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RESEARCH

Strategies for success: Early Helladic pottery production in Corinth, Greece

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Abstract
This paper presents the analysis of Early Helladic II (EH II) pottery from Keramidaki (Ancient Corinth) and the nearby settlement of Korakou. Based on macroscopic, petrographic and SEM–EDS data, the work builds on pioneering chemical research by Michael Attas who demonstrated the limited circulation of finewares in the region and posited the existence of a workshop in the area of the Corinthian Plain. The current research adds substantial detail to Attas' insights by characterising the varied range of pottery fabrics encompassed within his chemical groups, differences in raw material choice and manipulation, and the presence of both oxidation and reduction firing regimes to achieve different surface finishes. It is suggested that the area hosted a number of potters during this period, some making a broad range of pottery types to satisfy daily consumption needs of the local community, whilst others produced a more restricted repertoire.

Keywords Early Bronze Age · Corinth · Pottery production · Chaîne opératoire · Petrography

Introduction

As a period of significant social developments related to the rise of metallurgy, the latter's potential relationship to social differentiation, and as a time characterised by what Renfrew referred to as the 'international spirit' (Renfrew 1972: 451–455), the 3rd millennium in Greece and the wider Aegean has long held scholarly attention, particularly the Early Bronze Age (EBA) II[1] period which is seen as having many signifiers of emerging complexity associated with the rise of later palatial societies (Renfrew 1972; Cherry 1983; Branigan 1988; Parkinson and Pullen 2014). On the Greek mainland during this time, we see significant changes in ceramic assemblages as they shift from relatively simple EHI shapes usually with red or brown plain burnished or slipped surfaces, towards an increased diversity of vessel types, decorative styles and motifs to include buff fabrics, dark slips and pattern painted wares that comprise the EHII repertoire. Discussion of such changes during EB II has developed from early ideas around migration and influence from incoming cultural groups (cf. contributions in Crossland and Birchall 1973), to discussions around changes in contexts of consumption, the role of hospitality, and the advent of more complex dining practices which emphasise display (Day and Wilson 2004, Peperaki 2004).

Over the past 30 years, petrographic analysis of Aegean EBA potting technology and raw materials has significantly contributed to typologically derived understandings about the production, circulation and role of pottery. This work has revealed relationships between pottery production, consumption and expression of identity (Day et al. 1998; 2010; Nodarou 2011), broad spheres of contact and the influence of different technological traditions and innovations (Day et al. 2006; Hilditch et al. 2008; Gauß and Kiriatzi 2011; Choleva 2012). Such work has not only demonstrated a previously undetected complexity to the role of pottery during this time, but also the need to apply such analyses to EBA pottery more broadly, particularly in key areas such as the NE Peloponnese.

[1] Please note that chronological time periods will be referred to as Early Bronze Age/EBA, whilst cultural features associated with this period in the region will be referred to as Early Helladic/EH.

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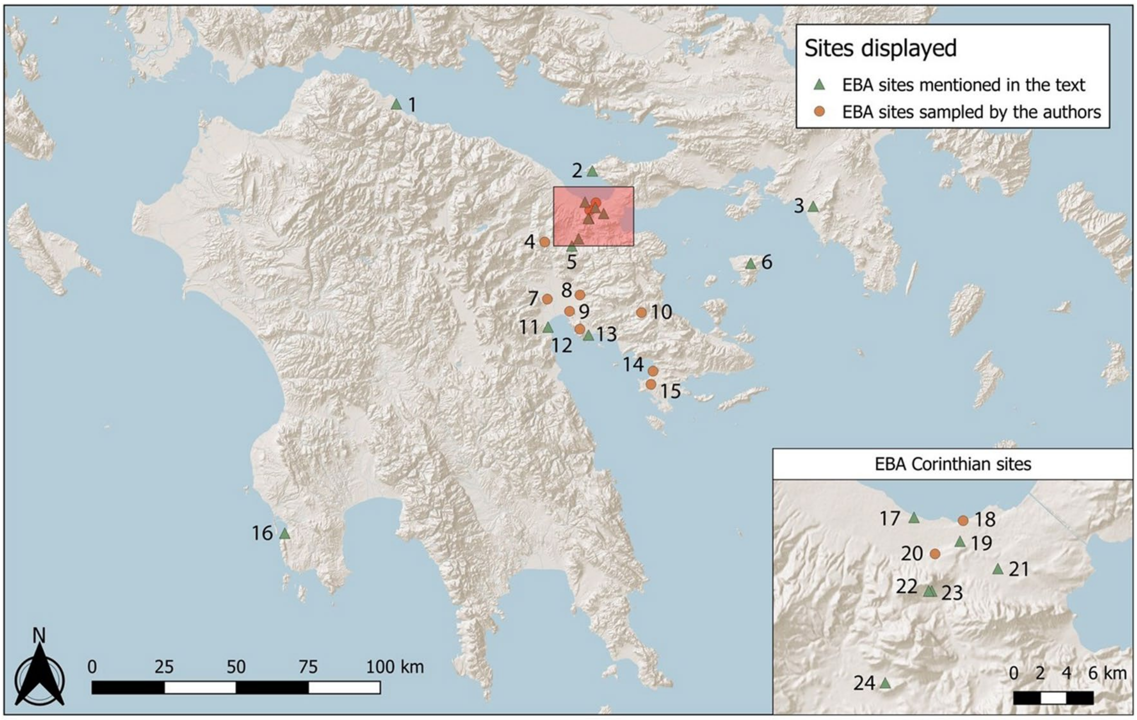

1) Helike; 2) Vouliagmeni; 3) Kontopigado; 4) Tsoungiza, Nemea; 5)Zygouries; 6) Aegina; 7)Lempetzi (Argos); 8) Midea; 9) Tiryns; 10) Epidavros; 11) Lerna; 12) Talioti; 13) Asnie; 14)Delpriza; 15) Agios Pantelimon; 16) Pylos; 17) Agios Gerasimos; 18) Korakou; 19) Koutoumatsa; 20) Keramidaki (Ancient Corinth); 21) Yiriza; 22) Aetopetra; 23) Gonia; 24) Ancient Tenea, Chiliomodi

Fig. 1 Map of sites mentioned in the text. Map design: D. Blattner

Corinth and pottery production

Located in the NE Peloponnese (Fig. 1), c. 80 km west of Athens, the area of Corinth has a long and important history of occupation, being best known for the site of Ancient Corinth which sits at the foot of the Acrocorinth mountain. The site holds a strategic position by the Isthmus that joins mainland Greece to the Peloponnese and lies at the head of the Corinthian Gulf that runs westwards to the Ionian Sea. It dominates passage south to the Argolid and is surrounded by a fertile plain with several natural springs that promoted early agricultural wealth in the area.

This position, combined with abundant stone and clay resources, underpinned substantial historical settlement, and long-standing ceramic and stone industries, with Corinth rising to prominence as an important potting centre during the eighth and seventh centuries BC in particular (Hasaki 2021). During this time, local workshops made a variety of ceramics, including building materials (Sapirstein 2009; Merker 2006) although Corinth became particularly well known as an innovator and a major centre of excellence for black-figure ware which it exported in large quantities (Hasaki 2021: 227–278; Brownlee 2003; DeVries 2003). Certainly, excavation of the Potters' Quarter has demonstrated well organised workshop production of painted wares well into the fourth century BC (Stillwell 1948; Stillwell and Benson 1984). During the Roman period, Corinthian workshops still supplied a range of high-quality ceramics (Whitbread 1995; Graybehl 2010) with recent archaeological and typological work on pottery from Panayia Field at Corinth by James (2014) supporting earlier suggestions (Williams and Russell 1981: 41–43) for the possible continuation of ceramic production after the sack of Corinth in 146 BC. Indeed, whilst political turmoil reduced Corinth's position, local ceramic production certainly continued in the later Byzantine and Frankish periods (Sanders 1987; Joyner 2007; White 2009).

Whilst Ancient Corinth is particularly well known for its Archaic and later archaeology, activity in the area dates to at least the Neolithic period (c. 6500–5750 BC, Lavezzi 1978: 404; Kosmopoulos 1948: 1) with evidence for more settled occupation from the Early Bronze Age (EBA) onwards (Wiseman 1967a and b; Blegen 1920, 1921). However, due to the extensive building activities during the Classical Roman and historical periods, there has been extensive disturbance and destruction of Corinth's prehistoric archaeology, and the EBA is largely characterised by artefactual finds and small areas of excavation (Lavezzi 2003:63, 1979; Blegen 1920; Wiseman 1967a, 1967b). In the broader area around Corinth, there are a number of sites including EH structural remains recorded on the small mounds at Aetopetra

(Blegen 1920: 3; Chatzipouliou-Kalliri 1978) and Arapiza (Blegen 1920: 5) which included the recovery of EH II pottery. Other excavated sites include a well containing EH II pottery excavated at Cheliotomylos (Wagge 1949: 421–422) and the important settlement sites of Korakou (Blegen 1921), Gonia (Blegen 1930) and Yiriza (Blegen 1920: 5–6). More recently investigated EH II remains include a well fill at Archaia Tenea-Chiliomodi (Koursoumis and Georgiadis n.d.; Ministry of Culture and Sports 2021), remains at Agios Gerasimos (Protonotariou-Deilaki 1974), a cemetary at Schinos (Balomenou 2013), and a house at Koutoumatsa, situated less than 2 km northeast of Ancient Corinth (Koursoumis and Georgiadis 2018). Excavation of such sites reveals a picture of extensive EBA inhabitation of the Corinthian Plain, whose EH pottery and architecture bears strong similarities to those noted at sites in neighbouring regions such as Tsoungiza in Nemea (Pullen 2011).

The importance of Corinth as a site and a craft centre has led to a number of detailed studies of its geological materials and specialised analysis of its pottery, especially focused on the Classical and historic periods (Farnsworth 1964, 1970; Hayward 2003a, 2003b; Whitbread 1995, 2003; Joyner 2007, White 2009; Siddall n.d.; Hasaki 2021: 236–239, Liard et al. 2022). This work has provided essential, and comparatively comprehensive, understandings of the nature and distribution of different raw material resources in the Corinthian landscape and the different utilisation of these resources in pottery making. However, to date, examination of Corinth's prehistoric pottery has primarily focused on typological and macroscopic observations (e.g. Lavezzi 1978; Cherry 1973), with the notable exception of the chemical study undertaken by Michael Attas on EBA from sites in the Corinthia using neutron activation analysis (NAA) (Attas 1982; Attas et al. 1987).

Attas and EH pottery provenance

Attas' ground-breaking work examined EH I, EH II and EH III (c. 3000–2100 BC) ceramics from eight sites across the NE Peloponnese, including Korakou and Keramidaki (Ancient Corinth), and remains a key source of information about the production and circulation of EH pottery in the region. Conducted at a time when early pottery making was characterised as local, small-scale, household production with limited circulation of 'specialist' wares, Attas' data indicated a number of unexpected trends. Firstly, whilst his chemical groupings confirmed that the sites within his study did largely rely on local potters whose repertoire included visually striking types such as lustrous slipped (Urfirnis) sauceboats, pottery was also exchanged between neighbouring sites, including the same vessel types that were produced in these different settlements (1982: 379; Attas et al. 1987: 89). Pullen's subsequent consideration of Attas' results suggested a specific directionality in the movement of vessels between particular sites, concluding that some sites were probably specialist suppliers for others (Pullen 1985: 341, Fig. 91).

