., Divari-Valakou, N., Maran, J., Mommsen, H., Prillwitz, S. and Walberg, G. 2017. 'Clay paste characterization and provenance determination of Middle and Late Helladic vessels from Midea', *OpAthRom* 10, 7–49.
Feuer, B. 2016. 'Mycenaeanisation in Thessaly: a study in differential acculturation', in E. Gorogianni, P. Pavúk and L. Girella (eds), *Beyond Thalassocracies: Understanding Processes of Minoanisation and Mycenaeanisation in the Aegean* (Oxford), 186–201.
Gilboa, A., Shalev, Y., Lehmann, G., Mommsen, H., Erickson, B., Nodarou, E. and Ben-Shlomo, D. 2017. 'Cretan pottery in the Levant in the fifth and fourth centuries BCE and its historical implications', *AJA* 121, 559–93.
Gilstrap, W. 2014. 'Indirect evidence for pottery production on the island of Aegina during the transitional LH IIIB–LH IIIC Early period', in V. Kassianidou and M. Dikomitou-Eliadou (eds), *The NARNIA Project: Integrating Approaches to Ancient Material Studies* (Nicosia), 32–41.
Intzesiloglou, A. 1992. "Οικόπεδο Μιχάλη Σαράντη του Γεωργίου", *ArchDelt* 42 (B′ 1), 256–7.
Jung, R., Mommsen, H. and Pacciarelli, M. 2015. 'From west to west: determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy)', *JAS: Reports* 3, 455–63.
Lis, B., Kiriatzi, E., Batziou, A. and Rückl, Š. 2020a. 'Dealing with the crisis: mobility of Aeginetan-tradition potters around 1200 BC', *BSA* 115, 269–327.
Lis, B., Mommsen, H., Maran, J. and Prillwitz, S. 2020b. 'Investigating pottery production and consumption patterns at the Late Mycenaean cemetery of Perati', *JAS: Reports* 32, 1–18.
Maran, J. 1992. *Die Deutschen Ausgrabungen auf der Pevkakia-Magula in Thessalien III. Die Mittlere Bronzezeit* (Bonn).
Maran, J. 2007. 'Emulation of Aeginetan pottery in the Middle Bronze Age of coastal Thessaly: regional context and social meaning', in F. Felten, W. Gauss and R. Smetana (eds), *Middle Helladic Pottery and Synchronisms. Proceedings of the International Workshop Held at Salzburg, October 31st–November 2nd, 2004* (Vienna), 167–82.
Marketou, T., Karantzali, E., Mommsen, H., Zacharias, N., Kilikoglou, V. and Schwedt, A. 2006. 'Pottery wares from the prehistoric settlement at Ialysos (Trianda) in Rhodes', *BSA* 101, 1–55.
Milojčić, V. 1974. 'Bericht über die Deutschen archäologischen Ausgrabungen in Thessalien 1973', *AAA* 1, 43–75.
Mommsen, H. 2003. 'Attic pottery production, imports, and exports during the Mycenaean period by Neutron Activation Analysis', *Mediterranean Archaeology and Archaeometry* 3, 13–30.
Mommsen, H. 2007. 'Tonmasse und Keramik: Herkunftsbestimmung durch Spurenanalyse', in G. Wagner (ed.), *Einführung in die Archäometrie* (Berlin), 179–92.
Mommsen, H. 2014. 'Provenancing by Neutron Activation Analyses and results of Euboean and Euboean related pottery', in M. Kerschner and I.S. Lemos (eds), *Archaeometric Analyses of Euboean and Euboean Related Pottery: New Results and their Interpretations* (Vienna), 13–36.
Mommsen, H., Andrikou, E., Aravantinos, V. and Maran, J. 2002. 'Neutron Activation Analysis results of Bronze Age pottery from Boeotia including ten Linear B inscribed stirrup jars of Thebes', in E. Jerem and K.T. Biró (eds), *Archaeometry 98: Proceedings of the 31st Symposium, Budapest, April 26–May 3, 1998* (Oxford), 607–12.
Mommsen, H., Bentz, M. and Boix, A. 2016. 'Provenance of red-figure pottery of the Classical period excavated at Olympia', *Archaeometry* 58, 371–9.
