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From Pottery Provenance to Multiscale Diachronic Connectivity at Middle Bronze Age Mitrou, Greece

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This study employs neutron activation analysis (NAA) to examine pottery from Middle Bronze Age (MBA) (c. 2200–1700 BC) Mitrou in East Lokris, central Greece. The analysis of 112 samples from all ceramic phases reveals complex patterns of production and exchange at multiple scales. Limited production of tablewares is evident within the immediate coastscape, contrasting sharply with abundant imports of tableware from other communities (most prominently, central Euboea and Boeotia), revealing a highly interconnected central Greek world. The NAA results also reinforce previous petrographic analysis, emphasizing connections with the broader regional maritime sphere, including the Cyclades, Aegina, Crete, and the south-eastern Aegean. The results challenge previous perceptions of the central Greek MBA as isolated, provide new insights into MBA connectivity, and highlight the need for further analytical work at other central Greek sites.

Keywords: Middle Helladic, neutron activation analysis, central Greece, pottery production and exchange, connectivity, Aegean Bronze Age

Introduction

Our understanding of ceramic production and exchange systems in Middle Bronze Age (MBA, *c.* 2200–1700 BC) central Greece remains limited due to a lack of comprehensive data. Previous attempts to address this issue through pottery provenance studies have been constrained by small sample sizes, reliance on surface survey and/or poorly dated material, and unpublished datasets (Mommsen et al., 2001a; Whitbread et al., 2002; Boileau et al., 2007). Clusters of petrographic or chemical groups representing clear recipes tied to specific localities or regions have therefore been difficult to isolate, which has obscured the dynamics of connectivity and reinforced perceptions of widespread *ad hoc* unspecialized production practices and disconnection compared to the southern Aegean (Spencer, 2010; Charalambidou et al., 2016 are rare exceptions).

This study aims to provide new insights into MBA central Greece through neutron activation analysis (NAA) of tablewares from Mitrou in East Lokris (Figure 1). Excavations in 2007 and 2008 by the University of Tennessee and the Ephorate of Antiquities of Phthiotida and Evrytania revealed substantial MBA remains from a coastal settlement located on critical

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Figure 1. *Map of the MBA Aegean showing Mitrou and selected sites.*

communication routes along the northern Euboean Gulf (Van de Moortel, 2012, 2020; Van de Moortel & Zahou, 2012; Hale, 2023c). Mitrou was a small tell on a low rise overlooking the Bay of Atalanti, and was built up through the regular relaying of surfaces and the rebuilding of architecture (Karkanas & Van de Moortel, 2014). This well-preserved deep stratigraphy and site formation process enabled a seven-phase ceramic sequence to be recognized, spanning the entire Middle Helladic (MH) phase (Hale, 2015, 2016), together with an underlying Early Helladic III phase and an overlying Late Helladic I sequence (Vitale et al., 2024), allowing a rare diachronic examination.

Previous petrographic analysis of selected MBA Mitrou pottery revealed shifting patterns of interaction with the southern Aegean, including numerous Cycladic islands and Aegina (Hale, 2023b). However, the fine fabrics that dominate tableware classes were not conducive to petrographic analysis. It was therefore unclear whether this material contained

additional imports or if it was consistent with local East Lokrian production, known from nearby Early Bronze Age Proskynas (Zahou, 2009), Late Bronze Age (LBA) Livanates-Kynos (Mommsen et al., 2001b), and at the transition to the LBA based on a kiln identified at Mitrou itself (Van de Moortel, 2022).

These new data reveal that Mitrou's MBA connections were more complex and extensive than previously understood. Our analysis demonstrates the site's integration into multiple spheres of connectivity at all stages of the MBA, both within central Greece and across long-distance maritime routes, providing new insight into connectivity with the wider MBA Aegean world.

Materials and Methods

The study of the Mitrou MBA pottery has avoided grouping pottery by ambiguous 'ware' types, which have often used inconsistent criteria and subjective nomenclature, and has instead divided the assemblage into different pottery 'classes' that highlight only the technical aspects of each sherd (see Hale, 2016: 246 with references). The main classes of pottery used primarily as tableware at MBA Mitrou include unpainted classes such as Fine Grey Burnished (often referred to as 'Grey Minyan' ware in the literature, strongly associated with coil-built and wheel-finished formation techniques and characterized by fine fabric, reduced firing, and highly-burnished surfaces) (Figure 2a), Dark Burnished (medium-fine to medium-coarse fabric, often incompletely reduced, and highly burnished) (Figure 2b), and Fine Pale (fine fabric, oxidized firing, and less consistently burnished) (Figure 2c). The decorated pottery classes are fewer but are more diverse in style and fabric. They predominantly occur in larger serving or small-scale storage vessels, and only occasionally among eating or drinking vessels, and are Matt Painted (fine to medium-fine fabric, oxidized firing, and dark-on-light decoration using a matt black pigment) (Figure 3a), Dull Painted (fine to medium-coarse fabric, oxidized firing, and dark-on-light decoration with a non-lustrous red pigment) (Figure 3b), or Bichrome Painted (fine to medium-fine fabric, oxidized firing, and dark-on-light decoration combining red and black along with occasional added white) (Figure 3c). For extensive descriptions of these classes, see Hale 2014, 2015, and 2016. Coarse cooking and bulk storage vessels were not targeted in our analysis. We occasionally sampled pottery from other less common classes, especially when they were a suspected import or were the subject of specific inquiries.

One hundred and twelve samples were selected for NAA (see Supplementary Material A for a full sample list and B for macroscopic fabric photographs). The material was sourced from stratigraphic units firmly located within the Mitrou relative chronological framework, dating from Early Helladic III to Middle Helladic III (Table 1; see Hale, 2016). Additional Late Helladic I pottery samples, often included in conceptions of the MBA period, will be presented in the future. To minimize the risk of sampling sherds from the same pot, samples were taken from distinct catalogued vessels in the Mitrou assemblage and not from the bulk pottery assemblage. Sampling also aimed to cover the full diversity within each ceramic class recognized during macroscopic study (Hale, 2015), both in terms of typological repertoire and fabric characteristics.

Despite these efforts, the dataset invariably represents a small sample of the assemblage and consequently has its limitations. In particular, the smaller number of samples

Figure 2. *The major unpainted pottery classes at MBA Mitrou. a) Fine Grey Burnished; b) Dark Burnished; c) Fine Pale. Note the different scale for MTR_061. See also Supplementary Material B for macroscopic fabric photographs of all samples.*