Secondly, Attas' data indicated that ladles, which were seen as commonly made objects, had a restricted area of production, which he associated particularly with Zygouries, something more indicative of their being a specialist product (Attas 1982: 379–382; Attas et al. 1987: 85–86), whilst the chemical groupings of rare yellow-blue mottled ware (Attas' fine slipped and polished ware) indicated that it was made in a variety of locations, and whose composition suggested a source beyond the sites in his study (1982: 387–388). Such results raised fundamental questions about definitions of specialised pottery and motivations for vessel movement, because if the assumptions about small-scale household production were correct, why would people go to the extra effort of obtaining vessels from other potting communities that they could also get locally? (Pullen 1985: 341; Rutter 1993: 23). Additionally, how could high-quality rare pottery such as yellow-blue mottled ware be made in multiple centres, whilst the production of the common ladle seemed to be more restricted?

Although this seminal work raised many questions that challenged existing models of pottery production and circulation, as Attas himself acknowledged, the use of chemistry alone created some difficulties in characterising EBA ceramic production more fully. Beyond provenance issues related to the similar chemical compositions of geological materials within and between regions of the NE Peloponnese (Mommsen et al. 1988; Hein and Mommsen 1999), there was no way to differentiate between multiple producers working in the same geological area who may have used similar raw materials but in different ways, because elemental data do not give detailed insights into raw material choices and paste recipes. It was also not possible to identify the provenance of pottery from sources outside of the reference data then available to Attas. Such additional information would be key to understanding if EH pottery was widely produced by many potters/potting groups or if it was a craft that involved specific technological traditions, spheres of knowledge and centres of production. Furthermore, Attas' analysis had difficulties examining the composition of coarser pottery (1982: 391; Attas et al. 1987: 89), preventing the characterisation of the full repertoire of vessel types in daily use, meaning he had to rely more heavily on finewares.

Since Attas' work there have been substantial analytical and paradigmatic shifts in the investigation of the EBA Aegean and its pottery, particularly on Crete (Whitelaw et al. 1997; Day et al. 1997; 1998; 2010; Day and Wilson 2002; Papadatos and Nodarou 2018; Mentesana et al. 2016), as well as recent work in the East Aegean (Day et al. 2009; Menelaou and Day 2020; Menelaou and Kouka 2021), Aegina (Gauß and Kiriatzi 2011) and on the Greek mainland such as in Thebes (Hilditch et al. 2008) and Pylos (Kordatzaki et al. 2018). The increasing utilisation of a range of methods, especially thin section petrography, in such studies has significantly expanded our understanding of pottery production, technology and circulation during both the Neolithic and EBA, bringing to light a more complex picture than previously assumed. This research has demonstrated the varied scales of production and movement of pottery in different places at different times, questioning traditional ideas about the evolutionary development and organisation of pottery making in early societies. A key to the success of such work has been the ability to characterise the products and 'technological style' (Lechtman 1977; Gosselain 1992) of different production locations, many associated with certain vessel types and/or finishes that underpinned the development of their reputations as potting centres (e.g. Aeginitan cooking pots Gauß and Kiriatzi 2011; Lis et al. 2015; Gauß et al. 2017).

With this background, the present research focuses on the raw material and technological characterisation of EH II ceramics from Keramidaki (Ancient Corinth) and the neighbouring site of Korakou (including some of the same samples examined by Attas, see Table 2 for concordance), using thin section petrography complemented by small-scale study using SEM–EDS. The trends identified are contextualised in relation to a larger regional multi-analytical study of EH pottery from across the NE Peloponnese undertaken by the authors (Fig. 1; Burke et al. 2018, 2020, 2016; Burke 2017), as well as recent work in Attica (Tsai and Day, work in progress; Tsai 2021), and published analysis at other EBA mainland sites. This multi-scalar approach provides a more holistic understanding of the repertoire of pottery being made and used by these EBA communities, and enables us to assess how this understanding fits with the trends suggested by Attas' chemical data.

In examining the ceramic raw materials and practices used to make pottery from Keramidaki and neighbouring Korakou, the following key questions are addressed:

- Which raw materials were used to make EH type pottery at these sites?
- Is it possible to suggest potential sources for the raw materials identified?
- By differentiating paste recipes and production strategies, including coarseware production, is it possible to build a more detailed picture of local production and consumption on the foundations laid by Attas?

Site background

Keramidaki (Ancient Corinth)

Between 1965 and 1971, the University of Texas conducted excavations of the Roman gymnasium at Ancient Corinth, under the direction of James Wiseman. The recovery of consistently EH II material culture in deeper soundings led to the excavation of sondages in six areas of the site to investigate these early deposits. Whilst it was not possible to define clear stratigraphical relationships due to the limited area of excavation and later disturbances, the deeper excavations uncovered an abundance of EH II finds, part of a wall, and a cutting into the bedrock, which contained a deposit of snail shells (Wiseman 1967a: 24; Cherry 1973: 14). The EH II finds included lithics of flint and obsidian, ground stone tools, loom weights, spindle whorls, a seal, and over 30,000 ceramic sherds, all of which commonly lay within a hard red clay matrix just above the bedrock (Wiseman 1967b: 403; Cherry 1973: 7). More generally, although there were few architectural remains, the abundance of EH II material and its wide distribution across Ancient Corinth indicated the presence of an extensive EB II settlement that was destroyed by later intensive building during the Classical and Roman periods. Certainly, the huge amount of EH II pottery is highly significant considering that at the neighbouring site of Korakou 100,000 sherds were recovered (Blegen 1921: 12), which represented the amount of excavated pottery for the entire Bronze Age at the site, not just the EB II period.

Korakou

The neighbouring site of Korakou lies on a low hill on the coast c. 3 km NE of Ancient Corinth and was excavated by Carl Blegen and Alan Wace in two seasons between 1915 and 1916, under the auspices of the American School of Classical Studies at Athens. Like Keramidaki, Korakou was excavated in a series of small test pits cut across the length of the site. The excavations revealed 11 stratigraphical layers representing multi-period occupation in the Early, Middle and Late Bronze Age, with the EBA deposit resting on bedrock and consisting of six levels totalling c. 2 m in thickness (Blegen 1921: 2).

The excavations of the EBA levels uncovered burnt mudbricks and portions of roughly made foundation walls of stone embedded in clay, similar to the construction method for the wall section found at Keramidaki. In addition, portions of a curvilinear wall associated with EH II pottery were uncovered, probably representing an apsidal building comparable to others found across the NE Peloponnese which also share similar construction methods (e.g. Tsoungiza: Pullen 2011; Epidavros: Theodorou-Mavrommatidi 2004). In addition to architectural features, Blegen's team also uncovered a number of pits, including a large clay lined pit or 'bothros' containing carbonised material below the last floor level, and a large cutting into the bedrock filled with Urfirnis pottery (Blegen's Class B. 1921: 76). Aside from the recovery of EH II and EH III pottery types, other EH finds at the site included spindle whorls (Blegen 1921: 104) similar in size and shapes to those at Keramidaki (Wiseman 1967a: Plate 16 photo d), ground stone tools, pierced clay cylinders, and lithic flakes and blades (Blegen 1921: 104).

Fig. 2 Examples of mended vessels following Cherry's typology (1973: 56–58) left to right: black Urfirnis sauceboat, red-brown Urfirnis bowl and saucer with incurving rim, red/brown slipped jug/pitcher, and plain beak spouted jug

Geological setting

The area of Corinth is characterised by Middle Triassic to Late Jurassic formations of limestones with interbedded shales, cherts and ophiolites, which form the mountains of Corinthia and Geraneia to the north, Acrocorinth and Penteskouphi in the centre, and the Oneia mountains east of Acrocorinth (Yannetakis et al. 1972; Papavassiliou 1985; Whitbread 1995; Siddall n.d.). These contain outcrops of serpentinite, volcanic lavas, sandstones, siltstones, cherts, tuffites, shales and radiolarite (Whitbread 1995: 263, 2003: 2). Additionally, deltaic sedimentation has deposited conglomerates and breccias which now cover the northern slopes of some hills, and partially cover some of the marine terraces towards the Corinthian Gulf (Hayward 2003a: 17, 2003b: 385). Pleistocene uplift has resulted in the sequential deposition of the earlier eroded material, forming basal conglomerate overlain by inter-bedded sandstones and coarse clastics, grading through to fine sandstones with inter-granular carbonate, capped by a sequence of limestones, with inter-bedded marl (Yannetakis et al. 1972; Keraudren and Sorel 1987; Whitbread 1995; Higgins and Higgins 1996; Hayward 2003a: 16, 2003b: 385; White 2009; Siddall n.d). Examination of Corinthian clay deposits by Farnsworth (1970), Whitbread (1995, 2003) and Hasaki (2021: 236–239) recorded the presence of red and white clays on Acrocorinth, in addition to red clays associated with terra rossa across a broad area, white clays in the Corinthian Plain and grey clays associated with lignite deposits (Whitbread 1995: 324–329).

Materials and methods

Whilst the pottery from the Keramidaki excavations in Ancient Corinth has not been published in full, a detailed typological and macroscopic fabric study was conducted by John Cherry (Cherry 1973) in which he classified 12,573 diagnostic ceramic fragments (including loom weights and spindle whorls) from a total of 31,643. The sorted material includes well-attested EH II types, dominated by sauceboats, and small bowls (usually with incurving rims) which make up over 50% of the assemblage, followed by large bowls which comprise over 20%, and then jars and jugs which are 4% and 6%, respectively (Fig. 2).

Other ceramic types include ladles, pithoi, baking pans, fire dog stands and hearth fragments, as well as unusual spouted vessels recorded as 'feeding bottles' (Cherry 1973: 56). In terms of surface finish, as would perhaps be expected by the abundance of fine tablewares, the pottery is dominated by Urfirnis lustrous slips (60%), with small amounts of slipped and polished wares (yellow-blue mottled) and pattern painted finishes (< 2%). Plain surfaces (nearly 22%) are found in all shape varieties, but mostly associated with larger vessel types such as jars, large bowls and jugs (Cherry 1973: 59–64).

