Ceramic Production and Exchange in the Late Mycenaean Saronic Gulf

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Abstract

This thesis examines the production, exchange and consumption of pottery around the Saronic Gulf, Greece, during Late Mycenaean period, specifically Late Helladic IIIB1 to Late Helladic IIIC Phase 1, roughly 1300-1130 BC. While the focus of many studies of Mycenaean political economy has fallen on Messinia and the Argolid, the choice of the Saronic Gulf offers the chance to examine ceramic crafting, movement and use in an area which hosts no accepted ‘palatial’ centres. It aims to examine the role of pottery in everyday social and economic transaction, taking a ‘bottom-up’ approach to shedding light on Mycenaean society and economy.

Pottery from a wide range of sites has been studied: urban centres such as Athens; harbours at Kanakia on Salamis and Kalamianos in coastal Corinthia; small settlements of Stiri in Corinthia, Myti Kommeni on Dokos and Lazarides on Aegina; sanctuary sites of Eleusis and Ayios Konstantinos, Methana; and finally the settlement and pottery production site of Kontopigado, Alimos near the Attic coast.

Based on typological and macroscopic fabric studies, a large number of samples have been chosen for examination by an integrated programme of petrographic, chemical (by neutron activation analysis) and microstructural analysis (by scanning electron microscopy), in order to group and characterise to pottery according to composition, to reconstruct key aspects of ceramic manufacture and, where possible, to suggest the area or location of their production. Major production centres are identified, including Aegina, which is well-known from previous work, and those from the Corinthia and Kontopigado, Alimos. The reconstruction of the production technology of wide range of ceramic products at the latter centre provides a basis to examine contrasts in the history and organization of pottery production in closely neighbouring centres and to trace the overlapping distributions of their products.

Patterns of choice in the use of pottery in different locations enable the exploration of consumption choices made on an everyday basis. It is suggested that the complex and widespread exchange of pottery and the choices made by communities carrying out differing activities make the correlation of pottery distribution and political boundaries problematic. Instead the wealth of information revealed by this approach for the first time offers basic information on the widespread movement of goods across clear geographical and, most likely, political boundaries

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Chapter One: Introduction

1.1 Introduction

Traditional approaches to the archaeology of prehistoric Greece have focused generally on the monumental structures, art, written language, material culture and practices of the powerful and the wealthy. Little has been done in the study of commonplace activities and the daily events of ordinary people although much of the archaeological record is made up of common, everyday objects. In Late Bronze Age Greece only but a few classes of objects have found their way into nearly every archaeological context and of these materials, pottery is the most prolific. It is heard all too often in the study of ancient ceramics that pottery is ubiquitous in the archaeological record, however, this statement has more than a kernel of truth in it. One explanation for this phenomenon is that pottery is constructed of a material that it does not deteriorate in ways that are common for other objects that were abundant in the past. Perhaps the reason pottery is so prevalent is that it reflects the social nature of the artefacts themselves. The functional utility of pottery in the past has a list that seems to go on *ad inifinitum*: storage, cooking, serving, consuming, transporting, architecture, manufacture, ritual, politics, child rearing, teaching, sport, bathing, and so on. In archaeology, the occurrence of pottery in nearly every social context does not go unnoticed and there is more literature concerning pottery than any other object class. This thesis takes up the challenge to observe and interpret everyday practice in and beyond the scope of the Mycenaean palatial estates by assessing pottery production and exchange through analytical means in a region that is comparably less well understood than its Peloponnesian neighbours.

The principal region of focus is the area of the Saronic Gulf, the body of water separating the geographic region of Attica from the north eastern Peloponnese (Figure 1.1). This region is well-known throughout Greek antiquity as a maritime hub linking the central mainland to the Peloponnese in the west and further abroad to the islands of the Aegean to the east and Crete to the south. The Saronic Gulf is a body of water that simultaneously separates and connects the people inhabiting its shores and beyond, and "in practically all periods there is evidence of contact and trade" (Hägg 2003: 372). During the end of the Late Bronze Age, in what I will call the Late Mycenaean period, the importance of this region is demonstrated by the stout increase in archaeological sites on its borders (Siennicka 2002), while the ship wreck at Modi (Agouridis 2011) further stresses its social significance and the reliance people had on its waters to stay connected with the wider Bronze Age world.

Figure 1.1: Map of the Saronic Gulf including all sites mentioned in the text.

1.2 Aims and contributions to the field

This thesis examines the ceramic evidence from eleven sites from around the Saronic Gulf during the Late Mycenaean period (c. 1250/60-1100/1090 BC), a period marking the extreme height and eventual decline of the palace period on the Mycenaean heartland in the Argolid and a period of prosperity and expansion in Attica and on the Saronic island of Salamis. While everyday activities can be characterized within any region in Greece, the Saronic Gulf provides the backdrop for a large number of archaeological contexts with evidence for day-to-day activities of the commoner and elite alike. During this period the Saronic Gulf boasts of increased maritime activity in the form of coastal and island settlements, harbours, anchorages, shipwrecks and more land-based contexts such as religious, administration, mining and industrial centres (Figure 1.1).

This research looks to interrogate the social nuances of the production, exchange and consumption of pottery from this important region through a multi-technique analysis of provenance, raw material selection and other technological choices of vessels from a regional assemblage. This study illuminates new insight as to the location of regionally specific pottery production and interprets the everyday transactions as compared those operating under the authority of the regional political factions. This opens up the possibility to observe and reconstruct interaction and organisation across and within Mycenaean social hierarchy in and around the Saronic Gulf.

Pragmatically speaking this thesis consists of an analytical programme that integrates three distinct, yet compatible techniques in order to address very specific questions of archaeological significance. First and foremost the goal of this project is to produce a coherent study of ceramic vessels in the Saronic Gulf from the Late Mycenaean period and on a fundamental level this project will:

1. Identify and characterise ceramic groups by thin section petrography and chemical compositional data derived through NAA,
2. Assess variability and innovation in ceramic production technology,
3. If possible, assign geographic provenance to individual fabric groups and
4. Track movement of ceramic fabrics and specific vessel types from places of production to places of consumption.

These four basic analytical products will provide a sturdy foundation for determining the place of pottery in the Saronic Gulf and wider Late Mycenaean world, the second aim of this project.