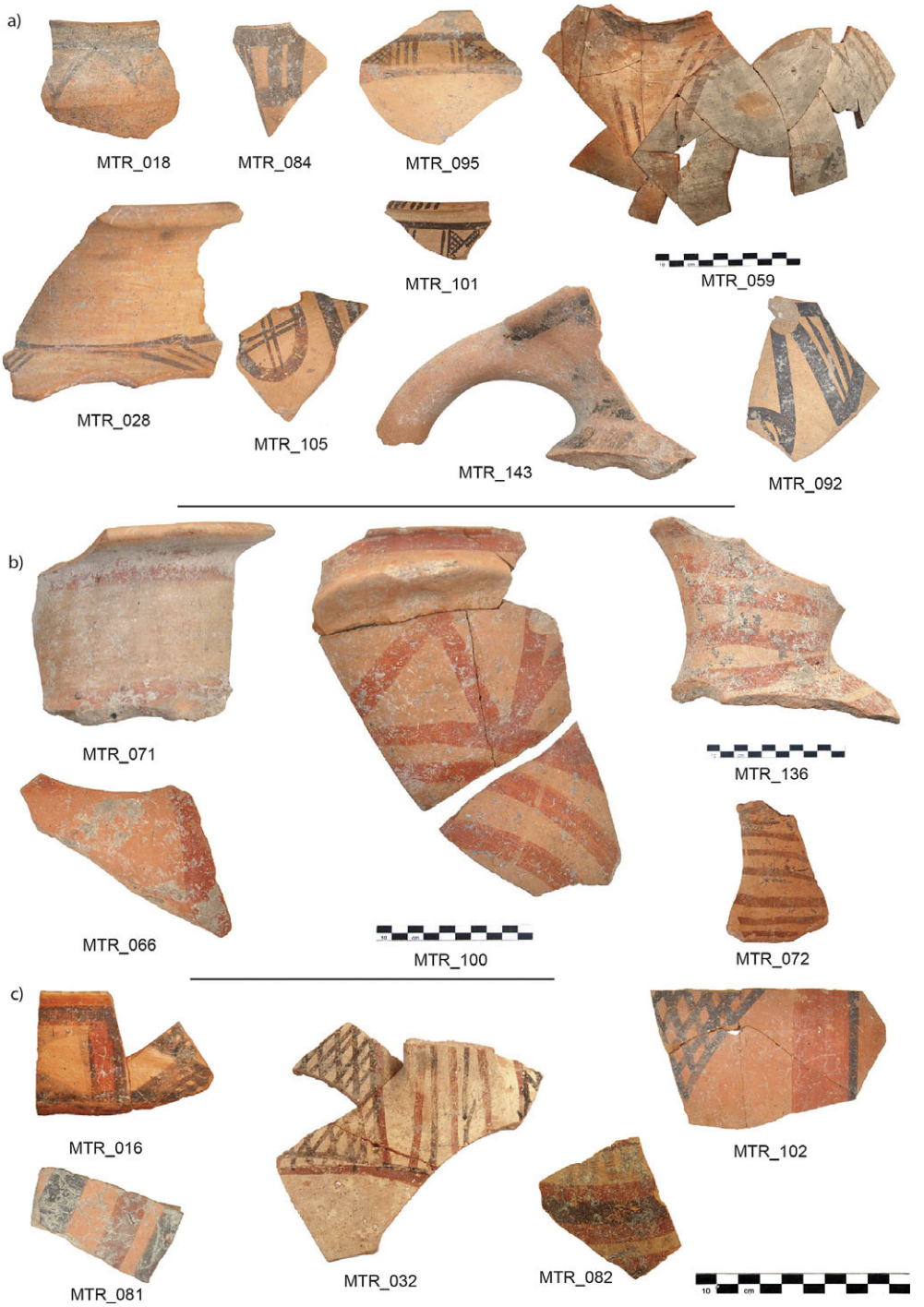

Figure 3. *The major painted pottery classes in the MBA Mitrou assemblage. a) Matt Painted; b) Dull Painted; c) Bichrome Painted. Note the different scales for MTR_059, MTR_100 and MTR_136 . See also Supplementary Material B for macroscopic fabric photographs of all samples.*

Table 1. NAA dataset breakdown by pottery class and phase.

Mitrou MH pottery class		Mitrou MH PHASE (Hale, 2016) Ph. 1–3	Ph. 4–6	Ph. 7	Total	% of class in assemblage by sherd count
Painted	Dull	2	7	2	**11**	2.5%
	Matt	2	13	7	**22**	2.4%
	Bichrome		6	3	**9**	1%
	Polychrome-on-Dark			2	**2**	<1%
	Light-on-Dark			1	**1**	<1%
	Lustrous			1	**1**	<1%
	Slipped and Burnished	2	1	2	**5**	<1%
Unpainted	Fine Pale	2	5	4	**11**	11%
	Fine Grey Burnished	6	17	11	**34**	19.5%
	Dark Burnished	7	7	2	**16**	11.4%
	Coarse and Medium Coarse Cooking/Storage/Utilitarian					51%
	TOTAL	**21**	**56**	**35**	**112**	15958

from the early MBA subphases reflects a combination of less diversity within the fine pottery classes and fewer stratigraphic units to source reliable material. This subset is thus more susceptible to outliers. Some caution is therefore warranted when applying the resulting observations to the assemblage as a whole.

NAA as a radiochemical analytical method measures the concentration of up to thirty-five chemical elements in a sample. For this, samples are cleaned, homogenized, sealed in irradiation containers, and then irradiated in the neutron flux of a reactor. The nuclear reactions that occur during irradiation result in radioactive isotopes that can subsequently be measured by gamma spectroscopy. Comparison with certified reference materials that are irradiated and measured together with the samples allows quantification of a set of chemical elements. Using this 'chemical fingerprint', samples can then be grouped by similar composition that represents common raw materials and paste preparation (recipes for pottery production). In the case where some members of such a 'chemical group' can be assigned a clear provenance, the whole group can be related to this provenance. In this work, samples sent for NAA were analysed at the Center for Labelling and Isotope Production (CLIP), TRIGA Center Atominstitut of the Technische Universität Wien, Austria. Sample preparation involved cleaning the clipped samples with a silicon knife and subsequent grinding in an agate mortar for homogenization. Irradiation and quantification followed the protocols established at the CLIP (Sterba, 2018). After analysis, the resulting concentration data were statistically evaluated by application of the statistical filtering method established in Bonn (Beier & Mommsen, 1994), using a Mahalanobis distance measure, modified by the best relative fit factor. Through comparison within the samples as well as to the database available in Bonn and Vienna, samples were assigned to groups and, if available, specific provenances.

Results

Comparison of all measured samples to the Bonn/Vienna database resulted in eighty-four samples that could be associated to known patterns or to each other. Information on which samples belong to which group and their respective best relative fit factor can be found in Table 2.