Cherry dates the assemblage to mid EBA II (Cherry 1973: 106), consistent with comparable EH II pottery types from other sites. Whilst some coarseware and larger vessel types, such as the saddle back firedog stand, have good parallels to EH II Initial types at Tsoungiza (Pullen 2011: 195), the rest of the Keramidaki assemblage finds closer parallels to later EBA II phases; the low proportion of incised pottery, alongside the domination of ring-based sauceboats and small bowls with incurving or inturned rim, large bowls with inturned rim, jars with flaring necks and strap handles, saucers, dark slipped finishes, and the small proportion of pattern painted vessels, is more congruent with EH II Developed at Tsoungiza (Pullen 2011: 379–439), Lerna III Phase B and particularly C (Wiencke 2000), and shapes and finishes at Zygouries (Blegen 1928: 82, Fig. 68; 83 and 111: Fig. 90). The distinctive beak spouted jugs from Keramidaki have a similar profile to square spouted types from Lerna Early C (Wiencke 2000: 404–405, P581), whilst the Keramidaki sauceboats with horizontal handle (commonly with a reserved area below the handle), a narrow body, long neck and downward pointed spout with pointed ear tips, correlate well to Lerna III Caskey types I and II (Caskey 1960: 291; Cherry 1973: 120), with parallels dated to Late Phase B and Early Phase C (e.g. Wiencke 2000: 412–413, P630). Such types are also found at Zygouries (Blegen 1928: 90) and Tsoungiza EH II Developed Phase II (Pullen Form 3, Type 1 2011: 349). Additionally, as noted by Pullen, a fragment of a sauceboat with dark painted cross hatch triangles from

EH IID Phase 1 at Tsoungiza (Pullen 2011: 390, drawing 423) is strikingly similar to an example from Keramidaki (Wiseman 1967a: 26 Fig. 9).

Turning now to the Korakou EH II assemblage, it should be noted that the site was excavated at the turn of the twentieth century when Blegen was developing the EH sequence we use today. As such the relative dating and publication of the ceramics focused on characteristic and often decorated pieces rather than the overall nature of the assemblage, and some of the dating might be questioned in light of more recent stratigraphic excavations at sites such as Tsoungiza (Pullen 2011). However, the types presented include tablewares and coarser vessel types comparable to those at Keramidaki, such as sauceboats with long necks and horizontal handles (Blegen 1921: 7 Fig. 6), and Korakou water jars (Blegen 1921: 8 Fig. 8) correlating to Cherry's Type J jar with their globular bodies, flaring necks and horizontal strap handles at the belly (1973: 58). Such jars also find parallels elsewhere, such as within the EH II Developed assemblage from House B at Tsoungiza (HV 33 Pullen 2011: 438–439). Unlike Keramidaki, the EBA repertoire excavated from Korakou also included later vessel types such as linear pattern painted tankards similar to EH III types from Tsoungiza (Pullen 2011: 515–516); however, at the time of sampling, only sherds belonging to EH II fine tablewares originally examined by Attas were available.

For the material presented in this paper and within our wider EH study, the pottery was first examined for macroscopic fabric, vessel form and finish, and where possible, evidence of forming. Samples were chosen to include technological and macroscopic fabric variability identified across the different pottery classes present in the available assemblages at Korakou and Keramidaki. In total, 144 sherds were sampled from Keramidaki for petrographic analysis from different excavation lots across the excavated area (including 54 also analysed in Attas' study). An additional 34 sherds were taken from Korakou, although as only Attas' original samples were available to study from Korakou there is a higher occurrence of tablewares from this site (see Table 2 for concordance of petrographic fabric groups with Attas' chemical groups and corresponding Attas sample number). Thin sections were prepared at the Fitch Laboratory, British School at Athens using standard procedures, and petrographically examined using the Leica DM 2700 microscope at the Department of Archaeology at the University of Sheffield. They are now stored at the National Center for Scientific Research, 'Demokritos', Athens.

To complement petrographic observations, seven samples were analysed using scanning electron microscopy with energy dispersive spectroscopy (SEM–EDS) as part of a broader comparative study of 66 EH samples from across the Corinthia and Argolid to examine microstructures and preserved slips in relation to firing conditions and surface modification (Burke 2017, Chapter 8; Burke et al. work in progress). Samples were chosen based on identified macroscopic variability in fired vessel colour, differences in optical activity under the polarising microscope within some FGs, and to encompass a range of surface finishes. The SEM–EDS was undertaken at the National Centre for Scientific Research 'Demokritos' using an FEI Quanta Inspect D8334 scanning electron microscope. Equivalent firing temperature (EFT) ranges are based on published comparative procedures, general standards and data (Maniatis and Tite 1981; Kilikoglou 1994; Day and Kilikoglou 2001; Faber et al. 2002).

Due to the differential surface preservation in the sampled pottery at both sites (particularly for chalky finewares), and varied terminology in respective typological studies, we will not use the term Urfirnis but instead list the technique of finishing such as 'slipped', and its associated colour, comparable for example to Wiencke's use of the term 'dark painted ware' (2000: 325). Additionally, the term yellow-blue mottled rather than slipped and polished ware will be used in order to differentiate this characteristic ware group whose vessel surfaces remained well preserved.

Results

Samples were assigned to petrographic fabrics based on a combination of shared elements relating to raw material selection and manipulation; those containing multiple samples were assigned to petrographic fabric groups (FG): with 21 FGs being identified in total (see Tables 1 and 2). At Keramidaki 16 FGs were assigned, of which 10 were also present at Korakou, the majority of which were considered to Corinthian, or from the broader Corinthian Plain/region. In addition, a total of eight fabrics comprising of a single sample were also identified (six were identified at Keramidaki and two at Korakou), with seven being assigned as from the Corinthian Plain and broader region, and one as having an unclear provenance. Petrographic descriptions and discussion of fabrics not presented in this article, including all of the single sample fabrics, are available in the open access copy of Burke's PhD thesis (2017: Chapters 7, 9, and Appendix 2).

This paper will focus on eight of the most prominent FGs that encompass the majority of the sampled material (131 samples out of a total of 178) offering the best insights into pottery production and consumption trends at these sites (see Table 2). Summary descriptions are provided below (petrographic colours are described in XPL relating to birefringence. Full descriptions are in Supplementary Information and follow a system adapted from Whitbread 1989; 1986; 1995).

FG1: fine green firing clay mix fabric

FG1 is dominantly associated with slipped tablewares (Table 2). Macroscopically, the sherds within this petrographic fabric group are very fine and chalky with a

Table 1 Overview of all FGs identified at Keramidaki and Korakou with proposed provenance

Petrographic fabric group (* = discussed in this paper)	Suggested provenance
Fine green firing clay mix fabric*	Corinthian Plain/Corinthian Region
Medium fine clay mix with rounded pellets fabric*	Corinthian Plain/Corinthian Region
Fine-medium fine clay mix with angular mudstone fabric*	Corinthian Plain/Corinthian Region
Argillite fabric*	Ancient Corinth/Corinthian Plain
Degraded basic igneous fabric*	Ancient Corinth/Corinthian Plain
Mudstone, mudstone breccia and tuffaceous rock fragments fabric*	Ancient Corinth/Corinthian Plain
Angular chert and volcanic rock fragments fabric*	Ancient Corinth/Corinthian Plain
Altered volcanic and serpentinite fabric*	Corinthian Plain
Subgroup with igneous rock fragments*	Corinthian Plain/NE Peloponnese
Mudstone, calcite-micrite and tuffaceous rock fragments fabric	Ancient Corinth/Corinthian Plain
Rounded serpentinite fabric	Ancient Corinth/Corinthian Plain
Fine quartz rich fabric	Corinthian Region/NE Peloponnese
Medium fine mudstone, siltstone and mudstone breccia fabric	Corinthian Region/NE Peloponnese
Sandstone and low-grade metamorphic fabric	Argolid/Talioti
Sandstone and altered sandstone fabric	Argolid/NE Peloponnese
Disaggregated sparitic limestone fabric	Corinthian Plain/NE Peloponnese
Fine clay mix with mudstone and mudstone breccia fabric	Corinthian Plain/NE Peloponnese
Fine quartz sand fabric	NE Peloponnese
Argillite, shale and mudstone fabric	NE Peloponnese
Intermediate igneous fabric	Aegina
Very fine quartz fabric	NE Peloponnese

distinctive buff or green-buff colour and usually with black-brown slips, or in rare examples a pink-buff colour usually with browner slips. Fresh breaks reveal very few to rare dark red-brown or brown-black inclusions that are usually difficult to see with the naked eye (Fig. 3). The primary petrographic fabric group contains few to rare fine silt sized, angular to sub-angular monocrystalline and polycrystalline quartz, feldspar and biotite, with rare to absent degraded basic igneous, and chert inclusions. It has a very fine to fine, green or brown-green coloured groundmass (Fig. 3) that is optically inactive, suggestive of a high degree of vitrification from firing. A sub-group has a green–brown to red-brown groundmass that contains more frequent silicate and mica grains, low optical activity, and is usually associated with pinker macroscopic fabrics (Fig. 3, top row). This variability suggests small differences in firing temperature ranges and/or in the soaking times across FG1.

SEM–EDS analysis of three samples from Keramidaki, with comparison to a further 15 samples in the same fabric at other sites, confirmed that this fabric was high fired, displaying extensively vitrified microstructures consistent with EFT ranges of 850–1050 °C. The SEM analysis also revealed variability across the group, with some samples displaying more extensive sintering with finer glassy areas and smaller pore structures compared to other samples (see contrast between SEM images in Fig. 3), suggesting a small degree of variability in firing conditions between samples. SEM–EDS and refiring experiments additionally confirmed that these vessels were coated with iron rich slips which would have required a short final reduction phase to convert them to dark brown and black colours, those with darker brown-black and black slips having been more extensively reduced.

All samples in FG1 have characteristic red-brown textural concentration features (TCFs) which are rounded, sub-rounded or consist of red-brown striations, suggestive of mixing red and buff/green firing clays. Farnsworth (1964: 227, 1970: 9) and Whitbread (1995: 314–331) have highlighted the common practice of mixing Corinthian clays, perhaps due to their highly calcareous and sticky nature (common in Pliocene marine clays) making them difficult to work and leading to failure during drying and firing. Additionally, clay sampling in Corinth and Nemea by Burke and Heather Graybehl identified a degree of natural heterogeneity in the structure and colour in local clays; however, these were confined to the presence of few darker clay inclusions rather than the regular rounded or striated features seen in the EH II pottery samples, which are more consistent with those identified in experimental clay mixes.