In Mycenaean studies, a large body of literature is dedicated to understanding where the role of the *producer* and that of the *consumer* fit into the broader scheme of politics and economics. By taking the stance that the structure of ancient economies are never quite so dualistic, pottery study is examined to observe interaction and interpret relationships between producers and consumers of ceramic vessels in a regional Mycenaean setting. Tracing patterns of pottery distribution on a regional scale will demonstrate that the economies of the Saronic Gulf at the end of the LBA were highly complex and should not be over-simplified in binary constructs of what aspects of society are to be considered *palatial* or *non-palatial*. Instead, this thesis aims to use patterns in pottery production, exchange and consumption to reveal interactions between several discrete archaeological sites in order to reconstruct day-to-day economic practice.

1.3 Interrogating interaction

This thesis will contextualise the resulting patterns of production and consumption in the region of the Saronic Gulf as they fit within the wider social and economic spheres of the Mycenaean world. Identification of places of pottery production and characterisation of their products make it possible to interpret general patterns of distribution by comparing fabrics from sites on local, regional and interregional geographic scales. The identification of a production centre enables the reconstruction of exchange direction for a particular ceramic fabric or vessel type. Data of this kind is invaluable in reconstructions of social relationships and economic practice because it illuminates three key facets of economy: production, exchange and consumption. Locating regional pottery producers leads to the identification of product consumers enabling the interrogation of production strategies and economic practice.

Mycenaean economy has been widely studied for over a century. However, the majority of these studies look at the economic and social actions in relation to the palatial estates (cf. Voutsaki and Killen 2001a; Pullen 2010a). Investigations of this kind tend to focus on the material culture of the elite within the Mycenaean social hierarchy, such as exotic objects or goods with inferred social value (e.g. Burns 2010). Pottery is a useful product because it spans the social hierarchy and thus makes for a perfect tool to investigate the interaction between social spheres. The reconstruction of production technology, exchange and consumption of pottery makes a significant contribution to the current understanding of social and economic organisation of Mycenaean society. Striving to look beyond the palaces and their influence, this thesis looks a rural settlements, urban centres, harbours, religious sanctuaries, burials, and industrial settings to produces a new interpretation of the kinds of interaction that took place on a more regular basis in the lives of Mycenaean people whether or not they are directly connected to the palaces and ruling elite. This new data is be compared to what is already known of palatial economy and social interaction in order to complement our and broaden our current interpretations of Mycenaean political economies.

1.4 Approach

To investigate commonplace economic transactions in the Saronic Gulf during the end of the Mycenaean period, ceramic assemblages from all eleven archaeological contexts have been examined through an integrated multi-technique analytical framework. This method combines traditional visual analysis with a series of scientific analytical techniques: thin section petrography, chemical composition analysis through neutron activation (NAA) and microstructure analysis through scanning electron microscopy (SEM). Traditional methods for studying archaeological pottery usually involve sorting large assemblages of sherds into groups based on diagnostic morphological and decorative criteria. Data of this kind forms the basis for the pottery typologies archaeologists use to date contexts and to track trends across time and space. While methods such as this are extremely useful in archaeology, they can only take us so far in trying to understand social complexity of the past. Typologies form the foundation of this project and guide the sampling stage of the analytical process. In other words, samples have only been selected from previously studied ceramic assemblages with identifiable chronological context and general morphology.

Using a combination of petrographic, chemical and microstructural analyses, fabric groups are examined, characterised and, if possible, assigned an origin of manufacture within geographic space. This combination of petrographic and chemical analysis has been long accepted as a means for ceramic analysis and provenance determination in the Aegean (Day et al. 1999) and the addition of microstructural analysis further enables technological assessment of both fabric groups (Wilson and Day 1994; Day and Kilikoglou 2001). Scientific examination of ceramic vessels creates a platform for making observations beyond what is visible with the naked eye, thus allowing us to refine typological groups and further redefine them in terms of mineralogical composition, micro-texture and discrete technological features that are the product of human choices. The shape and decorative motifs of ceramic vessels is representative of the final stages in a complex sequence of technological events (Rye 1981). The concept of *chaîne opératoire* is a useful tool for reconstructing any technology in order to observe and interpret the socially embedded actions and choices made at different phases of an artefact's manufacture. This integrated approach attempts just that, reconstructing a regional Mycenaean ceramic system through the characterisation of production practice, mechanisms of exchange and patterns of consumption.

1.5 Summary of chapters

The first half of this thesis, Chapters Two through Five, is a systematic overview of the archaeological, regional and analytical setting. Chapter Two provides an introduction to the topic of Mycenaean political economies. The discussion is centred on a theme of interaction between craft and the political economy to demonstrate the complexity of Mycenaean political and economic structure and synthesise several prominent studies that influence our current interpretations. Briefly, Chapter Two reflects on the interpretations of palatially controlled craft production from the Linear B records and what has been dubbed a "top-down" approach to research of Mycenaean society. Following a path paved by several previous scholars, pottery production is compared with other forms of production not mentioned in the Linear B texts, specifically agriculture and chipped stone tool, to characterise aspects of palatial influence. Finally, Chapter Two considers the binary system of what is "palatial" and "non-palatial" in the Mycenaean political economics. This chapter sets the tone for further discussion on the place of pottery in the Mycenaean world.

Chapter Three introduces the theoretical foundations for technology-based studies of archaeological ceramics. This chapter overviews concepts from both archaeology and anthropology used frequently in the study of pottery, with specific details concern determining the location of production centres through characterisations of raw materials, production technology, and aspects of pottery exchange and consumption. The role of scientific analysis is explained for both studies of provenance and production technology with the aim of demonstrating the close interplay between these two concepts. Provenance is explained in terms strictly related to ceramic materials leading into a brief discussion on past analytical short comings and more recent developments for the advancement of this line of inquiry. Of these developments, integrating the resulting information from several analytical techniques has enabled ceramic studies to move much further than studies of provenance alone. This study integrates thin section ceramic petrography and neutron activation analysis to form the foundation on which provenance is determined.

The combination of thin section petrography and chemical composition studies with the addition of microstructural analysis by SEM has proved fruitful in studies of Aegean ceramics for several decades and is increasingly viewed as a normal part of the post-excavation process. Mineralogical, petrological, chemical and microstructural data reveal a broad spectrum of information on ceramic production technology that is key for understanding the different choices that potters made during the process of manufacturing their respective wares. These choices include selecting different raw materials, those which are used by researchers to determine the place of production.

Chapter Two considers the utility of social theory, such as technological *chaîne opératoire*, provides key insight into not only the kinds of choices being made, but the process of production itself. The reconstruction of the social act of production technology belies several facets of cultural practice that are paramount in our understanding of the role pottery played in past societies.