Table 2. *Samples by NAA chemical group and their respective best relative fit factors. Photographs of the microfabric for each sample can be found in Supplementary Material B.*

Supplement B	Chemical group	MTR_ sample number with best relative fit factor in parentheses	Total
a)	EuA	021 (0.98); 028 (0.98); 034 (0.98); 037 (1.06); 056 (0.99); 059 (0.99); 060 (0.97); 061 (1.00); 064 (1.00); 065 (0.96); 067 (1.02); 076 (1.03); 088 (1.00); 108 (1.05); 115 (0.96); 116 (1.04); 117 (0.93); 118 (1.13); 125 (1.02); 131 (0.98); 138 (1.05); 149 (1.15); 156 (0.99)	23
b)	X190	018 (1.00); 063 (1.04); 077 (0.96); 080 (0.95); 089 (0.98); 123 (1.01); 129 (0.98); 135 (0.94); 139 (1.06); 141 (1.01)	10
c)	PhyT	130 (1.00)	1
d)	V035	068 (0.91); 091 (1.05); 098 (0.90); 107 (0.97); 122 (0.97); 134 (1.12)	6
e)	V036	111 (1.14); 132 (0.99); 137 (0.93); 142 (0.93); 145 (1.04); 147 (0.99); 150 (0.97); 154 (0.90)	8
f)	V037	032 (1.00); 051 (0.96); 085 (1.05)	3
g)	V046	084 (1.01); 090 (0.98); 092 (1.00)	3
h)	LivM	041 (1.04); 072 (1.01); 101 (1.00)	3
i)	PfkA	016 (0.96); 106 (0.97); 146 (0.99)	3
j)	TanA	031 (0.75); 066 (1.00); 102 (1.11); 143 (1.08)	4
k)	TheA	100 (1.15); 105 (0.94)	2
l)	AegA	062 (0.89); 075 (0.91); 086 (1.20); 133 (1.04)	4
m)	TKM7	153 (0.96)	1
n)	X204	046 (1.06)	1
o)	KnoL	052 (0.92)	1
p)	KosB	040 (1.03)	1
q)	Smee	112 (0.97)	1
r)	X029	014 (0.98); 022 (0.85); 110 (0.93)	3
s)	X066	095 (1.06)	1
t)	X120	081 (1.04); 124 (1.06)	2
u)	X167	127 (1.13)	1
v)	X211	026 (0.97); 036 (1.00)	2

The largest two groups (twenty-three and ten samples, respectively) belong to two very similar patterns, EuA and X190. Group EuA (Mommsen, 2014) includes more than 300 samples in the Bonn/Vienna database and is associated with the clay beds of Phylla located just north of Lefkandi in central Euboea. X190 comprises thirty-one samples in total, all found at Mitrou, Lefkandi, or Pefkakia. Chemically, their main distinction is in the elements Zn and Sm, with more Zn for X190 and more Sm for EuA. While separable on these grounds, their overall close chemical similarity together with their similar typological and chronological distribution suggest that the two patterns most likely represent natural variability within what is a large clay bed, and both are associated with a central Euboean provenance at this stage. Sample MTR_130 with pattern PhyT closely matches the chemical composition of raw clay samples from Phylla itself.

Twenty samples could be grouped into four new patterns that only contain samples from Mitrou. These have been labelled groups V035 (six samples), V036 (eight samples), V037 (three samples), and V046 (three samples). Figure 4 shows a discriminant analysis of these four groups, indicating that they can be clearly separated. The mean concentration values and errors for the groups are given in Table 3.

Several smaller sets were found to belong to existing groups. The composition of three samples (MTR_041, MTR_072, and MTR_101) fits the chemical group LivM, which is associated with East Lokris

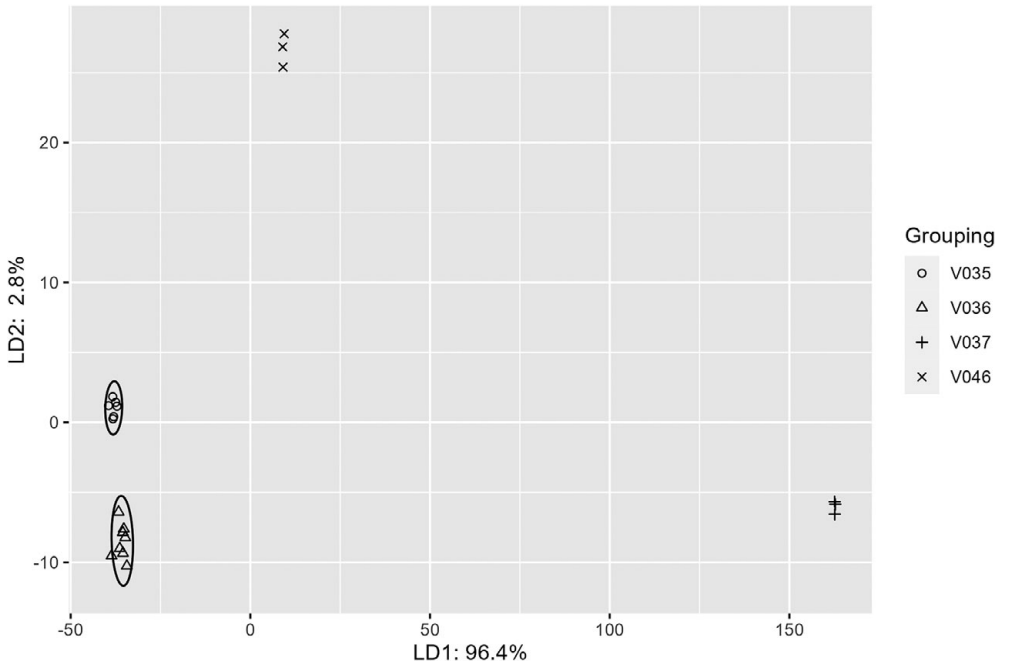

Figure 4. *Linear discriminant analysis along the first and second discriminant axes (LD1 and LD2) of the composition of groups V035, V036, V037, and V046 showing their clear separability.*

by LBA wasters at Kynos/Livanates (Mommsen et al., 2001b; Pilz et al., 2003). Three samples (MTR_016, MTR_106, and MTR_146) are associated with the group PfkA (Maran, 2007; Lis et al., 2023a), which likely comes from somewhere in or near Magnesia based on the group's distribution pattern. Four more samples (MTR_031, MTR_066, MTR_102, and MTR_143) chemically belong to the group TanA, associated with a clay found close to Tanagra (Tsota et al., 2010; Mühlenbruch & Mommsen, 2011), while two samples (MTR_100 and MTR_105) belong to the group TheA, which is the most common pattern recognized at Thebes across multiple periods (Schwedt et al., 2006; Lis et al., 2023b; Andrikou et al., 2024) .

Four samples come from further afield (MTR_062, MTR_075, MTR_086, and MTR_133), and chemically fit group AegA associated with Aegina (Mommsen et al., 2001a). Sample MTR_153 chemically fits with a group of technical ceramics from Olympia called TKM7 (Kiderlen et al., 2017). Two samples fit chemical patterns associated with Crete: MTR_052 to pattern KnoL from central Crete and MTR_046 to X204 (previously labelled KnoK) (Marketou et al., 2006). One sample (MTR_040) fits the chemical pattern KosB associated with Kos (Villing & Mommsen, 2017).