The fine nature of FG1 makes provenance on petrographic grounds alone difficult, but considering a variety of data it seems that a Corinthian origin is likely for these samples. Firstly, Attas placed the majority of the samples within this fabric as Groups M or N, both of which he assigned as Corinthian as they overwhelmingly contained only samples from Keramidaki or Korakou (1982: 353; Attas et al. 1987: 82–83). Secondly, the petrographic fabric

Table 2 List of all samples in the fabrics discussed in the paper, including the corresponding Attas sample number of chemical grouping. KER = Keramidaki, KOR or KRK = Korakou. Attas' provenance ascription—M & N = Corinthian Plain, O = Keramidaki, T = Lerna, U = Tiryns

Petrographic fabric group and macro example	Sample no. (Attas no. and group)	Vessel shape	Surface finish
FG1 fine green firing clay mix fabric	KER 11/5 (KER 6, M)	Flat based small bowl	Black slip (exterior)
	KER 11/6 (KER 7, M)	Ring based bowl	Black slip (exterior)
	KER 11/7 (KER 8, regional)	Small bowl with incurving rim	Black-brown slip (exterior and interior)
	KER 11/8 (KER 9, N)	Sauceboat	Black-brown slip (exterior and interior)
	KER 11/9 (KER 10, N)	Sauceboat	Black-brown slip (exterior and interior)
	KER 11/10 (KER 11)	Ring base (small bowl/sauceboat)	Black-brown slip (exterior and interior)
	KER 11/13 (KER 14, M)	Small bowl with incurving rim	Black slip (exterior and interior)
	KER 11/14 (KER 15, M)	Sauceboat	Black slip (exterior and interior)
	KER 11/15 (KER 16, outlier)	Sauceboat	Brown slip (exterior and interior)
	KER 11/16 (KER 17, N)	Sauceboat	Black-brown slip (exterior and interior)
	KER 11/17 (KER 18, N)	Sauceboat	Black-brown slip (exterior and interior)
	KER 11/30 (KER 32, O)	Jar	Undecorated
	KER 11/31 (KER 33, regional)	Jar handle	Brown slip (exterior)
	KER 11/45	Sauceboat	Black-brown slip (exterior and interior)
	KER 11/59	Ring base (small bowl/sauceboat)	Black slip (exterior and interior)
	KER 11/79	Ring base (small bowl/sauceboat)	Red-brown slip (exterior and interior)
	KER 11/84	Sauceboat	Black slip (exterior and interior)
	KER 11/95	Bowl with inturned rim	Black-brown slip (exterior and interior)
	KER 11/96	Small bowl/saucer	Black-brown slip (exterior and interior)
	KER 11/100	Jug	Undecorated
	KER 11/129	Neck (jug/jar)	Undecorated
	KER 11/134	Ring base (small bowl/sauceboat)	Undecorated
	KER 11/139	Bowl	Brown slip (exterior and interior)
	KER 11/143	Ladle	Red–orange slip (exterior and interior)
	KOR 11/4 (KRK 6, M)	Sauceboat	Black slip (exterior and interior)
	KOR 11/12 (KRK 14, M)	Sauceboat	Black slip (exterior and interior)
	KOR 11/13 (KRK 15, M)	Sauceboat	Brown wash? Burnished?
	KOR 11/14 (KRK 16, T)	Sauceboat	Black-brown slip and burnished (exterior and interior)
	KOR 11/20 (KRK 22, M)	Small bowl with offset rim	Black-brown slip (exterior and interior)
	KOR 11/23 (KRK 25, regional)	Neck (jug/askos)	Undecorated
	KOR 11/25 (KRK 27, excluded)	Base (bowl?)	Undecorated
	KOR 11/26 (KRK 28, M)	Jug	Undecorated

Table 2 (continued)

Petrographic fabric group and macro example	Sample no. (Attas no. and group)	Vessel shape	Surface finish
FG2 medium fine clay mix with rounded pellets fabric	KER 11/11 (KER 12, N)	Flat base small bowl	Orange-brown slip (exterior and interior)
	KER 11/12 (KER 13, O)	Ring based sauceboat/small bowl	Red–orange-brown slip (exterior and interior)
	KER 11/46 (KER 53, outlier)	Incurving rim sauceboat/small bowl	Black slip (exterior and interior)
	KER 11/48 (KER 55, N)	Bowl with internally thickened rim	Black-brown slip (interior)
	KER 11/61	Jar	Black slip (exterior)
	KER 11/83	Sauceboat	Black slip (exterior and interior)
	KER 11/85	Small bowl	Brown slip (exterior and interior)
	KER 11/87	Ring base small bowl	Black slip (exterior and interior)
	KER 11/137	Everted rim of jar	Red-brown slip (exterior)
	KER 11/141	Saucer	Black slip (exterior and interior)
	KER 11/144	Large bowl with inturned rim	Dark brown wash (exterior)
	KOR 11/3 (KRK 5, N)	Sauceboat	Black slip (exterior and interior)
	KOR 11/7 (KRK 9, outlier)	Sauceboat	Red-brown slip (exterior and interior)
	KOR 11/8 (KRK 10, N)	Sauceboat	Dark brown slip (exterior and interior)
	KOR 11/10 (KRK 12, regional)	Sauceboat	Black slip (exterior and interior)
	KOR 11/11 (KRK 13, N)	Sauceboat	Brown slip (exterior and interior)
	KOR 11/19 (KRK 21, N)	Small bowl with incurving rim	Black-brown slip (exterior and interior)
	KOR 11/21 (KRK 23, regional)	Small bowl with inturned rim	Black-brown slip (exterior and interior)
FG3 fine-medium fine clay mix with angular mudstone fabric	KER 11/1 (KER 1, M)	Jar with strap handle	Undecorated
	KER 11/3 (KER 4, N)	Jar with strap handle	Undecorated
	KER 11/27 (KER 29, outlier)	Thick wall sherd	Undecorated
	KER 11/28 (KER 30, excluded)	Jar	Undecorated
	KER 11/68	Sauceboat	Yellow-blue mottled (exterior)
	KER 11/91	Jar with everted rim/collar	Black-brown slip (exterior)
	KER 11/104	Pithos	Undecorated
	KER 11/107	Large bowl	Black slip (interior)
	KER 11/117	Jug/jar	Undecorated
	KER 11/121	Large bowl	Black slip (interior)
	KER 11/140	Ring base small bowl	Black slip (exterior and interior)
	KOR 11/34	Jar body	Black-brown slip (exterior)

Table 2 (continued)

Petrographic fabric group and macro example	Sample no. (Attas no. and group)	Vessel shape	Surface finish
FG4 argillite fabric	KER 11/29 (KER 31, (M))	Base jar/bowl?	Undecorated
	KER 11/33 (KER 38, O)	Large bowl with internally thickened rim	Red-brown slip (interior)
	KER 11/38 (KER 43, (U))	Neck of jug/jar	Undecorated
	KER 11/47 (KER 54, outlier)	Jar with short collar	Red-brown slip (exterior)
	KER 11/50 (KER 57, U)	Jar/large bowl	Black-brown slip (exterior)
	KER 11/60	Sauceboat	Black-brown slip (exterior and interior)
	KER 11/93	Jar	Undecorated
	KER 11/101	Ring base large bowl	Red slip (interior)
	KER 11/119	Jar	Undecorated
	KER 11/122	Ring base large bowl	Undecorated
	KER 11/125	Jar with short collar	Undecorated
	KER 11/126	Jar with long flaring collar	Undecorated
	KER 11/128	Jar with short collar	Undecorated
	KER 11/130	Jar with short collar	Undecorated
	KOR 11/24 (KRK 26, regional)	Jug/jar with long collar	Undecorated
	KOR 11/32 (KRK 34, regional)	Large bowl with internally thickened rim and handle	Red-brown slip (and burnished?) (interior)
FG5 degraded basic igneous and tuffaceous rock fragments fabric	KER 11/2 (KER 3, (M))	Rope twist jug handle	Undecorated
	KER 11/4 (KER 5, O)	Jar with strap handle	Undecorated
	KER 11/32 (KER 37, outlier)	Large bowl with internally thickened rim and handle	Red-brown slip (interior)
	KER 11/34 (KER 39, O)	Ring base large bowl	Red-brown slip (interior)
	KER 11/37 (KER 42, (O))	Large bowl with internally thickened rim and handle	Brown slip (interior)
	KER 11/41 (KER 47, outlier)	Rope twist jug handle	Incised (exterior)
	KER 11/42 (KER 48, O)	Double spouted vessel (‘feeding bottle’)	Undecorated
	KER 11/43 (KER 49, outlier)	Shoulder and neck of jug/jar	Undecorated
	KER 11/44 (KER 50, outlier)	Jar	Undecorated
	KER 11/62	Large bowl with internally thickened rim	Undecorated
	KER 11/63	Jug/jar	Undecorated
	KER 11/69	Jar with everted rim/short collar	Undecorated
	KER 11/80	Jug/jar with strap handle	Undecorated
	KER 11/81	Large bowl with internally thickened rim	Red slip (interior)
	KER 11/98	Large bowl with internally thickened rim	Red slip (interior)
	KER 11/99	Bowl with internally thickened rim	Red-brown slip (interior)
	KER 11/102	Strap handle of jar	Undecorated
	KER 11/123	Large shallow incurving bowl	Orange-brown slip (interior)
	KER 11/127	Jar	Undecorated
	KER 11/132	Cup?	Applied (exterior)
	KER 11/135	Ring base of large bowl	Black slip (exterior and interior)

Table 2 (continued)

Petrographic fabric group and macro example	Sample no. (Attas no. and group)	Vessel shape	Surface finish
FG6 mudstone, mudstone breccia and tuffaceous rock fabric	KER 11/18 (KER 19, O)	Large bowl/basin with internally thickened rim	Red slip (and burnished?) (interior)
	KER 11/24 (KER 26, outlier)	Firedog stand	Undecorated
	KER 11/36 (KER 41, N)	Large hemispherical bowl with rounded rim	Orange-brown slip (interior)
	KER 11/39 (KER 44, regional)	Flat base of jar/large bowl?	Undecorated
	KER 11/51 (KER 58, regional)	Flat base of jar	Undecorated
	KER 11/52 (KER 59, N)	Baking pan	Undecorated
	KER 11/53 (KER 60, N)	Jar/pithos	Applied and red-brown slip (exterior)
	KER 11/66	Vertical handle of bowl/jar	Red-brown slip (exterior and interior)
	KER 11/67	Jar with strap handle	Red–orange slip (exterior)
	KER 11/71	Large hemispherical bowl/basin	Applied (exterior)
	KER 11/72	Inturned rim of large bowl	Undecorated
	KER 11/73	Body sherd of bowl?	Burnished? (exterior)
	KER 11/77	Hearth/baking pan	Undecorated
	KER 11/78	Flat base small bowl	Undecorated
	KER 11/94	Flat base large bowl	Red slip (interior)
	KER 11/97	Small incurving bowl	Red slip (exterior)
	KER 11/104	Pithos	Undecorated
	KER 11/124	Vertical strap handle jar	Undecorated
	KOR 11/1 (KRK 3, outlier)	Pedestalled base sauceboat	Black-brown slip (and burnished?) (exterior and interior)
	KOR 11/30 (KRK 32, regional)	Baking pan	Undecorated
FG7 angular chert and altered volcanic rock fragments fabric	KER 11/21 (KER 22, regional)	Ladle	Undecorated
	KER 11/74	Incurving rim of deep bowl/cooking pot	Undecorated
	KER 11/88	Large hemispherical bowl/cooking pot	Applied (exterior)
	KER 11/92	Large hemispherical bowl	Undecorated
FG8 altered volcanic and serpentinite fragments fabric	KER 11/55 (KER 62, outlier)	Baking pan	Undecorated
	KER 11/58 (KER 45, outlier)	Baking pan	Undecorated
	KER 11/86	Large bowl	Black-brown slip (exterior and interior)
	KER 11/118	Jar	Brown slip (exterior)
	KER 11/136	Flat base jar	Black slip (exterior)
	KER 11/138	Large shallow bowl with inturned rim	Undecorated
	KOR 11/31	Baking pan	Undecorated
Sub-group: altered volcanic, serpentinite and igneous fragments fabric	KER 11/109	Large hemispherical cooking pot	Applied (exterior)
	KER 11/115	Large incurving bowl	Applied (exterior)
	KER 11/142	Large incurving bowl with rounded rim	Red-brown-black slip (exterior and interior)