Chapter Four describes the details of the analytical programme. This section creates a transparent view of the archaeological and analytical aims of this thesis. In order to provide a background on the samples selected for study, Chapter Four describes the region, chronology and archaeological context for each sampled assemblage. Having put down the foundation on how the sampling strategy will affect the final outcome of this study, the tools of examination are laid out and described in terms of provenance and reconstructing production technology. Thin section petrography and neutron activation analysis are techniques applied in the determination of raw materials used and the origin of production. A separate discussion on the statistical treatment of the chemically generated data highlights how the large body of chemical data is sorted into archaeologically meaningful groups and assessed for potential contamination. Chapter Four concludes with an in depth description of the methodology used in the assessment of firing conditions and surface modification through decoration by SEM microstructural analysis.

Chapter Five introduces the regional setting of the Saronic Gulf, its geography and geology. In studies of ancient ceramic materials, there is significant overlap between archaeology and geology, especially in the examination of raw materials. This chapter commences with a clarification about what is meant by the term *clay* in ceramic studies as compared to sedimentary geology. The difference is essential for provenance determination of cultural products versus raw geological sediments. Next, this chapter explores the geography of the mainland shores and islands within the study to introduce important topographical points of each region surrounding the Saronic Gulf. The geological formations in each region from this study, Attica, Corinthia, the isthmus of Corinth, Methana and Troezinia, Aegina, Salamis and Dokos, are considered to demonstrate potential locations of raw materials observed over the course of the analytical investigation.

An illustration of the resources available to potters of antiquity, or in other words, a view of the ceramic landscape exploited by potters in Mycenaean times, is requisite primarily to determine potential places of pottery production. However it also enables insight into the environments in which potters work and pots are discarded. This geological study illuminates the kinds of materials that potters had to work with, potential problems they encountered in terms of processing materials, developing slips and paints for finishing vessel surfaces and firing finished products. In other words, Chapter Five demonstrates that a comprehensive understanding of the local environment of the Saronic Gulf is a necessary step in reconstructing ceramic ecologies of the Late Mycenaean period.

Chapters Six through Eight form the second part of this thesis, reporting the results of the analysis and subsequent discussion. Chapter Six is explicitly a report of the analytical findings. Petrographic fabric groups are arranged according to the region of assigned production. Each fabric is described systematically, highlighting the mineralogical, petrological textural and technological features. Chemical compositional groups are presented following the petrographic descriptions and are illustrated as statistical clusters generated using methods described in Chapter Four. Having reported both petrographic and chemical groups, the following section compares and attempts to explain continuity and reconcile any differences. This is done by comparing compositional disparity with potential taphonomic contamination or variation within technological processes. Throughout this chapter, fabric groups are compared with regional and local geologies and locations of raw material sources to determine production origins. Technological features are reported from both petrographic and SEM studies. Firing conditions are reconstructed by assessing the degree of vitrification in the microstructure and surface modification technologies are examined with special attention given to red and black paints. Chapter Six concludes with a synthesis of the petrographic and chemical data and posits the potential provenance of several ceramic groups, specifically at Kontopigado in Attica, on the island of Aegina and in Corinthia.

Petrographic, chemical composition and microstructural data are integrated in Chapter Seven as reconstructions of technological signatures for each fabric group according to type. This chapter is organised by ware type, i.e. fine tablewares, coarse tubs, coarse storage jars and cooking vessels, in order to identify technological variation within similar vessels that have been produced in different places. The identification of Kontopigado as a pottery production centre in Chapter Six has enabled the reconstruction of several technological features for all of its known products. Production practices at Kontopigado are then compared to those now attributed to tablewares, coarse tub, storage jars and cooking vessels of other production centres of the Saronic

Gulf. The resulting picture identifies several regionally specific production technologies and highlights the shared practice of using organic temper.

Chapter Eight builds on the observations made in chapters Six and Seven by placing them within a wider archaeological context and examines issues of pottery exchange and consumption. Two case studies are employed to discuss several of the themes concerning Mycenaean economy and politics that were addressed in Chapter Two. First a single ware type is removed from the larger assemblage to illustrate the effects of choice in pottery exchange and consumption at different sites around the Saronic Gulf. Cooking vessels are then placed back into the broader assemblage in an attempt to construct a comprehensive view of pottery exchange and consumption beyond that of a single ware type.

In the second case, Chapter Eight explores pottery production, exchange and consumption without presuming any interest by the local ruling faction in pottery production except to fill their own stores. This bottom-up approach towards analyses of the production and movement of ceramics removes expectations of who was producing and what mechanisms determine the distribution of goods and reveals overlapping areas of consumption, the duplication of vessels of different function and widespread everyday movement of goods shows a very different picture from studies which start with what we think we know about craft production in Mycenaean society. At this point the discussion returns to economic transactions decoded from the Linear B archives. These records indicate a weighty presence of the palatial authority's involvement in the massing of resources and the organisation of manufacturing certain commodities. Pottery is one of the rarely mentioned products in these records indicating that it may have been produced and exchanged without much interference by local authorities, but as it will become clear, the picture is much more complex. Chapter Eight concludes by constructing a different view of exchange mechanisms which complements the current perception of Mycenaean political economies.

The thesis culminates in Chapter Nine by revisiting several key areas of discussion from this research project as whole. The research framework is evaluated according to three major themes that link this thesis together: provenance, production technology and interpretations of exchange and consumption in Mycenaean political economy. All three of these areas are discussed to summarise the new and important information generated through the integrated, multi-technique analysis of pottery.

Chapter Nine makes an attempt to show how interconnected these thematic points are in the study of ancient societies and especially in the Late Mycenaean Saronic Gulf.

This research investigates the place of pottery in the Late Mycenaean Saronic Gulf, and subsequently the wider Mycenaean world. Chapters Two through Five present a research framework where a large body of material was selected from one of the most well-known and well-studied complex societies of prehistory and studied through rigorous scientific analyses in order to interrogate aspects of social organisation, interaction and economic practice. Chapters Six through Eight report and interpret the resulting data generated from the analytical programme. The discussion in these chapters highlights new information about technologies of pottery production and how production, exchange and consumption patterns allow for an expansion of current interpretation of palatial influence in Mycenaean regional economies. Finally, the information generated through this research demonstrates a nuanced view of pottery's place in Mycenaean political economics on a regional scale.