Several other samples belong to chemical groups that have no clear provenance: Samples MTR_014, MTR_022, and MTR_110 to group X029; samples MTR_081 and MTR_124 to group X120, probably from somewhere in or near Boeotia based on the distribution of other group members (Jung et al., 2021). Sample MTR_095 fits into group X066, which should probably be separated into two groups, one with a likely provenance in Rhodes and one with a likely provenance in Boeotia (Villing & Mommsen, 2017; Jung et al., 2021); the fit to the likely Boeotia subgroup is slightly better

Table 3. *Mean concentration values and errors for groups V035, V036, V037, and V046.*

	V035 (n=6)		V036 (n=8)		V037 (n=3)		V046 (n=3)	
	conc (µg/g)	σ (µg/g)	conc (µg/g)	σ (µg/g)	conc (µg/g)	σ (µg/g)	conc (µg/g)	σ (µg/g)
As	5.64	2.12	5	3.98	8.21	9.27	4.37	1.32
Ba	295	35.6	310	22.3	599	45.3	311	15.4
Ce	45.5	1.92	51.4	2.31	75.7	1.72	52.6	1.79
Co	14.9	1.46	22.1	2.36	33	2.51	41.6	4.2
Cr	269	59.2	359	60.7	432	14.3	501	87.3
Cs	4.05	0.265	4.01	0.0994	11.2	0.211	5.44	0.263
Eu	0.95	0.0381	1.02	0.034	1.24	0.0432	0.969	0.0311
Fe	39,000	1660	41,000	1940	49,200	450	53,000	3800
Hf	4.79	0.189	4.84	0.231	4.53	0.256	3.38	0.181
K	15,400	1110	15,800	705	33,000	3720	19,600	1170
La	22.4	1.41	25.7	1.12	33.6	1.73	23.9	0.307
Lu	0.343	0.0483	0.376	0.0178	0.405	0.0135	0.309	0.0234
Na	9730	2600	9550	726	6490	701	6170	877
Nd	18.9	3.46	18	2.34	29.9	1.47	24.5	7.58
Ni	158	20	279	62.9	372	70.3	655	60.7
Rb	89	4.59	93.9	4.84	179	3.18	119	2.19
Sb	0.358	0.0716	0.402	0.0363	2.14	0.821	0.46	0.0647
Sc	15.1	0.557	15.1	0.447	21.8	0.609	19.1	1.19
Sm	3.82	0.0851	4.38	0.174	5.44	0.313	3.85	0.108
Sr	73.7	20.7	86.7	26.9	141	34.9	191	35.2
Ta	0.689	0.0159	0.783	0.0228	1.09	0.0562	0.728	0.0351
Tb	0.589	0.0478	0.629	0.0294	0.758	0.0374	0.632	0.0182
Th	8.57	0.333	8.77	0.26	14.8	0.501	8.76	0.292
Ti	4580	208	5380	419	6960	573	7090	47.7
U	1.63	0.147	1.84	0.102	2.89	1.11	1.67	0.0513
W	1.29	0.41	1.36	0.376	3.68	0.349	1.37	0.325
Yb	2.35	0.193	2.58	0.11	3.06	0.101	2.68	0.0762
Zn	67.4	2.15	77.2	2.77	109	14.7	98.5	3.83
Zr	147	11.8	160	9.34	143	6.83	106	10.5

based on chemical composition. Sample MTR_127 is chemically a member of group X167, formerly known as PhtH (Mommsen et al., 2001b; Maran, 2007) with no clear provenance (but see discussion below). Samples MTR_026 and MTR_036 are attributed to group X211 (formerly known as EryB) with unclear provenance, and, finally, sample MTR_112 chemically belongs to a poorly defined group called Smee, also with unclear provenance.

The remaining twenty-eight samples are singles with an archaeometrically unknown provenance, having no known similar composition in the Bonn/Vienna databank at this stage. However, petrographic analysis for eight of these singles tied them to a southern Cycladic lithology (see Supplementary Material A; Hale, 2023b).

Discussion

Our analysis provides insight into connectivity at different spatial scales. Following Tartaron (2013: 182–202) for LBA maritime cultural landscapes (Table 4, Figure 5), these scales are the 'coastscape', the 'local world', and the 'regional maritime sphere'. The coastscape refers to the immediate territorial zone surrounding Mitrou that could be exploited daily (i.e. the Bay of Atalanti). The local world (or the 'maritime small

Table 4. *Breakdown of NAA chemical groups by Mitrou MBA pottery class.*

		Coastscape	Local world											Regional maritime sphere					Unprovenanced						
		East Lokris	C. Euboea			Boeotia						Magnesia/ Malis?		Achaea	Aegina	Crete		Kos							
Mitrou MBA Pottery Class		**LivM**	**EuA**	**PhyT**	**X190**	**V035?**	**V036?**	**TanA**	**TheA**	**X066?**	**X120?**	**PfkA**	**X167?**	**TKM7**	**AegA**	**KnoL**	**X204**	**KosB**	**Smee**	**V037**	**V046**	**X029**	**X211**	**Singles**	**TOTAL**
Painted	Dull	1						1	1			1												7	**11**
	Matt	1	5		1			1	1	1			1		3						2			6	**22**
	Bichrome							1			2	1								2				3	**9**
	Polychrome-on-Dark															1	1								**2**
	Light-on-Dark																							1	**1**
	Lustrous																	1							**1**
	Slipped and Burnished																							5	**5**
Unpainted	Fine Pale		2		1							1			1					1	1			4	**11**
	Fine Grey Burnished	1	16	1	8														1			3	2	2	**34**
	Dark Burnished					6	7	1						1											**15**
	Coarse Dark						1																		**1**
	TOTAL	**3**	**23**	**1**	**10**	**6**	**8**	**4**	**2**	**1**	**2**	**3**	**1**	**1**	**4**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**2**	**28**	**112**