Mommsen, H., Gauss, W., Hiller, S., Ittameier, D. and Maran, J. 2001a. 'Charakterisierung Bronzezeitlicher Keramik von Ägina durch Neutronaktivierungsanalyse', in E. Pohl, U. Recker and C. Theune (eds), *Archäologisches Zellwerk. Beiträge zur Kulturgeschichte in Europa und Asien. Festschrift für Helmut Roth zum 60. Geburtstag* (Rahden), 79–96.
Mommsen, H., Hein, A., Ittameier, D., Maran, J. and Dakoronia, F. 2001b. 'New Mycenaean pottery production centres from eastern central Greece obtained by Neutron Activation Analysis', in Y. Bassiakos, E. Aloupi and Y. Facorellis (eds), *Archaeometry Issues in Greek Prehistory and Antiquity* (Athens), 343–54.
Mommsen, H. and Japp, S. 2014. 'Statistical interpretation of elemental concentration data and the origin of Pergamene pottery', in H. Meyza (ed.), *Late Hellenistic to Medieval Fine Wares of the Aegean Coast of Anatolia: Their Production, Imitation and Use* (Warsaw), 31–40.
Mommsen, H., Kreuser, A., Lewandowski, E. and Weber, J. 1991. 'Provenancing of pottery: a status report on Neutron Activation Analysis and classification', in M.J. Hughes, M.R. Cowell and D. Hook (eds), *Neutron Activation and Plasma Emission Spectrometric Analysis in Archaeology: Techniques and Applications* (London), 57–65.
Mommsen, H., Kreuser, A. and Weber, J. 1988. 'A method for grouping pottery by chemical composition', *Archaeometry* 30, 47–57.
Mommsen, H., Lewandowski, E., Weber, J. and Podzuweit, Ch. 1988. 'Neutron Activation Analysis of Mycenaean pottery from the Argolid: the search for reference groups', in R.M. Farquhar, R.G.V. Hancock and L.A. Pavlish (eds), *Proceedings of the 26th International Archaeometry Symposium: Held at University of Toronto, Toronto, Canada, May 16th to May 20th, 1988* (Toronto), 165–71.
Mommsen, H. and Sjöberg, B.L. 2007. 'The importance of the "best relative fit factor" when evaluating elemental concentration data of pottery demonstrated with Mycenaean sherds from Sinda, Cyprus', *Archaeometry* 49, 359–71.
Mountjoy, P.A. 1986. *Mycenaean Decorated Pottery: A Guide to Identification* (Gothenburg).
Mountjoy, P.A. 1999. *Regional Mycenaean Decorated Pottery* (Rahden).
Perlman, I. and Asaro, F. 1969. 'Pottery analysis by neutron activation', *Archaeometry* 11, 21–38.

Rice, P.M. 1987. *Pottery Analysis: A Sourcebook* (Chicago, IL).
Schwedt, A., Aravantinos, V., Harami, A., Kilikoglou, V., Kylafi, M., Mommsen, H. and Zacharias, N. 2006. 'Neutron Activation Analysis of Hellenistic pottery from Boeotia, Greece', *JAS* 33, 1065–74.
Stockhammer, P.W., Athanassov, B., Mommsen, H. and Ragehot, M. 2020. 'Travelling objects – travelling ideas? A Mycenaean alabastron from the Late Bronze Age settlement of Bresto (southwestern Bulgaria)', in J. Maran, R. Băjenaru, S.-C. Ailincăi, A.D. Popescu and S. Hansen (eds), *Objects, Ideas and Travelers: Contacts between the Balkans, the Aegean and Western Anatolia during the Bronze and Early Iron Age. Volume to the Memory of Alexandru Vulpe Proceedings of the Conference in Tulcea, 10–13 November, 2017* (Bonn), 91–106.
Theocharis, D. 1956a. "Ιωλκός (Βόλος)", *Έργον*, 43–50.
Theocharis, D. 1956b. "Ἀνασκαφαί ἐν Ιωλκῷ", *Prakt*, 119–30.
Theocharis, D. 1957. "Ἀνασκαφαί ἐν Ιωλκῷ", *Prakt*, 54–69.
Theocharis, D. 1960. "Ἀνασκαφαί ἐν Ιωλκῷ", *Prakt*, 49–59.
Tsountas, Ch. 1900. "Ἐργασίαι ἐν Βόλῳ", *Prakt*, 72–3.
Villing, A. and Mommsen, H. 2017. 'Rhodes and Kos: east Dorian pottery production of the Archaic period', *BSA* 112, 99–154.