Chapter Two: Pottery and Mycenaean Political Economies

2.1 Introduction

The emergence, formation, structure and organisation of political economies in complex societies has been a common focus in studies of the Aegean Bronze Age, and indeed elsewhere (for examples, see papers in Feinman and Nichols 2004), over the past decade. In Mycenaean culture, much of the discussion has revolved around the extent of centralised government control over economies of regional polities (Voutsaki and Killen 2001b). Some of the main questions asked address the degree of control the palatial centres of Mycenaean societies exerted over the economic spheres of agriculture, craft production and trade (Voutsaki and Killen 2001b: 1), including intra-regional (Galaty 1999), inter-regional (Sherratt 2001) and extra-regional (Burns 2010) exchange. Out of this line of questioning came the conclusion that when considering Mycenaean civilisation, one cannot simply discuss a single overarching political economy as scholars have attempted in the past (Parkinson and Galaty 2007; Pullen 2010b: 3). Indeed, there is a growing recognition of the variability that lies, not only between the palatial communities of Minoan Crete and Mycenaean mainland, but between each polity and region.

Parkinson and Galaty (2007) have taken this distinction a step further in suggesting that the differences between Minoan and Mycenaean political units are much deeper than had previously been recognised. They characterise the organisation of the Minoan state as “corporate” in which the ruling elite incorporated Near Eastern and Egyptian symbols and beliefs into pre-existing tribal groups that emphasised larger corporate groups thus resulting in a “corporate” or “heterarchical” theocratic system (Parkinson and Galaty 2007: 124). The Mycenaean polity, on the other hand, is characterised by Parkinson and Galaty (2007: 124) as a “network” state which was more exclusionary in its organisation (for a wider discussion on secondary states types see Blanton et al. 1996). This broad distinction between Cretan and mainland polities clearly indicates that in order to reconstruct political organisation and economic activity, each need to be considered in isolation before a more general model is constructed. This, of course, is most difficult when taking into consideration that a large number of Mycenaean citadels are found in the region of the Argolid in the northeast Peloponnese and nearly all of the archival texts, discussed in detail below, are found at but a few of these palatial estates.

Voutsaki (2010: 86) points out that this discussion has proved fruitful and clarified many aspects of both politics and economy over the past few decades. However, she indicates that there are two major weaknesses with the debate overall. Firstly, the majority of research on political economies in the Greek Late Bronze Age feature only one kind of evidence, mortuary or settlement, or perhaps only one area of the socio-economic world, production or trade or consumption, or they only focus on one set of material culture, for example, pottery (Galaty 1999, 2007, 2014; Knappett 2001; Whitelaw 2001) or lithics (Parkinson 2007). Voutsaki goes on to argue that, in order to make new headway on this topic, it is essential to carry out study on settlement and mortuary evidence, to look at economics as a composite of production, distribution/trade and consumption and to focus on more than one artefact class (Voutsaki 2010: 86). The second weakness mentioned by Voutsaki is that the discussion only focuses on the palatial period, though there are a few exceptions (Burns 2010; Sjöberg 2004; Voutsaki 2010). The static nature of the debate means that much of the discussion has focused on the final result of centralisation, e.g. LH IIIB economics, rather than the process of centralisation itself, a process of change over time. Voutsaki is correct in this criticism. However we might identify a third and additional weakness, which the majority of studies of Mycenaean political economy focus on the palaces themselves or the related palatial elite as a means to characterise the entire social group that resides within a Mycenaean polity.

In the following section the prevailing top-down approach is outlined, as it has been employed by scholars over the recent decades. Secondly, this chapter is used to identify the limitations created by this kind of research framework in order to move beyond the Mycenaean palatial elite and characterise the daily lives and activities of common people. The goals set for this chapter are not to criticise previous scholarly study in a negative light, rather they will spotlight alternative and under-pursued avenues of research. Thus, the chapter seeks to build a new bottom-up approach to supplement the most positive aspects of the previous concentration on the Mycenaean elite and state apparatus. In doing so it will become transparent that both top-down and bottom-up approaches on their own do not provide enough scope to generate a detailed and nuanced understanding of economic practice during the Late Bronze Age. It is the combined mechanism of these methods, a multiscalar approach that provides enough insight to take on the task of reconstructing early political economies such as we find in the Mycenaean period in Greece.

2.2 The "top-down approach" and the role of texts and Linear B

The top down approach is best illustrated in research regarding the regulation of specialised craft production as demonstrated by the Linear B inscribed clay tablets. From the initial decipherment by Ventris in the mid-20th century, (see Chadwick 1958), the Linear B texts have been used by archaeologists, philologists, linguists and ancient historians as a means for reconstructing societies of Late Bronze Age Crete and mainland Greece. The resulting systematic study of the Linear B texts has resulted in a widely accepted notion that the tablets are the archival records of economic interactions between palatial administration and the area of their dominion. The study of the Linear B archives has uncovered the diversity of social groups engaged in craft production and other administrative links between the palaces and their surrounding region. At the same time, however, close study of the texts has increasingly led to the identification of the gaps within the palatial records; missing aspects of production that may yet be visible in the archaeological record that provide key details about economic practice in areas outside the palatial sphere (e.g. Halstead 1992; Killen 1985; Parkinson 2007; Parkinson and Pullen 2014; Schon 2007, 2011; Whitelaw 2001).

2.2.1 Linear B texts and the ta-ra-si-ja economic system

Many of the Linear B texts provide insight into the organization of agriculture, craft production, and many more facets of state-level administration in a complex Bronze Age society. It is clear from several sets of inscriptions that there was a system which linked certain craft producers to the palatial authority. This system, referred to as ta-ra-si-ja, is well represented in the tablets for a variety of craft products (Bennet 2008; Duhoux 1976, Killen 2001; Montecchi 2012; Nosch 2000, 2006; Ventris and Chadwick 1973). The term ta-ra-si-ja has been translated as the Classical Greek ταλασία – a term rooted in weight: as in talanton or talent (Killen 2001). The system works by assigning a quantity of material to a group, who return it in finished form, verified by weight, in return for support (rations). For these reasons, it is understandable that industries such as those involved with woollen textiles and bronze production would fit this model well (Killen 2001). Both industries work in a fashion in which the weight of the raw materials is directly proportional to the final product. This is attested in a numerous tablets from both Knossos on Crete and Pylos in Messenia.