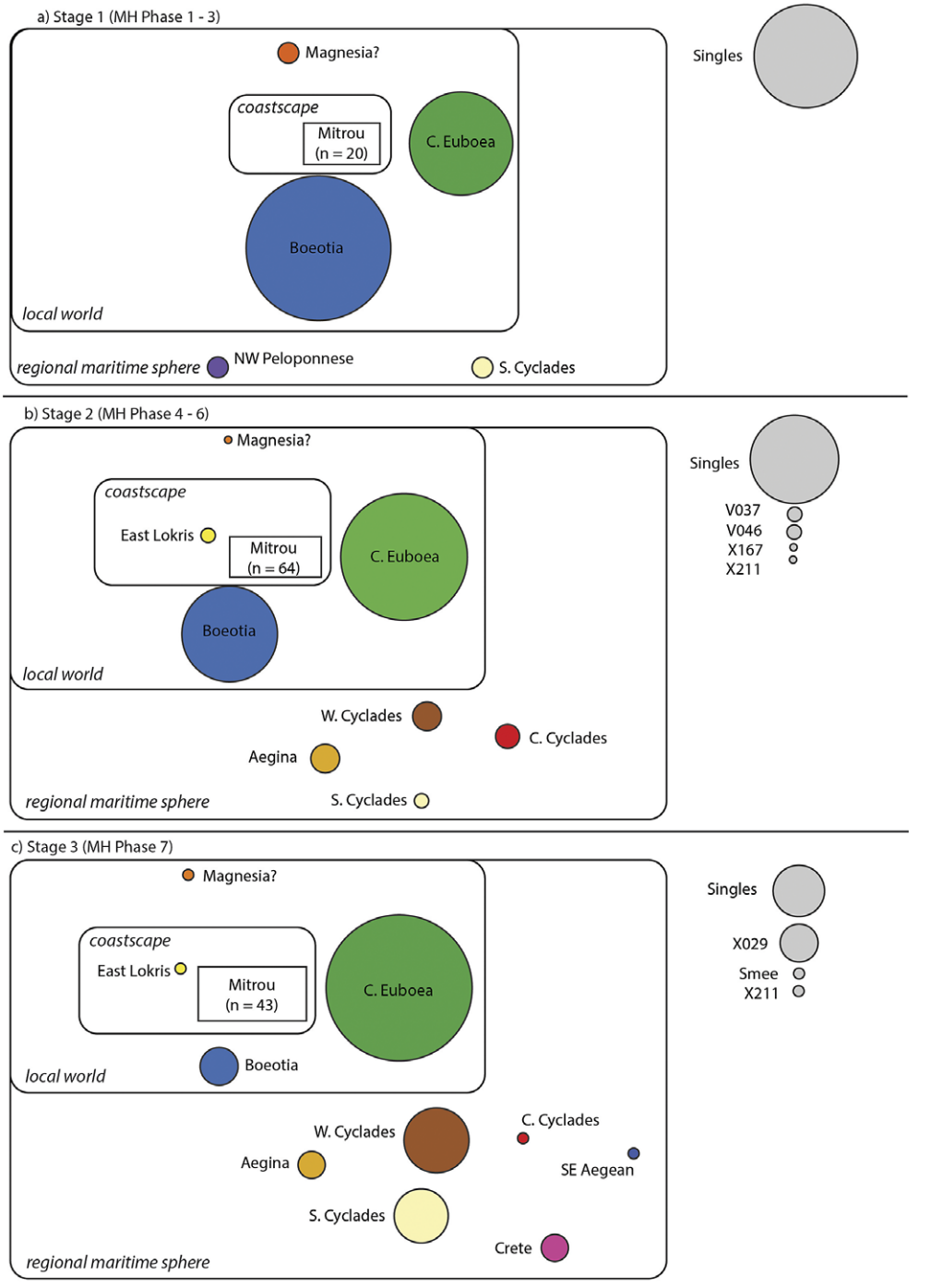

Figure 5. *Multi-scale pottery provenance at Mitrou through time (following Tartaron, 2013), incorporating both NAA and petrography (Hale, 2023a). The node size is scaled to relative frequency in the sampled assemblage by phase/s.*

world' in Tartaron, 2013) incorporates habitual links to other coastscapes, but here also includes connections to the hinterland within an approximate two-day round trip (i.e. most of the Euboean Gulf and interior central Greece, depending on the mode of transport). The regional maritime sphere is the wider Aegean basin. Furthermore, by sourcing samples from an assemblage grounded in a relative chronological sequence, diachronic shifts in connectivity can be recognized across three stages. Stage 1 spans Mitrou MH Phases 1–3, Stage 2 is covered by MH Phases 4–6, and Stage 3 corresponds to Mitrou MH Phase 7 (see also Hale, 2023b).

Pottery production within Mitrou's coastscape

Our dataset does not provide evidence for substantial local production of tableware during the MBA. However, the LivM samples indicate that Matt Painted (MTR_101), Dull Painted (MTR_072), and high-quality Fine Grey Burnished (MTR_041) pottery were being produced in limited quantities near the Bay of Atalanti by the middle of the period. In the case of the Matt Painted (MTR_084, MTR_092), Bichrome Painted (MTR_032, MTR_051), and Fine Pale (MTR_085, MTR_090) pottery represented in the new groups V037 and V046 from Stage 2, limited local production can neither be confirmed nor excluded. On the other hand, the fourteen samples associated with V035 and V036 across all subphases may originate from nearby western Boeotia or eastern Phocis as they strongly resemble a common pottery class and fabric known from Orchomenos (see below).

The lack of clear local products within the sampled Mitrou assemblage is surprising, given that a kiln (without associated wasters) was identified at the end of the MBA sequence (Van de Moortel, 2022). While local production of tablewares may be present in some unprovenanced small groups or in the singletons, it seems clear that such a production was not at any significant scale. Additionally, these potential local products may not form coherent chemical groups perhaps because of inconsistencies in clay recipes, which could be expected of an *ad hoc* production rather than of goods made by a specialized craft community. It is also quite possible that local production was largely limited to the coarser cooking and storage pottery not targeted in this analysis. Further clay prospection and analysis of additional sources in Mitrou's vicinity may help clarify this.

On the other hand, the three LivM samples represent limited local production of fine pottery classes tied more closely to other regions (see below), suggesting a degree of technological knowledge transfer and connectivity with other pottery-producing communities, albeit on a small scale. Indeed, these extremely high-quality products from *chaînes opératoires* consistently associated with central Euboea (see below) but using an East Lokrian clay source, such as MTR_101 and especially MTR_041 (among the best technical examples of Fine Grey Burnished pottery in the entire Mitrou assemblage), may suggest the presence in East Lokris of a highly skilled potter trained in the central Euboean tradition. Nevertheless, this local production output was clearly limited and the Mitrou community relied primarily on imported pottery for local consumption, indicating strong trade connections with other regions. That some of these specific types (most notably Fine Grey Burnished) are almost exclusively vessels used for eating and drinking implies shared consumption habits across these communities. Altogether, the absence of evidence for a strong local production tradition of fine wares suggests that Mitrou's inhabitants were active

participants in regional trade and cultural exchange, with pottery serving as a tangible marker of these interactions.

Mitrou and the local world

In contrast, the sampled pottery contains abundant indications of connections with a local world sphere of interaction. New insights into the Fine Grey Burnished class, the most common fine pottery at MBA Mitrou, are a particularly significant result. Boeotia has always been considered a major source, ever since the type was first recognized at Orchomenos and initially named 'Grey Minyan' after Minyas, its mythical king (Bulle, 1907: 53; Sarri, 2010a). The high frequency of Fine Grey Burnished pottery in central Greece has consistently been seen as evidence for its Boeotian production (Forsdyke, 1914; Childe, 1915; Dickinson, 1977: 17; Konsola, 1985; Sarri, 2010a; Pavúk & Horejs, 2012: 16–31, map 1).

Despite Mitrou's proximity to the Boeotian hinterland, the chemical analysis suggests that central Euboea was in fact a major source of Fine Grey Burnished pottery throughout the MBA. The class represents twenty per cent of almost 16,000 sherds and would typically be considered a local product due to this abundance. However, approximately seventy-five per cent of the sampled Fine Grey Burnished pottery can be associated with central Euboea across all sub phases (Table 4).

This evidence strengthens arguments advanced by Choleva (2018, 2020) and Spencer (2007, 2010) for a central Euboean ceramic production community specializing in coil-built and wheel-finished Fine Grey Burnished pottery by the MBA. The same NAA pattern associated with the Phylla clays has previously been found in wheel-finished Fine Grey Burnished pottery sampled from Orchomenos and Thebes in Boeotia, Eleusis in Attica, Kolonna on Aegina, Tsoungiza in Corinthia, and Lerna in the Argolid (Cosmopoulos et al., 1999; Mommsen et al., 2001a, 2014; Gauß & Kiriatzi, 2011: 143–44, 211–12; Hoffmann et al., 2020; Whitbread et al., 2024a). While less precise, other archaeometric techniques applied to wheel-finished Fine Grey Burnished pottery sourced from Eretria (Charalambidou et al., 2016: FG8, 2018: 7), Lerna (Hoffmann et al., 2020; Whitbread et al., 2024b: Grey Polished group II; Spencer, 2024), Kolonna (Gauß & Kiriatzi, 2011: 143–44, 211–12), and Ayia Irini (Jones & Mee, 1986; Abell, 2021: 184) have all also returned results compatible with a central Euboean provenance. Most of these previous examinations, however, have included only limited quantities of Fine Grey Burnished samples.