bears a striking similarity to published Corinthian fabrics from other periods, such as the Frankish Clay Temper Group A3 identified as local by Harriet White (2009: 109, 222 Fig. 8.2.16) which included wasters confirming local production. The fabric also contains inclusions consistent with other Corinthian fabrics discussed below, such as chert and degraded basic igneous fragments, which although found in rare amounts and not present in every sample, are compatible with pillow lavas and chert outcrops located on Acrocorinth (Yannetakis et al. 1972; Whitbread 1995: 276; Joyner 2007: 200; Graybehl 2015: 101; Siddall n.d.: 28). Further, this fabric has a distinctive distribution pattern during EB II in the wider comparative study that also points towards a Corinthian origin, as presented in detail elsewhere (Burke et al. 2018: 153–154; Burke et al 2020). Principally, this fabric is particularly associated with dark slipped tablewares (Fig. 3), and although found at all sites we have examined across the Argo-Corinthia, it is notably rarer within assemblages in the Argolid, standing in marked contrast to the usually brown, orange or red firing Argive fabrics (Burke et al. 2018: 151–152; 2020). Additionally, there are typological differences between Argive vessels and members of FG1 (Alram-Stern 2018: 172–175). Certainly, the existence of distinct Argive and Corinthian spheres of technological knowledge and raw material utilisation fits well with evidence from other key EBA potting areas, with differences in skill and know-how in relation to iron reduction black slips already noted for EM II pottery on Crete in relation to potters from the Mesara (Wilson and Day 1994), and in comparison between EM II black slipped vessels at Myrtos Fournou Korifi from the Mirabello and Myrtos areas (Whitelaw et al. 1997: 269–273).

Fabrics similar to FG1 have been interpreted as Corinthian or NE Peloponnesian imports for EH II tablewares, mainly dark slipped sauceboats and ladles, at Koropi and Kontopigado in Attica (Day, Tsai and Hein, reported in Gilstrap et al. 2021: 229), and Late Bronze Age finewares, including *kylix* stemmed goblets, found at Eleusis, Ayios Konstantinos-Methana, Dokos, Lazarides on Aegina, Kanakia and the Cave of Euripides on Salamina, and in quantity at Kalamianos and Stiri both on the mainland and on the island of Aegina (Gilstrap 2015: 103–106; Gilstrap et al. 2021: 228–229; Kiriatzi et al. 2011: 116–117). Corinth was well placed to produce dark slipped buff tableware vessels, with its access to fine clay sources that could produce both buff ceramics and dark slips, and knowledge of the firing regimes required to convert the iron rich slips to dark colours, something also seen with other Corinthian fabrics (Burke et al. 2018: 154; Burke 2017, chapter 8).

FG2: medium fine clay mix with rounded pellets fabric

This petrographic fabric group is closely related to FG1 and is again dominantly associated with slipped tablewares (Table 2). In hand specimen, it shares the same buff chalky appearance; however, it has a pink-buff or orange ceramic colour commonly with more abundant red-brown inclusions visible in the break. In thin section, the groundmass ranges from green–brown to orange-brown and displays moderate to high optical activity suggestive of a lower firing temperature range than the samples within the core group of FG1. The fabric is characterised by well-sorted, red-brown and brown rounded TCFs in a fine silicate rich matrix (Fig. 4).

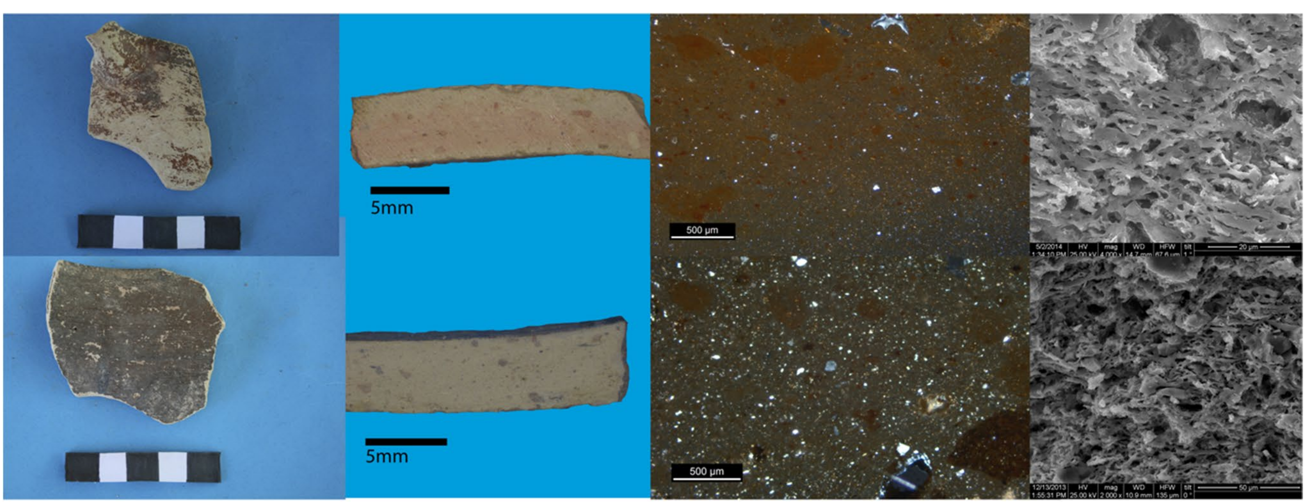

Fig. 3 Top left to right: KER 11/8, black-brown slipped sauceboat with horizontal handle, pink-buff macroscopic fabric, petrographic fabric with red-brown TCFs and SEM image of extensively vitrified microstructure with fine pore structure and glassy filaments. Bottom left to right: KER 11/45 black-brown slipped sauceboat, pink buff macroscopic fabric, petrographic silt rich fabric with rounded TCFs and SEM image showing extensive vitrification but a slightly coarser microstructure

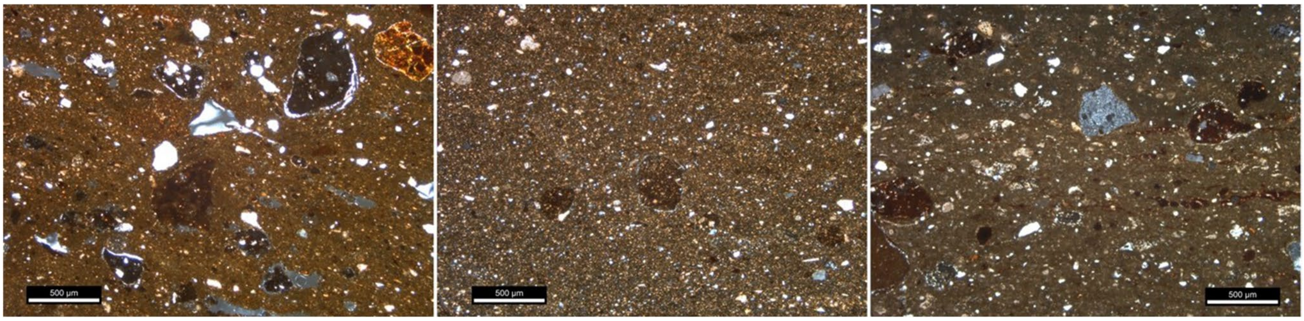

Fig. 4 Photomicrographs illustrating variability within FG2. Left to right: KER 11/11 orange-brown slipped bowl, KER 11/12 base of red slipped bowl/sauceboat and KOR 11/21 black slipped bowl with incurving rim

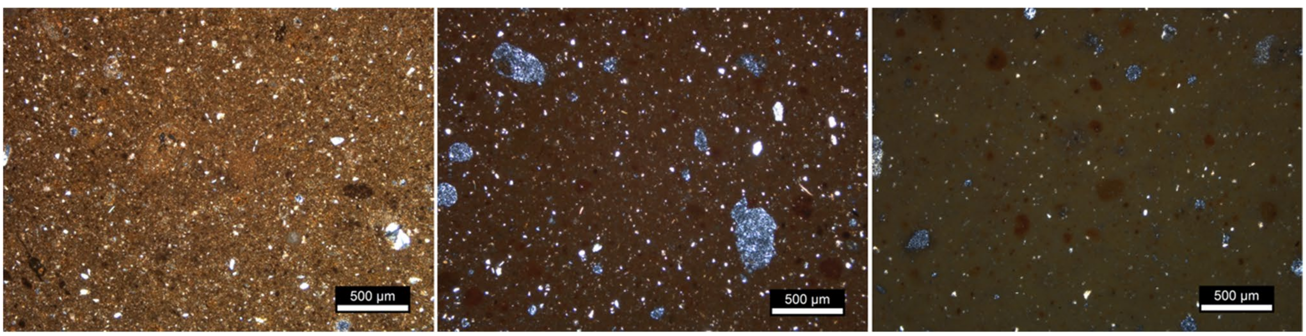

Fig. 5 Photomicrographs of an experimental mix of red and yellow clays in XP. The same mix fired at left: 700 °C. Middle: 900 °C. Right: 1100 °C. Figure reproduced from Burke 2017: 162 Fig. 7.4

FG2 is distinguished from FG1 by its coarser nature and more varied range of inclusion types that are found in variable frequencies across the group, including polycrystalline quartz, ooidal grains, chert, serpentinite and micritic calcite, bearing some similarities to Liard et al.'s late mediaeval Fabric 1 (particularly sample COR 53), which they assign as local to the Corinthian Plain (2022: 508–510).

Such a degree of variability is often naturally present in calcareous, clay rich marine sediments (Hein et al. 2004), and can be compounded by variation in firing temperature (Day and Kilikoglou 2001: 120–121; Whitbread 1987: 212–213; Wilson and Day 1994: 58, 60; Day 1991; Nicholson and Patterson 1985: 231). The significant impact of firing temperature on the coarseness and inclusion visibility of similar clay mixes is illustrated here by the experimental firing of clay briquettes sampled from Corinth and Nemea (Fig. 5; clay sampled and analysed by Graybehl and Burke—Burke 2017: 166–167).

In this case, the variability in FG2 may represent clay pastes that were more poorly mixed and that were certainly lower fired than FG1. In some instances, it may represent the active choice by potters to make red–orange vessels, which would not require the same firing conditions as the dark slipped vessels of FG1, something also suggested by the dominant association of this fabric with red slipped tablewares at other sites such as Tsoungiza (Burke 2017: 160–162). Indeed, several pottery fabrics from Corinth encompass both optically inactive, higher fired pottery, usually with dark slips and/or a reduced finish, and lower-fired, optically active examples of the same shapes with a red or orange surface and/or slip.

As with FG1, FG2 is taken to represent production in the area of Corinth, as serpentinite inclusions are compatible with the ophiolitic outcrops in the area of Acrocorinth, which also encompass chert and calcite as part of the Middle Jurassic limestone formations. Ophiolitic outcrops are also known from the northern side of the Isthmus and in the Gerania mountains (Yannetakis et al. 1972; Papavassiliou 1985; Whitbread 1995: 261).