However, perfumed oil, where ingredients are consumed within the production process, could not have been entirely regulated under ta-ra-si-ja as the final product could not be measured in terms of the raw materials used, except for, perhaps, the oil (Killen 2001; Shelmerdine 1985). Though it is evident from production contexts that perfumed oil was a craft directly connected to palatial activities and the mitigation of its distribution was recorded in the Linear B tablets, it is unclear how production was regulated. Furthermore, John Killen argues that a second system of palatial control on craft production can be read in tablets that contain the term o-pa, a term that relates to the noun ἑπω or the obligatory finishing or completion of the production process or perhaps in the refurbishment of objects such as bronze armour or javelins (Killen 1999; see also Lejeune 1958; Montecchi 2012). The references to ta-ra-si-ja- and o-pa make a transparent case for the involvement of some centralised organisation in some areas of resource mobilization.

Schon (2007) moves a few steps beyond the identification of palatially controlled craft by investigating the degree to which the administration influenced the production and distribution of a particular craft. Following up his earlier study, Schon (2011: 219) is in agreement with Halstead's (1988, 1992, 1999a, 1999b) suggestion that several types of transactions were occurring outside of the palatial regulation system, i.e. ta-ra-si-ja, thus arguing that the archaeological record may provide missing information that will illuminate different types of redistribution that occur on different economic levels . Looking at systems of perfumed oil, textile and chariot production, Schon (2011: 220) contends that the palatial authorities did not have complete control over their regional economies or the production of many high-valued items. Going one step further, he states that when reading into the meaning of the Linear B texts that preserve bureaucratic activities, one must consider them as attempts to exert power and not as "reflections of authority that was already a fait accompli" (Schon 2011: 220). In this view, the palatial records are examples of a ruling authority's attempt to exercise conspicuous displays of power through exertion of political influence over the craft economy. Pointedly, Schon (2007, 2011), like Killen (1985, 1988) and Halstead (1988, 1992, 1999a, 1999b, 2001) before him, has illustrated that though there is significant palatial influence over craft systems, but these systems did not operate in such a simple manner. Rather they were complex social institutions, many of which existed before the emergence of Mycenaean palatial political economies (Parkinson 2007; Parkinson and

Pullen 2014) and consisted of multiple levels of operation that included active roles by both elite and non-elite participants (see also Nakassis 2006, 2013).

2.3 Identifying undocumented economic activities

The idea of an administrative system with some degree of economic control, with interests in specialised craft production and resource management has led some early scholars to suggest that the Mycenaean palaces were "massive redistribution operations" (cf. Finley 1957) where the central power would collect resources locally and redistribute them among the social hierarchy. However since the 1980s there has been a trend of seeking out economic parallels and thus characterising production within the texts as under palatial influence (Bennet 2008; Killen 1985; Halstead 1992, 2001). This has been productive in developing our understanding of palatial bureaucracy and the socio-political organisation of Mycenaean society. At the other end of the spectrum there is a need to understand what these texts do *not* say. There are several studies central to the research of "non-palatial" sectors (Killen 1985; Halstead 1992; Parkinson 2010; Nakassis et al. 2011; Whitelaw 2001). These tend to ask how the documents can be read in order to reveal that which was left unrecorded. A task originally addressed by Killen (1985) nearly 30 years ago, this has since been taken up by scholars such as Halstead (1992; 2001) in his discussion of the sheep and wool economy at Knossos. In those studies, Halstead suggests that as long as shepherds provided their quota to take care of the special needs of the palace they had the freedom to slaughter animals for their own personal use. It is also striking that food staples such as the pulses and legumes which are regularly found during excavation are apparently not referred to in palatial documents, and perhaps may be found behind some unidentified ideogram. Staple foodstuffs require land, labour and a means of distribution, all features that come at considerable cost for the producers. Moreover, if these products were a major feature in the diets of the general Mycenaean population, why are they not in the Linear B records? By identifying palatial interests in agriculture and the palace's dependency on the non-palatial sector, including labour and resources of rural communities, Halstead indicates that the wider economy of the Mycenaean world is broader and more complex than that which is illustrated in the Linear B texts.

Outside of agriculture, there are two traditional materials that are prevalent in the archaeological record, some can be found in nearly every context within the Mycenaean world, including the palaces, though are noticeably absent from or underrepresented within the written record, namely pottery and chipped stone tools. Parkinson (2007) maintains that chipped stone tool production, especially obsidian blades and bladelets, was not a craft industry controlled by the ruling elite for it has a long history that predates the palaces and the formation of a palatial polity by a number of millennia. Perles (1992, 2001) suggests that these tools were originally produced by itinerant craftsmen in the Neolithic period as production evidence is rarely found away from the coast and only at a select locations and though it appears that production begins to be attached to specific locations, the general pattern continues through the Mycenaean period (see also Parkinson and Pullen 2014). Parkinson (2007, 2010; see also Parkinson and Pullen 2014) insists that the Mycenaean palatial authority is only interested in controlling some areas of the craft economy, especially high valued goods related to the ruling elite, and this is why there is no mention of chipped stone production in the Linear B texts. Moreover, he suggests that the regional Mycenaean palatial systems grew around certain specialized niche economies leaving others, especially utilitarian craft production like that of chipped stone tools, to exist outside their powerful influence.

Unlike chipped stone tools, ceramic vessels *are* mentioned in the texts, but in comparison to other craft products, regulation of production cannot be identified, nor is it evident that the palatial authorities had any interest in controlling its production. Pottery is the most common artefact found in the archaeological record of Late Bronze Age Greece and can be argued to be a material embodiment of the everyday activities and interactions of the ordinary people and elite alike. At the Mycenaean palatial centre of Pylos at Ano Englianos in Messenia, pottery is found in huge quantities in many of the palace storerooms and closets (Bendall 2004; Galaty 1999, 2010; Hruby 2006; McDonald and Rapp 1972); it is widely accepted that pottery was a material that played a significant role in the social events of the palaces (Bendall 2004; Hruby 2008; Wright 1996). Pottery is also found outside the palaces in places of ritual (Konsolaki-Yannopoulou 2001; Konsolaki 2002; Cosmopoulos 2003), on ships (Agouridis 2011; Day 1999) in settlements (McDonald and Rapp 1972) and beyond.

Pottery is rarely mentioned in the texts and yet is the most ubiquitous material in the archaeological record. This fact has not gone unnoticed by scholars and several have addressed this topic specifically. Whitelaw (2001) investigated the involvement of palatial authorities in pottery production by comparing predictions of regional annual production to the predicted annual consumption at Bronze Age Pylos in Messenia. The results of this study suggested that the palace only procured approximately 1% of the annual regional ceramic production. This number suggests that while there was a need for palatial authorities to commission the production of vessels throughout the year, it was not of such significance to warrant the organization and control of the raw materials, land and labour needed to produce this amount of vessels. It can be argued that the natural resources used to produce ceramic vessels would be too difficult to regulate, as clay suitable for producing pottery is found in many areas in Greece and the amount of labour involved is not large enough to support a ta-ra-si-ja regulated system of craft production and thus could not be regulated by the palace (Killen 2001; Montecchi 2012). Whitelaw concludes by suggesting that although pottery plays a significant role in the lives of Mycenaean people, the production and distribution of ceramic vessels may have been far enough outside the interest for the palatial authorities to attempt regulation.