The more substantial Mitrou evidence overwhelmingly indicates a predominantly central Euboean origin for this class, but from Mitrou MH Phase 6, there are also two sherds (MTR_026, MTR_036) with an unlocated X211 pattern. During Mitrou MH Phase 7, limited production in East Lokris is represented by one bowl with the LivM pattern (MTR_041), and three pots (MTR_014, MTR_022, MTR_110) have the unlocated X029 pattern previously identified in small numbers at Thebes (labelled group G in Mommsen et al., 2001b). Therefore, while Fine Grey Burnished pottery was predominantly imported to Mitrou from central Euboea throughout the MBA, limited quantities were also acquired from other production communities later in the MBA.

No central Euboean imports other than Fine Grey Burnished pottery appear during Stage 1. During Stage 2, two Matt Painted pots (MTR_028, MTR_108) are known. This diversifies in Stage 3 to include four Matt Painted (MTR_018, MTR_021, MTR_059, MTR_115) and three Fine Pale (MTR_061, MTR_063, MTR_067)

pots alongside more common Fine Grey Burnished ceramics, confirming that other MBA pottery classes were also being produced in central Euboea using this clay recipe. Almost all of this pottery consists of small eating or drinking vessels, with some small-scale storage or transport vessels in the Matt Painted class. Overall, the Mitrou evidence reveals sustained pottery production in central Euboea and a trans-Euboean Gulf local world maritime network operating throughout the MBA, involving the consistent movement of specialized pottery products (mostly tableware) from central Euboea to East Lokris across the Euripus Strait.

Evidence for local world interaction with Boeotia is also present. This connection may be more common in Stage 1 (though the sample size is smaller) and steadily reduces as a proportion in the sampled assemblage across Stages 2 and 3. The TanA (MTR_031, MTR_066, MTR_102, MTR_143) and TheA (MTR_100, MTR_105) samples are clear links to eastern Boeotia, while the unlocated groups X066 (MTR_095) and X120 (MTR_081, MTR_124) are also likely to be Boeotian products based on the distribution of other group members in the Bonn/Vienna database. Unlike the central Euboean imports, these samples are all painted serving or small-scale storage vessels, suggesting a different relationship. Other than a large Dull Painted bowl (MTR_100), these vessels may have been imported for their contents rather than as specialized products.

Additional links to western Boeotia may be represented by Dark Burnished pottery, which comprises about eleven per cent of the assemblage (Hale, 2015, 2016). Almost all samples belong to chemical groups V035 and V036 and none to central Euboean patterns. While local production cannot be ruled out, very similar macroscopic fabrics have been described at MBA Orchomenos in western Boeotia; indeed, all Mitrou samples find direct parallels in the common *grobe grauminysche* (coarse Grey Minyan) class associated with the same two-handled bowls well-represented in both chemical groups (Sarri, 2010b: 76, 236–47, 428, pls. 1–6, fig. 15). Macroscopically, samples belonging to V035 have darker black surfaces and often a slightly reddish sandwiching of the core, which recalls similar technological features found on some so-called 'Black Burnished' or 'Argive Minyan' pottery with red cores, common in the north-eastern Peloponnese (Spencer, 2024: 45–47), but none of these samples returned any NAA pattern known from the region, none of the common north-eastern Peloponnesian morphologies like faceted bowls appear in the V035 samples, and typological links to Orchomenos seem much stronger. Preliminary examination also indicates that the V035 and V036 chemical groups are petrographically very similar. While not particularly indicative of a specific provenance, both groups have petrographic parallels in MBA pottery sampled from Orchomenos in the Fitch Laboratory collection and to clays associated with Lake Kopais (Boileau et al., 2007; Kiriatzi et al., 2011: 111–12, 142–43; Liard et al., 2019, Fabric 3). Most of the V036 samples are dated to Phases 1–3, with one from Phase 4, while the V035 samples date from Phases 4–6 with one from Phase 7, suggesting a diachronic shift in the use of clay sources if both are linked to a similar provenance. The two groups together would thus suggest a sustained connection between western Boeotia and Mitrou throughout the MBA.

Northern links, on the border between the local world and regional maritime sphere, are represented by one Bichrome Painted (MTR_016), one Dull Painted (MTR_106), and one Fine Pale (MTR_146) sample with the PfkA pattern previously associated with Magnesian Polychrome, a distinctive

class tentatively linked to Magnesia in Thessaly, of which MTR_016 is a good example (Maran, 2007). These new PfkA samples belonging to different classes now indicate that other types were produced using this clay recipe, that it was used throughout the MBA, and that it was exported to the south. Additional links to the north or west are likely to include the Matt Painted pot (MTR_126) with the currently unprovenanced X167 pattern, an example of the Δ1β type well-known from the Spercheios valley in Phthiotis, Magnesia, and Phocis (Maran, 2007; Dakaronia, 2010; Papakonstantinou & Krapf, 2020). This interaction was, however, comparatively limited, and the primary direction of the trans-Euboean Gulf maritime network for pottery exchange was south-east to north-west.

Mitrou and the regional maritime sphere

It is probable that the Euboean Gulf was a major route through which many imports from the southern Aegean reached Mitrou (Figure 6). As summarized above, previous petrographic analysis of the Mitrou material revealed imports from Aegina and a range of Cycladic islands (Hale, 2023b). Our elemental analysis expands this diversity to include rare Cretan Polychrome-on-Dark products (MTR_046, MTR_052) and one Lustrous Decorated import likely to have come from Kos (MTR_040), indicating that rare material from as far away as the south-eastern Aegean made its way to Mitrou near the end of the MBA. Given their rarity, it is likely that these more exotic imports arrived at Mitrou down-the-line through intermediaries such as Kolonna and/or Ayia Irini, and through the more intensive local world maritime connections to central Euboea. These imports are a mix of large closed storage or transport vessels as well as some smaller tablewares.

Mitrou's reorientation towards a maritime local world during Stages 2 and 3 is also reflected in the regional maritime sphere. This may indicate the increasing importance of MBA island entrepôts such as Ayia Irini and Kolonna to Aegean networks (Overbeck, 1982, 1989; Crego, 2007, 2010; Overbeck & Crego, 2008; Abell, 2021; Hale, 2023a). In addition, it is tempting to connect this shift to arguments for the increased proliferation during the MBA of the expanded log boat and perhaps also the sail (Van de Moortel, 2012, 2017, 2024).