FG3: medium-fine clay mix with angular mudstone fabric

This petrographic fabric group is primarily associated with thicker walled vessels such as jars and large bowls, but does also include some finer tableware shapes (Table 2). Macroscopically, this fabric has a buff colour with dark long angular inclusions, or an orange colour with pink and brown

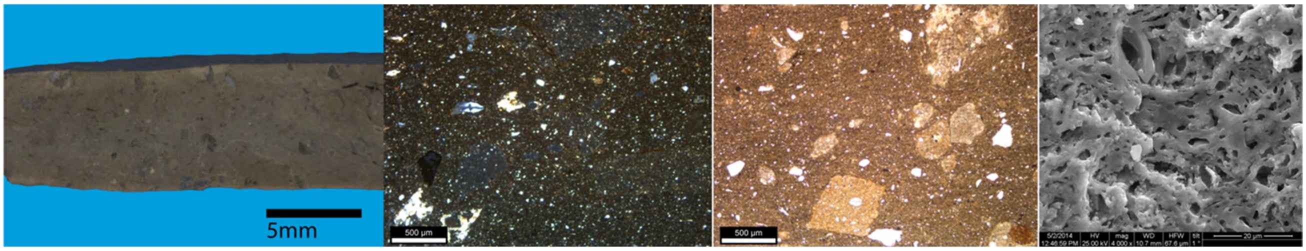

Fig. 6 Left: macroscopic fabric of KOR 11/34 black slipped jar; middle left and right: photomicrographs of KOR 11/34 illustrating FG3 in XP and PPL with mudstones more clearly visible. Right: SEM image of the extensively vitrified microstructure of KER 11/28, a jar strap handle (photomicrograph in Table 2)

long angular inclusions (Fig. 6). A weak firing core may be visible in the breaks of thicker walled vessels, especially those with orange body colours. In thin section, samples have a very fine to medium fine silicate-rich matrix of quartz and feldspar, and include rounded red-brown TCFs, generally similar to examples within FG1 and FG2. In many samples, the groundmass displays low to no optical activity, suggestive of higher firing temperature ranges. This was also confirmed through SEM of KER 11/28 which revealed extensive to almost continuous vitrification with fine glassy filaments, consistent with an EFT of 850–1080 °C (Fig. 6).

The fabric is characterised by the presence of fine-grained angular to sub-angular mudstone inclusions that are poorly to well sorted and vary in colour to include brown-black, grey, yellow–brown and orange-brown examples, some only clearly visible in PPL (Fig. 6). The mudstones vary in coarseness from very fine mud, to examples with more abundant fine, angular, silicate grains, that grade into siltstones. Additionally, chert, sandstone, sparry calcite and serpentinite are present in few to rare amounts in some samples. The common bimodal distribution and angularity of the mudstones indicate their addition as temper.

The notable variability in the texture of the groundmass, the colour of the fired clay, and the frequency and appearance of mudstone and other inclusions, suggests the use of similar raw materials, probably by different potters. Mudstone fabrics have been found at all sites within the wider EH ceramic study and are usually associated with large, thicker walled vessels such as jars, firedog stands and pithoi. Certainly, the choice of mudstone to temper jars and thick-walled vessels was widespread in the Peloponnese and has a long history of use beyond the EBA (Matson 1972; Vaughan et al. 1995: 677; Sauer 2006: 92–93; Whitbread et al. 2007; Iliopoulos et al. 2011; Graybehl 2015: 94; Burke 2017: 163; Burke et al. 2018: 149; Burke et al. 2021). Although a potter's choice of raw materials is the result of specific and culturally embedded contexts of learning, their potting knowledge encompasses both cultural and technical requirements in order to produce a functioning vessel. As such, the association of mudstone fabrics with thicker walled shapes suggests a degree of functional consideration related to enhancement of clay workability, the paste's ability to maintain the vessel shape during the forming and drying stages, and potentially preventing vessel failure during firing and use.

Whilst the wide distribution of mudstone raw materials and their use across the NE Peloponnese means they are far from diagnostic of provenance, the other inclusion types in some of the examples in this study, such as serpentinite, are again compatible with the area around Ancient Corinth, which has extensive mudstone outcrops on the western and southern sides of Acrocorinth and Penteskouphi (Whitbread 1995: 334). Indeed, such fabrics are characteristic of Corinthian pottery from later periods (e.g. Farnsworth 1964; Whitbread 1995: 269; Joyner 2007: 195–196; White 2009: 99–100). Therefore, whilst the coarseness of these vessels provided obstacles for the ascription of provenance by Attas based on chemistry, the petrography does indicate a Corinthian origin for some.

FG4: argillite fabric

Macroscopically this group can be subdivided into those with a buff to green-buff fabric with elongate angular red-brown or black inclusions and those with an orange body colour and angular elongate red inclusions. Darker firing cores are rare and this, together with relatively homogeneous body colours, indicates longer soaking times, with oxidising conditions to produce orange bodies, and a short reduction phase for production of the green buff bodies and darker slip colours (Table 2).

The petrographic fabric is characterised by a bimodal distribution of well to moderately well sorted, fine-grained, slightly metamorphosed argillaceous rock temper in a fine silicate-rich matrix. Samples with an optically active yellow–brown groundmass, commonly contain micrite, whilst those with an optically inactive, green–brown groundmass display degraded micrite, if present (Fig. 7), reflecting a difference in the degree of vitrification. This variation was also seen in SEM–EDS analysis as illustrated in Fig. 7: with

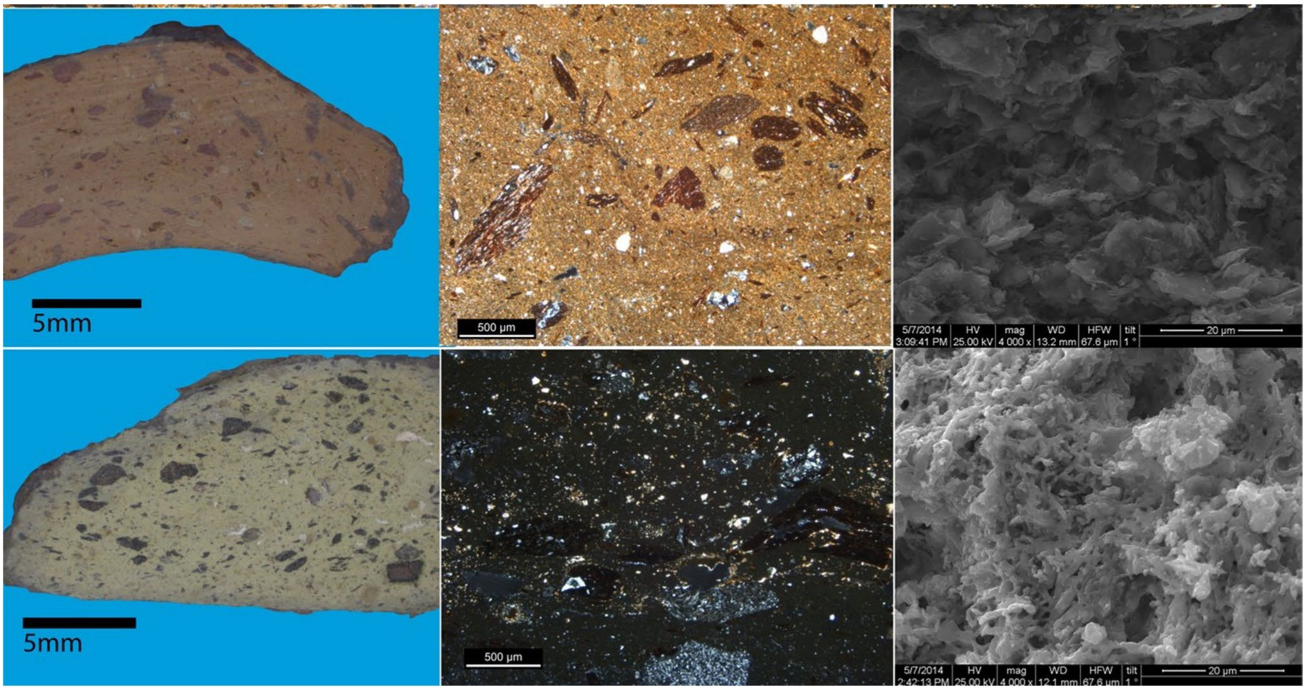

Fig. 7 Samples from FG4 displaying variability due to firing conditions. Top row, left to right: KER 11/125 with orange macroscopic fabric in XP, microphotograph of the optically active yellow–brown matrix and SEM image showing no vitrification visible in the microstructure. Bottom row, left to right: KER 11/130 displaying a green buff macroscopic fabric, green firing optically inactive groundmass in XP and an extensively vitrified microstructure under the SEM

sample KER 11/125, an orange bodied collared jar with out turned rim displaying no vitrification, suggestive of an EFT of below 800/750 °C, whilst in contrast, KER 11/130, a buff-green collared jar with everted rim, shows extensive vitrification indicative of EFT of 850–1050 °C.

FG4 appears in a narrow range of shapes, overwhelmingly associated with jars, accompanied by large bowls with an internally thickened rim and/or a red slip on their interior (Table 2). Significantly, a small number of EH II argillite tempered jars have been identified at Midea and Tiryns, indicating that these products or their contents were potentially exchanged across the wider region, making it the only coarse fabric from Corinth identified elsewhere within our broader study.

FG5: degraded basic igneous and tuffaceous rock fragments fabric

Vessels from this group can appear similar to those from FG4 with buff, green-buff and orange body colours, commonly without darker firing cores and frequent red inclusions within the orange fired examples, and black inclusions within buff fired vessels (Fig. 8). They are differentiated in fresh break macroscopically only by FG5's rounded rather than elongate inclusions.