Galaty (1999, 2007, 2014) has argued that in the case of Pylos, the production of kylikes, stemmed drinking vessels often associated with feasting and religious events, is attached to the palace even if the records are not available in the text archives. He further argues that Whitelaw has over estimated the number of pots produced per year and the availability of clay suitable for potting purposes indicating that the number of potters needed to generate a sufficient number of pots to be consumed in and out of palatial contexts is far fewer than Whitelaw suggests (Galaty 2010). Shelton (2014) suggests similar attached pottery production can be inferred from the storage rooms containing very high quality painted vases at Petsas House near the citadel of Mycenae. Parkinson and Pullen (2014) argue that, like obsidian, the economic system that surrounded pottery production predates the palatial system and thus only certain aspects of this economic system were viewed by the palatial elite as needing control, leaving the rest to operate as it had in the past. Other craft industries, such as textiles and metal working, were incorporated into the palatial system as they were seen as more critical in the successful operation of the palatial political economy (Schon 2007; see also Parkinson and Pullen 2014) This view leaves the pottery production industry as mostly autonomous with what can be argued as fairly strong links to the palatial political economy, but not completely under its power.

Here lies the conundrum. If the palatial authorities had little interest in the regulation of the pottery industry *in toto* then how are the references to land given to the four potters found in the Linear B texts (cf. Anderson 1994-1995; Lindgren 1973;

Palaima 1997) to be understood? What of the "Royal Potter" (cf. Palaima 1997)? Nakassis (2013) argues that some of the potters are mentioned in more than one context where goods of different sorts are being delivered. If this is the case, it may be that the "Royal Potter" is actually the person in charge of procuring the requisite goods rather than a craftsman in his own right. However, Galaty (2010) has suggested that some of the potters mentioned in the texts only fulfil one job and that perhaps only one potter made all of the palatial fineware kylikes, a vessel of significance in Mycenaean feasting rituals, and that this potter could have been the "Royal Potter" known from the texts. Thus, it is plausible that craftsmen from within the higher ranks of society may have been commissioned directly, making the recording of transactions unnecessary. However it is just as likely that there were people who interacted with craftsmen as go-betweens for the palaces (Nakassis 2006, 2013). Positing both a single "Royal Potter" and a middleman facilitating transactions between the palatial and craft production sectors may muddle the overall picture, but it does highlight the relative complexity of the relationship between political authority and economic transactions outside of the Linear B archives records.

2.4 Specialisation and Bronze Age political economies

In a recent volume concerning the political economies of the Aegean Bronze Age (Pullen 2010a), Day et al. (2010: 208) provide a quote from economic anthropologist Charles Cobb that states "political economy involves *historical relations*, not universal categories, of power and inequality" (Cobb 1993: 79, emphasis added by Day et al. 2010: 208). It is with this statement that Day and his colleagues begin to discuss the idea of craft specialisation, and to a lesser extent product standardisation, in understanding political power and economic prowess of prepalatial Crete and Cobb's notion of historical relations is no less relevant here. As Parkinson and Pullen (2014) have made clear, the practice of specialisation in craft activities on mainland Greece, especially that of stone tool and pottery production, has a much longer history than that of Mycenaean palaces. Yet it is clear from the Linear B inscribed tablets that there is an intimate connection between palatial elite and specialist craft producers (cf. Palaima 1997). Written records of transactions may show a link between specialised craftsmen and palatial authorities, but to what degree can this relationship really be observed.

The notion of specialisation in craft activity came from attempts of archaeologists to link production to social complexity (Rice 1981). Specialisation here refers to the act of people devoting all of their time to a specific activity, e.g. full time potters. Specialisation, then, is linked with idea of social organisation and divisions of labour (Brumfiel and Earle 1987; Cobb 1993; Costin 1991, 2004; Earle 2001; Rice 1981), may be seen as a primary means of establishing, legitimising political power (Brumfiel and Earle 1987; Cobb 1993; Costin 1991, 2004; Earle 2001; Peregrin 1991; Stein 1996) or perhaps it demonstrates commercial and economic growth as industries grow to fulfill the needs for intensification and efficiency (Branigan 1983; Cherry 1986; Costin 1991: 7-12; Day et al. 2010: 209; Earle 2002: 129-144; Renfrew 1972). In connecting specialisation to politics and economics, an inherent value is placed on the craft goods without any justification on how this value is formed (Day et al 2010: 209; see also Barrett and Damilati 2004).

In Late Bronze Age Greece, the Linear B tablets demonstrate that there is indeed some value attached to craft goods, and that there is an interest by the palatial elite to control aspects of craft economy. Looking more closely at the archaeological record, as discussed above, has shown that there are aspects of specialised craft production that lie outside the control of the palaces and therefore elicit new questions concerning the *degree* to which palatial authorities exude power over certain specialised craft activity.

2.5 Palatial political economy as a reflection of Mycenaean culture?

It is apparent that a binary interpretation of Mycenaean political and economic institutions as “palatial” and “non-palatial” is misleading, and inaccurate (cf. Schon 2011). Both textual and material records indicate that understanding political economies is a very complex issue, a comment that is clearly represented in Whitelaw’s graphical representation of Mycenaean political and economic interaction (Whitelaw 2001:79, Figure8). Furthermore, regarding these institutions as economic systems of redistribution (Finley 1957; Polanyi 1957) is unmerited. Where there is some evidence in the ta-ra-si-ja and o-pa resource mobilisation strategies employed by Mycenaean state officials that forms of redistribution occurred (Schon 2011), it by no means characterises the system as a whole. Indeed, it is confounding that scholars continue to refer to Polanyi’s redistribution-market dichotomy as it has been refuted a number of times since its inception (Berdan 1989: 106; Feinman 2004: 3; Nakassis et al. 2011).