Comparing Mitrou against the analytical results from MBA Kolonna reveals some interesting similarities and important differences (see Gauß & Kiriatzi, 2011: 178–217 for a summary of imported pottery at MBA Kolonna). Clear Aeginetan imports at Mitrou and central Euboean imports at Kolonna, along with likely Boeotian imports at both sites, suggest that they were part of overlapping networks (Mommsen et al., 2001b, group B; Kiriatzi et al., 2011: 142–44, with the B (BOET) NAA group renamed to EuA in Mommsen, 2014). Both sites have confirmed consistent imports from a similar range of Cycladic islands and Crete, though the latter are more common at Kolonna (Kiriatzi et al., 2011: 139–40, 143). Mitrou also provides small but consistent evidence for northern central Greek connections, largely absent at Kolonna. This accords well with known evidence of Aeginetan pottery distribution as, despite some similarities in decorative syntax on some pottery classes (Maran, 2007), very few (if any) analytically confirmed MBA Aeginetan imports have been identified as far north as Malis or Magnesia (note that the rare Aeginetan pottery in Magnesia listed in Gauß & Knodell, 2020 has not been analytically confirmed). On the other hand, the Kolonna evidence includes consistent imports from the north-eastern Peloponnese that seem

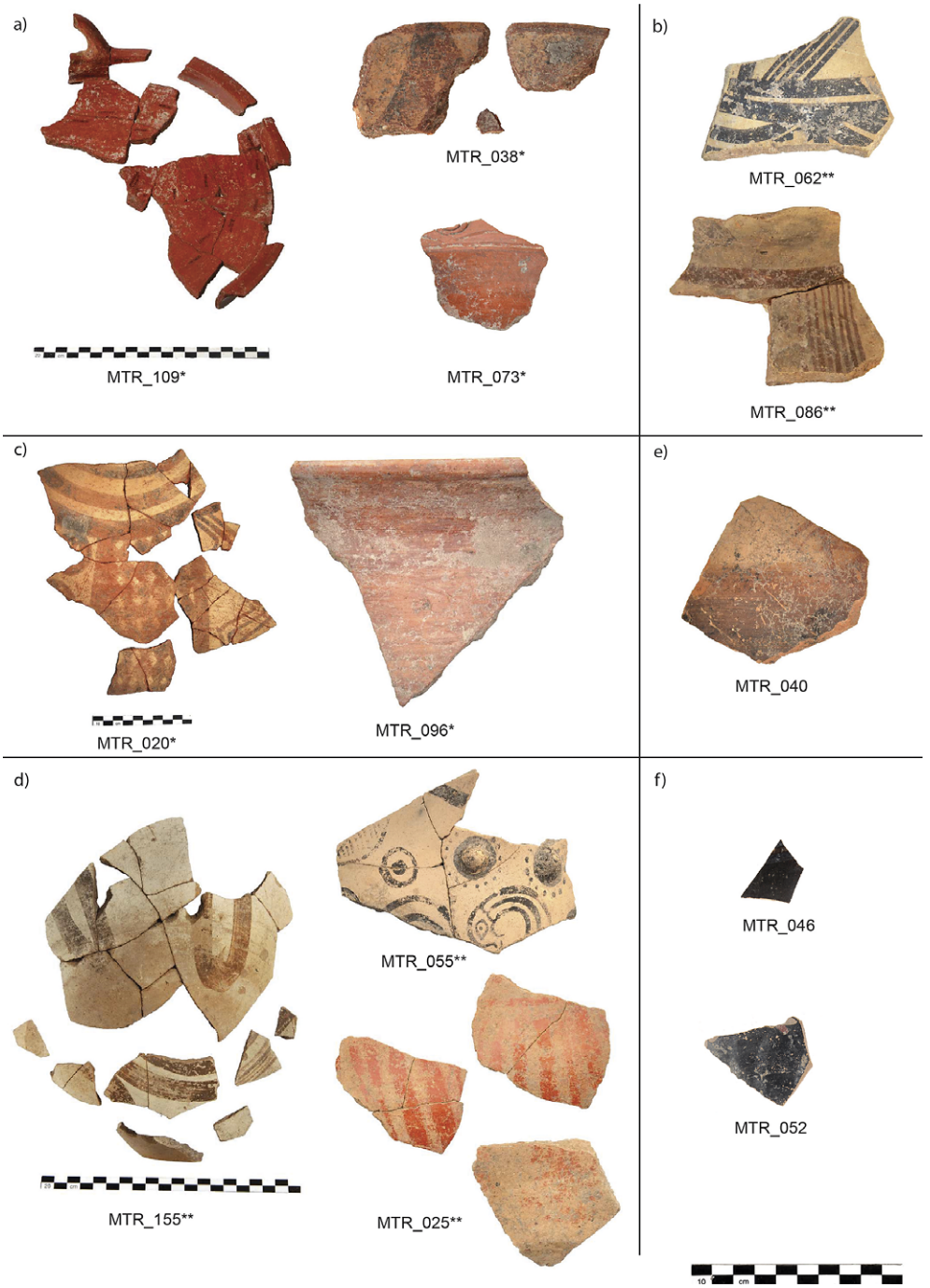

Figure 6. *Selection of analytically confirmed regional imports at MBA Mitrou. a) Probably western Cyclades (Kea?); b) Aegina; c) Probably central Cyclades (Naxos?); d) southern Cyclades (Melos–Thera); e) SE Aegean; f) Crete. *Only subjected to petrographic examination (Hale, 2023a). **Subjected to both petrographic examination (Hale, 2023a) and NAA. Note the different scales for MTR_020, MTR_109, and MTR_155.*

largely absent in the sampled Mitrou material (Kiriatzi et al., 2011: 140–42, 144–45).

Recent analytical results published from Lerna in the Argolid and Tsoungiza in Corinthia reinforce this perception (Hoffmann et al., 2020; Lindblom, 2024: 349–57; Spencer, 2024: 395–418; Spencer & Mommsen, 2024; Whitbread et al., 2024a, 2024b; see also less detailed results from Argos in Kilikoglou et al., 2003). Some similarities with Mitrou are apparent. Both Lerna and Tsoungiza show consistent connections to Aegina during the MBA, more commonly than at Mitrou. Wheel-finished Fine Grey Burnished ceramics consistent with a central Euboean provenance also appear at both sites, but are much rarer than at Mitrou. These become even rarer late into the MBA, and examples from an alternate source also appear at Lerna by Late Helladic I, much like the later MBA assemblage at Mitrou. Cycladic imports also appear at both Lerna and Tsoungiza, but seem rarer than at Kolonna or later MBA Mitrou. Unlike at Mitrou, the analysis of the Lerna and Tsoungiza assemblages revealed a vibrant north-eastern Peloponnesian pottery production environment; however, none of the petrographic or NAA groups consistent with north-eastern Peloponnesian production appear in the Mitrou dataset. Moreover, the Lerna assemblage in particular shows strong connections to the south, including the southern Peloponnese and/or Kythera and Crete, which are all but absent at Mitrou.

What emerges from these comparisons is evidence for distinct regional maritime spheres of connectivity. While Mitrou was connected to Aegina and the Cyclades from the middle of the MBA, the north-eastern Peloponnese was far more closely linked to Aegina, the southern Peloponnese, and Crete, with Cycladic connections only really becoming notable by the end of the MBA. While Aegina clearly bridged both spheres, the north-eastern Peloponnese and the northern Euboean Gulf appear to have been largely separate for much of the MBA apart from occasional Fine Grey Burnished imports making their way to Lerna (perhaps via Aegina as specialized products). This contrasts sharply with subsequent phases at Mitrou, where imports from the Argolid and Argive influence on the ceramic assemblage begins in Late Helladic I, before becoming overwhelming in Late Helladic IIA, indicating a dramatic shift in regional connectivity (Vitale et al., 2024).