Whitbread, I.K. 1992. 'Petrographic analysis of Barbarian Ware from the Menelaion, Sparta', in J. Motyka Sanders (ed.), *Philolakōn: Lakonian Studies in Honour of Hector Catling* (London), 297–306.
Wolters, P. 1889. 'Mykenische Vasen aus dem Nördlichen Griechenland', *AM* 14, 262–70.

Παραγωγή, ανταλλαγή και κατανάλωση κεραμικής, στην Ύστερη εποχή του Χαλκού στη Μαγνησία (Θεσσαλία). Αποτελέσματα της Ανάλυσης με Ενεργοποίηση Νετρονίων σε δείγματα κεραμικής από το Διμήνι, το Βόλο (Νέα Ιωνία, Κάστρο/Παλαιά), Πευκάκια και Βελεστίνο

Αυτό το άρθρο παρουσιάζει τα αποτελέσματα της Ανάλυσης με Ενεργοποίηση Νετρονίων (NAA) συνολικά 145 δειγμάτων κεραμικής και πηλού, που προέρχονται από πέντε θέσεις από την περιοχή της Μαγνησίας στη Θεσσαλία: Διμήνι, Νέα Ιωνία, Κάστρο/Παλαιά (Βόλος), Πευκάκια και Βελεστίνο. Χρονολογικά, η κεραμική, στην οποία πραγματοποιήθηκε δειγματοληψία, καλύπτει ολόκληρη την Ύστερη Εποχή του Χαλκού, ενώ λίγα δείγματα χρονολογούνται στη Μέση Εποχή του Χαλκού. Μέσα σε αυτό το ευρύ χρονολογικό φάσμα κυριαρχεί η μυκηναϊκού τύπου κεραμική, η πλειονότητα της οποίας είναι διακοσμημένη, ενώ συμπεριλαμβάνεται λεπτή άβαφη κεραμική, καθώς και αυτή που χρησιμοποιείται για μεταφορά και μαγείρεμα. Η κεραμική που δεν συγκαταλέγεται στη μυκηναϊκή, αντιπροσωπεύεται από μια ποικιλία τύπων που ανήκουν στην πρώιμη φάση της Ύστερης εποχής του Χαλκού καθώς και σε δύο κατηγορίες της πρώιμης μεταανακτορικής περιόδου (δηλαδή μετά το 1200 π.Χ.) - χειροποίητη στιλβωμένη και τεφρή κεραμική. Είναι σημαντικό ότι στη μελέτη συμπεριλήφθηκαν δείγματα που σχετίζονται με δύο κεραμικούς κλιβάνους στο Διμήνι και στο Βελεστίνο, αλλά δεν εντοπίστηκαν απορρίματα από αυτούς. Τα αποτελέσματα της ανάλυσης παρέχουν σημαντικές γνώσεις τόσο για την τοπική θεσσαλική παραγωγή κεραμικής όσο και για τις ενδοπεριφερειακές και διαπεριφερειακές ανταλλαγές κεραμικής. Η τοπική παραγωγή που χρησιμοποιεί κοιτάσματα πηλού που εντοπίζονται γύρω από το Διμήνι τεκμηριώνεται καλύτερα, με τη διακίνηση των προϊόντων της να ξεπερνάει τα όρια της Θεσσαλίας. Δύο ακόμη χημικές ομάδες φαίνεται να συνδέονται με το Βελεστίνο, ενώ δύο επιπλέον μικρές χημικές ομάδες είναι πιθανώς επίσης Θεσσαλικές. Όσον αφορά τις προσδιοριζόμενες εισαγωγές, η Αργολίδα ξεχωρίζει ως η κύρια πηγή μη τοπικής κεραμικής από την αρχή της Ύστερης εποχής του Χαλκού μέχρι το τέλος της ανακτορικής περιόδου. Άλλες περιοχές και τόποι παραγωγής διαδραματίζουν σημαντικά μικρότερο ρόλο ως πηγές εφοδιασμού. Με βάση τη μελέτη, για πρώτη φορά τεκμηριώνεται με επιστημονικά μέσα η τοπική παραγωγή αλλά και η εισαγωγή αγγείων στην περιοχή της Μαγνησίας, ανοίγοντας νέες ερευνητικές προοπτικές και ενισχύοντας τη θέση της περιοχής ως μέρος του μυκηναϊκού κόσμου.