In recent years there have been several attempts to revisit these aspects of political and economic organization in order to generate a more nuanced understanding of Mycenaean society (e.g. Pullen 2010b; Galaty et al. 2011; Parkinson et al. 2013). In each case there is an attempt to distance the discussion from the bisection of Mycenaean society into "palatial" and "non-palatial" sectors. Pullen (2010b) directs the discussion toward issues concerning the role and scale of centralization and specialisation in craft economic systems (i.e. production, distribution/exchange and consumption), investigating the Aegean political economic system as a monolithic process and tracing the historical trajectory of the Mycenaean state. Alternatively, both Galaty et al. (2011) and Parkinson et al. (2013) consider new lines of investigating Mycenaean state organisation in order to create new mechanisms of interpreting old data. All three of these forums have generated fresh new ideas and approaches to this issue and have formed much of the theoretical foundation for this thesis.

Galaty et al. (2011: 176) state that the old way of thinking about economic issues in Aegean prehistory, specifically redistribution economics, "is limited and limiting" while the new way of thinking, "those stemmed by archaeological theory building, are ripe with possibilities." Indeed Galaty and his colleagues are correct, this new way of approaching Mycenaean society is more fruitful then it ever has been. However they still have not taken the issue far enough as the discussion continues to be limited with the palatial centres continuing to control focus of discussion rather than merely playing their role as active participants within wider cultural systems. Aprile (2013) and Shelmerdine (2013) both attempt to look beyond the palatial scope, but only Aprile actually succeeds in making a regional satellite site as the focus in her work on the intersite distribution of objects in the non-palatial regional settlement of Nichoria. Others have attempted to look at regional data from non-palatial sites as well, but none take credible steps to look beyond the Mycenaean elite towards that of the social majority. In fact, some have taken this kind of information as a means to redraw political boundaries and to recreate possible political takeovers (Pullen and Tartaron 2007; Pullen 2013; Tartaron 2014).

2.6 Market systems as economic practice

Of late there has been a strong push to distance the study of economic issues in anthropology and archaeology from the broad influence of Polanyi (1944, 1947; Polanyi et al. 1957) and some of his key followers (Dalton 1961, 1968, 1975; Finley 1957, 1999; Sahlins 1972) that have impeded research into complex economic issues, such as markets. Feinman and Garraty (2010: 169) contend that despite the "methodological roadblocks" set out by Polanyi and others after him, archaeologists have the means to investigate markets and market-based economic systems in the preindustrial world. Parkinson et al (2013: 415) further this argument by stating that Polanyi's (1944) view of markets as socially disembedded systems and his expression that all markets are inherently capitalist is disingenuous and misleading (see also Feinman and Garraty 2010: 172-174; Garraty 2010; Garraty and Stark 2010; Smith 2004).

Feinman and Garraty (2010; see also papers in Garraty and Stark 2010; Hirth 1998) in anthropology more generally and Parkinson et al. (2013) in the Late Bronze Age Aegean, have attempted to rework and develop the theoretical framework in which archaeologists can a. identify and b. characterise market economies in the past. The first step in this theoretical redevelopment has been to provide a new working definition of the term *market exchange*. As with Parkinson et al. (2013: 418), this thesis uses the definition employed by Feinman and Garraty (2010: 171; see also Pryor 1977; Granovetter 1985):

> We conceptualize market exchange as economic transactions where the forces of supply and demand are visible and where prices or exchange equivalencies exist. In theory, market exchanges may be atomized/impersonal or personal/embedded. However, in practice, all market transactions presuppose social relationships among the parties to an exchange and so are embedded.

This definition is much less rigid than Polanyi's (1944: 68) definition of market exchange as "an economic system controlled, regulated and directed by markets alone" and allows for the focus to shift away markets as post-industrial, capitalist settings how markets became institutionalised entities within a given social context (Parkinson et al. (2013: 418).

With an understanding that the *market* is "an idealized conception that an economic (market) system [that] is the cumulative effect of market transactions between self-interested buyers and sellers" (Feinman and Garraty 2010: 171), where does such activity take place in past societies. One such venue is the M*arket place* or "physical places which market exchanges are generally conducted at customary times" (Feinman and Garraty 2010: 171). The idea of market places existing in the Greek Bronze Age has already been broached by Parkinson et al. (2013: 213) in a short discussion on the origins of the Athenian Agora, the central market place of the Athenian Greeks during the Archaic and Classical periods. The existence of the agora in antiquity fits, unsurprisingly, into the definition set up by Feinman and Garraty, as there is specific space devoted to exchange of goods and resources. However this definition presents a problem during prehistoric periods in Greece where no such space designation exists in the current record.

Hirth (1998, 2009: 89-90; see also Feinman and Garraty 2010: 176-177; Parkinson et al. 2013: 418) presents a solution to this problem by laying out four methods of identifying market activity in past societies. The identification of the actual, identifiable remains of a market space, such as the Athenian Agora or the Roman Forum, is what Hirth refers to as the configuration approach. This approach focusses on the identification of physical evidence such as site plans and architectural remains. While this approach is straight forward, the other three rely on indirect evidence. First there is the contextual approach where an assumption that a market system exists is based on logical inference, an example is using the assumption that a market system exists to provision a large urban centre or system of centres (Stanish 2010). This approach is based on conjecture rather than actual empirical evidence (Feinman and Garraty 2010: 177). The spatial approach examines relationships between patterns of exchange and idealised spatial configurations such as Renfrew's (1975, 1977) "falloff curves." Lastly, the distributional approach examines the spatial effects of marketplace exchange at the household level. Here Hirth (1998: 455) indicates that marketplaces, unlike other mechanisms of exchange, necessitate equal access to commodities to all households regardless of social ranking. Stark and Garraty (2010: 177-178) have provided a fifth method of market identification: the regional-distribution approach. This approach focuses on the distribution scale of "quotidian" craft goods, pottery, e.g. stone tools, in relation to their locations and scales of production in order to assess the probability of market-based exchange compared to other non-market mechanisms.

As Feinman and Garraty (2010: 178; see also Parkinson et al. 2013: 418) rightly point out, all five of these approaches are affected by the problem of equifinality as "[i]t is rarely, if ever, possible to rule out alternate exchange mechanisms for observed archaeological patterns." For this reason, they suggest taking a multiscalar approach to observe economic activity in past societies. In this way it is possible to observe economic actions by and *interactions with* different levels of past political economies.