Once again, in thin section, there are samples with an optically active and yellow–brown matrix associated with orange fired vessels and samples with an optically inactive green–brown matrix, related to sherds with a buff and green-buff colour (Fig. 8), corresponding to differences in firing conditions and soaking times. All samples are characterised by the bimodal distribution of angular to sub-angular, moderately well sorted, degraded basic igneous (basaltic) rock fragments, whose distribution and geological difference to the calcareous base clay indicates their addition as temper. These are accompanied by welded tuffs, altered tuffaceous fragments, mudstone and rare mudstone breccia (following Whitbread 1995: 273) in frequent to very few amounts. The altered, welded tuffs and mudstone breccia are also noted in other fabrics such FG6 discussed below. The degraded basaltic rocks are characterised by a red-brown matrix containing plagioclase feldspar laths, and more rarely fragments of serpentinite, with many examples appearing to have degraded towards mudstone. These rock types are compatible with those noted within the mudstone/chert deposits in close proximity on the slopes of Acrocorinth, with Whitbread recording similar welded tuffs within his Type A pottery and breccia rock fragments within Late Geometric pottery (1995: 272–273). Additionally, mudstone breccia has been identified in Byzantine and Frankish cooking pots from Corinth

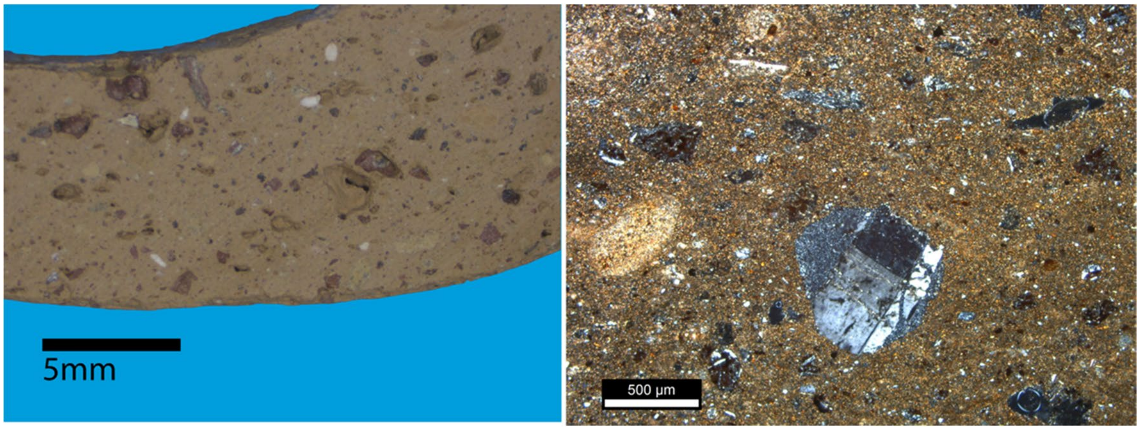

Fig. 8 Left: macroscopic image of KER 11/123, a large plain bowl with incurving rim. Right: photomicrograph of welded tuff fragment in XP

by Joyner ('Quartz-mudstone-chert Fabric' 2007: 221–223) where she also noted the presence of a 'weathered volcanic fragment', commenting that such inclusions are not unusual within Corinthian sediments originating within local ophiolitic sources (2007: 220). Certainly, geological maps and literature record tuffaceous and breccia outcrops associated with the ophiolitic formations on Acrocorinth, Penteskouphi and in the Geraneia mountains (Yannetakis et al.1972; Whitbread 1995: 334, 2003: 3), whilst Siddall (n.d.) notes the presence of pillow lava outcrops in the area of the mountain that could potentially explain the prevalence of the degraded basic igneous inclusions. Sauer (2006: 94–95) has also commented on the co-occurrence of a range of these inclusion in Late Helladic material from Aigeira, which may be imported from Corinth.

As with FG4, this fabric is associated with a narrow range of shapes, dominantly jars and large bowls, again commonly with an internally thickened rim and/or internal red-brown slip (Table 2). The jars are found in both an optically active and optically inactive version, whilst the red-brown slipped bowls/basins are only associated with the more optically active version suggesting a lower firing temperature range associated with the oxidising firing required for such red slipped vessels.

The strong similarity between this and FG4 may indicate that the two fabrics represent production by the same potting group who did not differentiate between the argillite rock and the altered igneous rock types when mining their raw materials. If so, the difference in these fabrics may relate to natural variability in the sources of the rock temper. It should be noted that whilst this fabric was only identified at Keramidaki, thick walled and jar shapes from Korakou were unavailable for study.

FG6: mudstone, mudstone breccia and tuffaceous rock fabric

In hand specimen, this fabric is pink to brown and only rarely displays darker cores in the break, normally associated with thicker walled vessels (Fig. 9). In thin section, it contains poorly to well-sorted angular mudstone, radiolarian mudstone, mudstone breccia (as described above) and altered tuffaceous rock fragments. Some samples also contain micrite and sparitic calcite. Varied optical activity of the groundmass is again a feature, with the majority of samples having an orange yellow birefringence colour and high to moderate optical activity, accompanied by fewer samples with a heterogeneous yellow–brown groundmass and little to no optical activity, reflecting differences in firing conditions. The characteristic tuffaceous rock fragments range from welded tuffs to altered fragments with a more sedimentary siltstone or brecciaceous appearance (Fig. 9), including examples of tuffaceous rocks attached to mudstone and radiolarian mudstone showing a shared origin. The altered tuffites have a dominantly yellow–brown matrix that displays a characteristic optical activity with mixed orientation, and contain angular grains of quartz and feldspar, opaques and orange serpentinite, which are usually more visible in PPL (Fig. 9). As discussed above, the mudstone breccia and tuffaceous inclusions are compatible with geological outcrops in and around Ancient Corinth, whilst Whitbread has also recorded radiolarian mudstone in the area of Ancient Corinth (1995). As such, both the lithology and distribution of this fabric suggest it has a Corinthian origin.

In terms of the shapes made using this paste recipe, it is notable that in marked contrast to the groups discussed above, this fabric was used to make a wide repertoire of

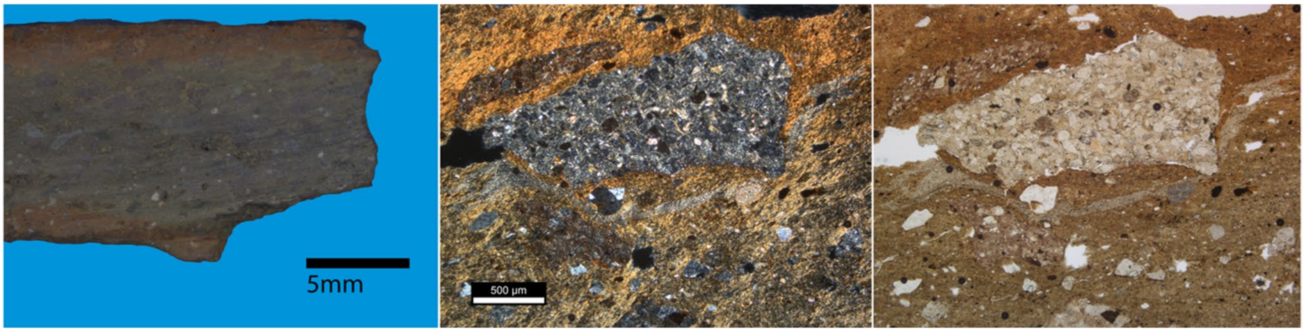

Fig. 9 Left: KER 11/53, a baking pan, macroscopic fabric. Middle: KER 11/53 altered tuffaceous rock fragment with brecciaceous appearance in XP. Right: same image in PPL

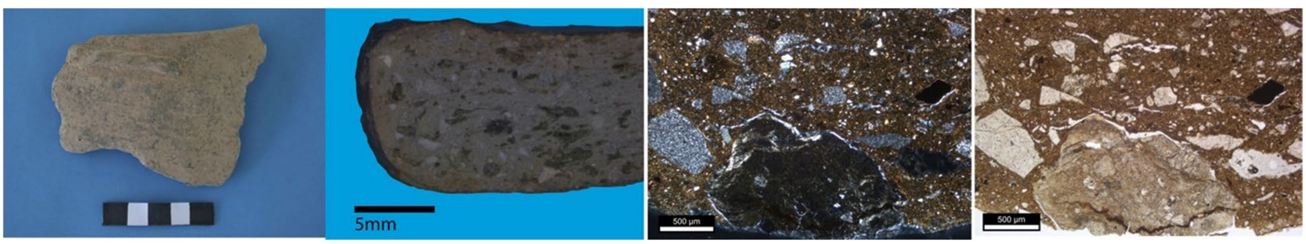

Fig. 10 Far left and left: macroscopic fabric of KER 11/88 a large bowl/cooking pot. Right and far right: photomicrographs of KER 11/88 showing chert and volcanic inclusions, in XP and PPL

shapes (Table 2), including large vessel types, such as jars and baking pans, and smaller ones including tablewares such as red slipped bowls, a rather different production strategy compared to other fabrics, which tended to focus on particular shapes.

FG7: angular chert and altered volcanic rock fragments fabric

In hand specimen, this group is orange to brown with hard angular white inclusions, with or without a darker grey core, indicating occasional incomplete oxidation. In thin section, the fabric is characterised by the bimodal distribution of large angular and sub-angular volcanic rock fragments and chert (including radiolarian chert), which lie in a silicate-rich, green–brown to orange-brown, groundmass that commonly displays low to no optical activity (Fig. 10). The volcanic fragments include welded tuffs and altered tuffs, which match those identified in other fabrics such as FG4 and FG5 discussed above, along with serpentinite fragments that are partially or completely isotropic, similar to examples in FG8 discussed below suggesting a similar origin for the raw materials. Samples from this petrographic fabric group were only found in material from Keramidaki, which is most likely related to sampling and the reliance on Attas' samples at Korakou which was more abundant in finer pottery, especially tablewares.

Several authors (Joyner 2007: 200; Graybehl 2015: 101; Whitbread 1995: 276) have argued for the production of chert fabrics at Corinth, a suggestion commonly supported by frequency and typological data. As the nature and wide distribution of chert does not lend itself to the ascription of provenance this had led some to question the confidence with which we can source such fabrics. In this respect, the identification of a chert fabric in the EBA samples from Keramidaki offers an important contribution to the debate, as FG7 includes very characteristic ophiolitic inclusions, recorded in other fabrics we have discussed whose local origin can be more confidently proposed. As such, it may be that the absence of such inclusions in later fabrics is the result of the depletion of specific raw material sources.

With a low number of samples, it is difficult to comment on the repertoire of vessels made using this fabric but it seems in the sampled material at least that thicker walled and un-slipped vessel types were included (Table 2). The possible association with such coarser pottery also supports the hypothesis that its absence from Korakou is a product of sampling and the restricted range of material available from Korakou.