Conclusions

The results of our elemental analysis, supported by previous petrographic studies, provide significant insight into pottery production and multi-scale connectivity at MBA Mitrou. Evidence for the production of major tableware classes within the immediate coastscape is limited despite extensive sampling of the most frequent classes represented in the assemblage. This suggests that no specialized ceramic tableware production community operated at any significant scale in the vicinity of MBA Mitrou.

In contrast, major tableware classes were predominantly imported through local world connections. The most important of these (and the major source of Fine Grey Burnished pottery for most of the MBA) was central Euboea, some 60 km distant via a maritime route down the Euboean Gulf. This connection was intense and sustained, lasting for at least half a millennium and perhaps accounting for around twenty per cent of the total MBA pottery at Mitrou (mostly tableware). Such habitual long-term connectivity implies deep cultural and social connections between East Lokris and central Euboea, likely to have included common consumption habits, 'shared cultural traditions, language, social networks such as kinship ties and intermarriage,

mutual protection arrangements, and dense economic relations' (Tartaron, 2013: 190).

Beyond this maritime link, Mitrou's connections to the Boeotian hinterland were also important, especially in the early MBA. Additional analysis of MBA Orchomenos material is required, but if Dark Burnished pottery is associated with western Boeotia or eastern Phocis as proposed here, then Mitrou operated as a critical intermediary linking the Euboean Gulf with western Boeotia and Orchomenos (see also Hale, 2023c). In contrast, links to northern central Greece are consistently present but sparse, suggesting the primary direction of interaction along the Euboean Gulf was south-east to north-west in terms of pottery exchange.

With no evidence for clear Boeotian production of Fine Grey Burnished pottery at Mitrou despite its proximity to Boeotia, the problems with the 'Minyan' label and its implicit association with Orchomenos are becoming increasingly apparent (Gauß & Kiriatzi, 2011: 211–15), strengthening arguments for an alternative terminology such as 'Fine Grey Burnished' (following Rutter, 1983; Gauß & Kiriatzi, 2011: 182; Hale, 2016). The publication of data from other sites in central Greece, including earlier archaeometric analyses conducted at Orchomenos and Thebes (Boileau et al., 2007), and from nearby Attica (Balitsari, 2021), is needed to address further questions related to the existence and chronology of additional production centres for this class and associated overland networks.

Interaction with the regional maritime sphere is evidenced by southern Aegean pottery identified both through the NAA and previous petrographic examination (Hale, 2023b), especially with the north-western Cyclades (probably Kea) and Aegina. These connections increased in frequency and diversity as the MBA progressed. Given the persistent strength of local world connections between Mitrou and central Euboea, it is likely that much of this material reached Mitrou via the Euboean Gulf. The lack of north-eastern Peloponnesian imports in the Mitrou dataset, despite known pottery production with relatively well-understood petrographic and chemical groups from sites like Lerna, together with the almost total absence of common imports known at those sites such as southern Peloponnesian and Cretan products, suggest that MBA Mitrou was part of a very different regional maritime sphere of connectivity.

Our analysis demonstrates that Mitrou was highly integrated into a vibrant central Greek local world during the MBA. While persistent connections to the Boeotian hinterland are apparent throughout, a particularly intensive and long-lasting maritime connection to central Euboea is evident by the early MBA at least. This connection became increasingly dominant towards the late MBA, while Mitrou was also engaging with the wider Aegean maritime sphere (especially Aegina and the Cyclades). Such a characterization is far removed from previous perceptions of the poorer and more isolated MBA communities of the central Greek mainland.

Supplementary Material

The supplementary material for this article can be found at http://doi.org/10.1017/eaa.2025.9.

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De la provenance de la céramique à la connectivité diachronique multi-échelle à Mitrou, (Grèce) au Bronze moyen

Cette étude utilise l'analyse par activation neutronique (AAN) pour examiner la céramique de l'âge du Bronze moyen (environ 2100–1600 av. J.C.) provenant de Mitrou en Locride orientale (Grèce centrale). L'analyse de 112 échantillons issus de toutes les phases de son occupation révèle des modèles complexes de production et d'échange à multiples échelles. Une production limitée de vaisselle de table est évidente dans la

région côtière aux alentours immédiats de Mitrou et contraste nettement avec les nombreuses importations de vaisselle de table provenant d'autre communautés (surtout du centre de l'Eubée et de la Béotie), signe d'un monde hautement interconnecté en Grèce centrale. Les résultats de cette analyse renforcent aussi les conclusions d'études pétrographiques antérieures en mettant l'accent sur les connexions que Mirtuu entretenait avec le monde maritime plus large, notamment les Cyclades, Égine, la Crète et le sud-est de la mer Égée. Ces résultats remettent en cause les idées que l'on se faisait d'une Grèce centrale isolée à l'âge du Bronze moyen, apportent un éclairage nouveau sur la connectivité au Bronze moyen et soulignent le besoin d'effectuer des travaux analytiques sur d'autres sites de Grèce centrale. Translation by Madeleine Hummler

Mots-clés: Helladique moyen, analyse par activation neutronique, Grèce centrale, production et échange de céramique, connectivité, âge du Bronze égéen

Von der Herkunft der Keramik zur diachronen Konnektivität auf mehreren Skalen in Mitrou (Griechenland) während der Mittelbronzezeit

In dieser Studie wird die Neutronenaktivierungsanalyse (NAA) eingesetzt, um die Keramik aus der mittelbronzezeitlichen (ca. 2100–1600 v. Chr.) Stätte von Mitrou in der östlichen Lokris in Zentralgriechenland zu untersuchen. Die Analyse von 112 Proben aus allen Phasen der Siedlung Mitrou offenbart komplexe Herstellungs- und Austauschmuster auf mehreren Skalen. Eine begrenzte Produktion von Tafelgeschirr ist in der Küstenlandschaft der unmittelbaren Umgebung von Mitrou erkennbar, im scharfen Gegensatz zu den zahlreichen Tafelgeschirrimporten aus anderen Gemeinschaften (vor allem aus Mitteleuböa und Böotien), was auf eine stark verbundene zentralgriechische Welt hinweist. Die Ergebnisse der Neutronenaktivierungsanalyse verstärken zudem die Schlüsse von früheren petrografischen Untersuchungen und betonen die Zusammenhänge mit der weiteren maritimen Welt, besonders mit den Kykladen, Ägina, Kreta und der südöstlichen Ägäis. Sie stellen auch frühere Vorstellungen, wobei Zentralgriechenland in der Mittelbronzezeit isoliert war, infrage, liefern neue Einblicke in die mittelbronzezeitliche Konnektivität und unterstreichen die Notwendigkeit weiterer Untersuchungen von anderen zentralgriechischen Stätten. Translation by Madeleine Hummler

Stichworte: Mittelhelladikum, Neutronenaktivierungsanalyse, Zentralgriechenland, Herstellung und Austausch von Keramik, Konnektivität, ägäische Bronzezeit