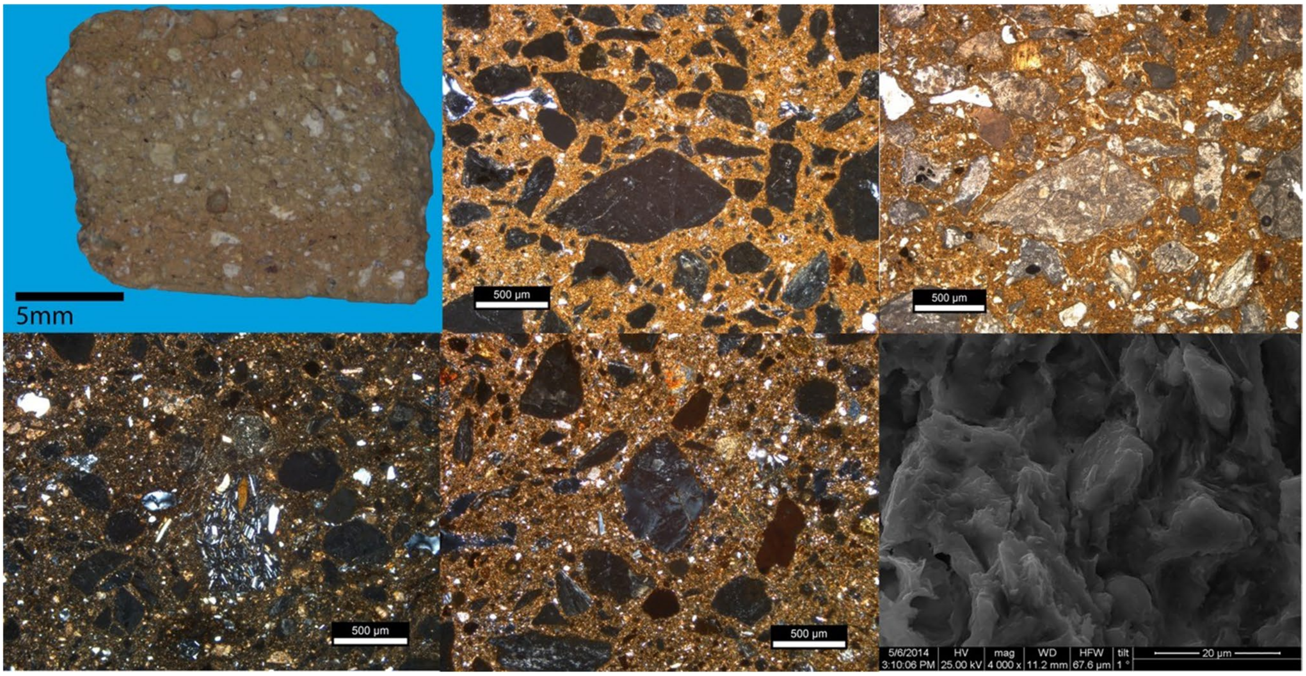

Fig. 11 FG8. Top row, left to right: KOR 11/31 a baking pan, macroscopic fabric and photomicrographs in XP and PPL showing serpentinised and volcanic rock fragments. Bottom row left to right: photomicrograph of KER 11/142, a red slipped bowl, with an intermediate igneous rock fragment, XP; photomicrograph of KER 11/138, a plain bowl with SEM image of its microstructure showing no vitrification

FG8: altered volcanic and serpentinite fragments fabric

Macroscopically, this fabric has angular white-cream inclusions with few to rare orange inclusions, and vessels are fired orange to grey or brown-buff. The petrographic fabric is characterised by the presence of red and orange serpentinite, alongside commonly isotropic fragments containing altered feldspars that are also likely serpentinites (Siddall pers. comm.) as well as other altered volcanic rock fragments. These angular inclusions lie within a fine silicate-rich, orange-brown moderately to highly optically active groundmass with SEM–EDS analysis of KER 11/138 (a plain bowl), revealing an unvitrified microstructure consistent with an EFT below 800–750 °C (Fig. 11). In PPL, the character of the altered and serpentinised rocks varies in a way consistent with a range of alteration states, but commonly appear greyish in PPL and, in some cases, almost granulated. The rock fragments are not compatible with the calcareous base clay, which along with their bimodal distribution, suggests they have been added as temper. The group also includes rare samples from Keramidaki that contain intermediate igneous rock fragments and tuffs whose origin is not clear (Fig. 11 bottom row first image); however, the dominant presence of such ophiolitic rocks and the occurrence of this fabric only at Korakou and Keramidaki strongly supports a local origin.

Like FG6, this paste recipe was used to make a variety of vessel types including both large and smaller shapes suggesting that potters making this fabric aimed to satisfy a range of domestic consumption needs, rather than focusing on specific shapes or finishes as seen in FG1, FG4 and FG5 (Table 2).

Discussion

In his formative chemical study, Michael Attas proposed the existence of EBA pottery production in the area of the Corinthian Plain based on the shared chemical grouping of EH pottery from Korakou and Keramidaki, both sites relying on local production during this period. Petrographic analysis of a range of pottery from both sites has not only confirmed this picture of local production but extended it to a spectrum of vessels from fine through coarse, and offered new detailed information on technology, vessel distribution and what we might refer to as ‘micro-provenance’.

Our results allow a first characterisation of important variation within local production in terms of the identification of specific raw material choices and manipulation, allowing the reconstruction of potters’ paste recipes, firing techniques and their production strategies. In this respect, our analysis demonstrates that Corinthian potters shared the choice of fine calcareous clays in their craft, the tradition of adding rock temper (the sources of which commonly appear to have been around Acrocorinth and the surrounding area) and the probable use of clay mixing for finewares. Many producers had both high and low temperature firings, with some also using both reduction and oxidising regimes associated with the desired final colour of the vessel and respective slips.

Although these practices were common across the different fabrics identified, there are clear signs of differentiation within local production. Whilst the research shows that a wide variety of EH II types were made by Corinthian potters, there are different production strategies in terms of the range of vessels being made, with FG1 and FG2 used for tablewares, particularly slipped wares, whilst FG4 and FG5 relate overwhelmingly to the production of jars and large red slipped bowls. In contrast FG6 relates to the production of a wide range of vessel types from baking pans, pot/firedog stands and pithoi, through to the same large red slipped bowls and jars that we find in FG4 and FG5, all of which would easily satisfy a range of pottery needs to include cooking, storage and serving. The structure of this data, the correlations between vessel shapes, finishes and the fabrics identified, and indeed the nature of the large fill from which the pottery was recovered at Keramidaki suggest that this picture is not a product of change over time within EH II. Instead, it is more consistent with broadly contemporaneous ceramic practices by different potters or potting groups, using raw materials from the same geological area. Importantly, the analysis also adds clarity to our understanding of the coarseware production that created difficulty for Attas, showing not only the presence of multiple coarseware pastes, and that separate chemical groups from his study actually belong to the same fabric and paste recipe tradition, but also that some of the suspected regional imports and outliers, including from unknown centres, are compatible with local geology and traditions.

The results presented here from Korakou and Keramidaki are markedly different to the picture from comparative EBA settlement sites in the NE Peloponnese such as the small settlement at Tsoungiza and that of Apollon Maleatas, Epidavros. At these sites, there are weak to no links between vessel and specific paste recipes (with the partial exception of using mudstone for some thicker walled vessels such as pithoi and firedog stands) (Burke et al. 2016; Burke 2017), less specific or controlled firing regimes, and variation in the quality of vessel finishes. Notably, vessels produced locally to these contemporaneous sites also do not appear to have been distributed outside of the immediate settlements. Taken together, such trends at comparable sites are consistent with local production to meet the daily needs of the settlement, with potters producing a wide repertoire rather than focusing on specific shapes or finishes.

Further, whilst it is clear that Korakou and Keramidaki largely consumed vessels from the same potters, there is a distinctive trend in relation to the broader distribution of vessels made in different paste recipes, with examples of jars of FG5 being found at Midea and Tiryns in the Argolid, and dark slipped tablewares which match FG1 being consumed at sites in the Corinthia, Argolid and Attica. The slipped fineware occurs in characteristic shapes, primarily the sauceboat, but also saucers, small bowls and ladles, components of a mainland drinking set, a version of the range of such sets whose emergence characterises Early Bronze II in the Aegean (Day and Wilson 2004; Barrett and Boyd 2019: 75–83). In this respect, it is also interesting to note that two of the only clear imports found in the sampled material from Korakou and Keramidaki belong to such wares. The first is a red slipped small bowl with burnish (KOR 11/22. Burke 2017: 234–237) whose andesite fabric is well known from Aegina, a centre of production for such slipped and polished pottery. The second is a red slipped sauceboat (KOR 11/6) which likely came from another major production area in or near the Talioti valley in the Argolid that was known for making red fired and/or slipped vessels in particular (Burke 2017: 208–212; Burke et al. 2018; Burke et al. 2020: 11), a provenance also supported by Attas' assignment of the sample to his Tiryns chemical group Q (1982: 379). These distribution trends suggest that slipped tablewares were a focus of exchange between within Corinthia and the Argolid, and included supra-regional exchange to encompass pottery from Aegina. This certainly fits the EBA picture more broadly where we see more that specialist products from specific production centres start to be more prominently distributed regionally and sometimes over long distances (Dimopoulou-Rethemiotaki et al. 2007; Menelaou and Day 2020; Wilson et al. 2008; Day and Wilson 2016).

The presence of multiple production strategies within the Corinthian Plain, represented by specific coarseware and fineware paste recipes, distribution trends and firing strategies, as well as the differences in the repertoire of shapes produced, suggest that during the EBA the area saw a move towards organised and more focused modes of production on a significant scale, with a demand for pottery that could support multiple potters in the area. The diversity of production seems to have encompassed some potters who produced a range of vessels for local consumption to satisfy daily needs, whilst others concentrated primarily on the production of specific shapes and wares, some of which were consumed beyond the local area. Similar trends are seen at Romanos Pylias in Messinia, where the potting community specialised in the production yellow-blue-mottled fine tablewares using a fine micrite rich fabric (Kordatzaki et al. 2018), which was also used on a limited scale for the production of fine pattern painted wares. To accompany this, cream slipped and larger pottery types were made using chert-based pastes suggesting the presence of more than one chaîne opératoire and different expertise which Kordatzaki et al. convincing argue points to the presence of distinct production units (2018: 263).

Certainly, similar to the case at Romanos Pylias, pottery production in the Corinthian Plain, particularly slipped tablewares, reflected a specific set of raw material resources and knowledge possessed by its craftspeople who had the necessary tools and skills to manipulate firing regimes to produce different vessel types. This allowed Corinth to take its place as a distinctive centre of production, alongside the well-polished red pottery of Aegina (Burke et al. 2016: 106, 108) and the grey-blue pottery that characterises production at EBA Kontopigado in Attica (Tsai 2021).

Conclusions

The analytical programme has provided important new insights into the role of Corinth as an early centre of ceramic production, with a reputation outside of the immediate area for dark slipped pottery. The abundance of natural resources, and clear accumulation of the knowledge and skills required to make high-quality pottery in different finishes, formed the foundation of an enduring reputation for Corinthian ceramic craft, perhaps most notable in the demand and wide distribution in the Archaic period.

Our study has suggested the existence of a range of different production units at Corinth. Some of these units, whether individuals or groups, seem to have produced almost the full repertoire of pottery vessels needed by an EBA community, whilst others were more specific, including being involved in broad trade/exchange networks. This multi-scalar picture of EH II pottery production in Corinth perhaps mirrors the picture over the Argolo-Corinthia as a whole, with a number of major centres being complemented by a larger number of smaller, less specialised production locations. Indeed, whilst the Corinthian Plain may stand out as an important centre of pottery production in the region, it fits well within the broader model of EBA pottery making and distribution at a wider geographical scale, joining Aegina, Talioti in the Argolid and Kontopigado in Attica, as a major centre, whose products were distributed across a wide area.

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Author contribution C. Burke: permit preparation, sampling, analysis, writing and editing. P.M. Day: access to material for study, funding acquisition, analysis, writing and editing.

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Data Availability The data that support the findings of this study are openly available in the online copy of Burke 2017 https://etheses.whiterose.ac.uk/16671/ Thin sections are stored at N.C.S.R. Demokritos whereby the authors can be contacted for access.

Declarations

Competing interests The authors declare no competing interests.

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