2.7 Conclusions and thesis contributions

This review has suggested where much of the information concerning the political economies of Mycenaean society is to be found. The studies referenced are by no means exhaustive, rather they have been chosen to reflect the most recent theoretical paradigm in studies of politics and economy in the Aegean Late Bronze Age. There has been an intentional emphasis on craft production and exchange, as this is the general focus of this thesis, however it is clear that much of the literature that explores craft production and exchange is linked to the wider discussion of Mycenaean political economy. While this thesis, like many others, attempts to join the fray so to speak, it differs in its emphasis on interaction in the Mycenaean socio-political system within the Saronic Gulf, approached through the characterization of everyday events and transactions in a single craft system. Using the methods described in the following chapters, this thesis attempts to reconstruct aspects of Mycenaean political and economic activity primarily from the bottom up before drawing comparisons from previous top down studies. In this way the craft economy, specifically ceramic systems, of the Mycenaean society local to the region of the Saronic Gulf are characterized through interaction by looking at production, exchange and consumption of both palatial and non-palatial Mycenaean communities in order to reconstruct this aspect of society on a continuum of interaction (cf. Costin 1991; Knappett 2012).

Chapter Three: An Integrated Study of Pottery

3.1 Introduction

Pottery is perhaps the most common class of artefact in the archaeological record. It has played many roles in interpretations of the past products of technological innovation, markers of external influence, marital traditions, defining factors of domestic or market economic practice and virtually all other culturally significant phenomena (DeBoer 1984: 529). Though the study of pottery is indeed fruitful, the heightened significance researchers have placed on it is most probably a reflection of the composition of the archaeological record rather than a feature of ancient society (Day et al. 2006). On balance, however, although there is more than a modicum of truth in this statement, pottery *is* a prominent source of information with concern for social organisation and wider political and economic trends in past societies. Currently, the state of the art in studies of Aegean pottery, while still concerned with traditional approaches that focus on stylistic attributes such as decoration style and motif because these aspects are useful features for the development of chronological sequence, relies increasingly on a technological perspective (cf. Wilson and Day 1994; Day et al. 1999; Aloupi et al. 2001; Shaw et al. 2001; Tomkins and Day 2001; Day et al. 2006; Belfiore et al. 2003; Kiriatzi et al. 2012). This shift towards a combination of robust analysis with traditional approaches has proved to be quite favourable in archaeology for it integrates typology and context into technological reconstructions which showcases the interconnected aspects of the social and the technological.

Reconstructions of past technical systems must be explicitly aware of dynamic relationship between the physical actions taking place within a technological practice and the social forces of which they form a part. Lemonnier (1993: 10) suggests that "… the identification, location and deciphering of technological choices correspond to a series of crucial questions regarding how, and in what respect, technologies are a mediation (as well as a compromise) between inescapable physical laws and the unbounded inventiveness of cultures." By taking into consideration the premise that technology is the embodiment or representation of social phenomena that encompass far wider implications than technical action itself (Lemonnier 1993), it is possible to reconstruct specific choices and processes within a technical action. It is generally assumed that a technical act can be separated into a series of operations relating to both dependent and independent components of a sequence (Balfet 1975; Roux and Rosen

2009). Approaching a sequence of operations, or *chaîne opératoire*[1], makes it convenient to investigate each operative action independently while simultaneously placing it within a technical system. This method creates a dialogue of interaction between object and technician delineating socially acquired knowledge and gesture.

3.2 The role of scientific analysis

In the Aegean, as with many areas of the world, much of the research became focused on the characterisation and source determination of raw materials used in pottery production (cf. Catling et al. 1961, 1963; Catling and Millet 1965). Aegean pottery has traditionally been categorized according to regional provenance, chronological sequence and stylistic decoration. Such attributes, when combined with find spots were then used to generate cultural regions which were then used to compare one group to another: e.g. Minoan vs. Mycenaean (Day et al. 2006: 24). Analytical studies have become much more dynamic over time, integrating raw material source determination with investigations into complex social phenomena such as identity (Day and Wilson 2007) and ethnicity (Day et al. 1998), imitation and assimilation (Broodbank 2004) and social organisation (Day 2004). Scientific analysis has progressed from identifying basic tenets of economic systems – production and distribution – to constructing a platform in which to make fundamental observations of cultural practice which lead to a more nuanced understanding of the past.

Beyond provenance, aspects of production technology are explored. The most basic and successful application of a chaîne opératoire approach is the identification of the sequential technical operations that transform natural raw materials into culturally significant and functional objects (Pelegrin et al. 1988; Dobres 1999). It is then up to the investigators to determine how best to observe these phenomena. In the case of pottery, there is an extensive body of literature devoted specifically to the topic of technology. The application of scientific analytical techniques has "a long and venerable history in archaeology" (Neff 2005: 209); the extent of which reach back to the end of the 19th century. But it was Anna O. Shepard in the 1930s who illustrated the potential of

[1] There are a number of definitions for *chaîne opératoire*. The term was originally coined by A. Leroi-Gourhan (1964: 164) though the most commonly used definition is presented by Creswell (1976: 13): "*Une chaîne opératoire* est *un série d'opérations qui transforme une matière première en un produit fini, que celui-cisoit objet de consommation ou outils*", (a *chaîne opératoire* is a series of operations that transform raw material into a finished product, either consumption object or tool [Translation by Roux and Rosen 2009: 12]).

scientific ceramic analysis through her application of thin-section petrography to pottery from the American Southwest (Shepard 1935; see also Shepard 1956). Since the publication of this seminal work ceramicists in archaeology and anthropology have exploited a range of physical and chemical techniques to observe different stages of the production process.

3.2.1 Provenance studies

In the early phases of scientific study of Aegean ceramics, chemical, or rather elemental, analysis was used to measure elemental compositions of the ceramic paste (cf. Catling et al 1961, 1963; Catling and Millet 1965). The traditional method of ceramic provenance determination has relied on the application of chemical analysis in which a sherd is prepared and exposed to one source or another in order to generate chemical compositional data. The compositional characterisation of the artefact is only part of the provenance problem (Glascock 2002). Provenance determination requires a comparison with other forms of relevant datasets or control groups to bridge the gap between artefact and location of its origin of manufacture. Researchers have bridged this gap using the "Provenance Postulate" (Weigand et al. 1977: 24). The Provenance Postulate states that source determination is possible if intra-source variability is less than variability between sources (Day et al. 1999). This postulate is still in use today and can be a very useful tool in the chemical assessment of archaeological ceramics, however it does not consider the fact that ceramics have undergone a series of physical and chemical changes, or dilution effects, over the course of their manufacture process and they are not representative of a geological reality. Moreover the notion of source is easily misconstrued as the geographic location of the raw materials rather than the place where the actual pottery was produced as Neff (2002: 107-108) demonstrates by stating that "sourcing" is referring to raw material provenience.

Weigand and colleagues developed this postulate in their analysis of turquoise, a naturally occurring material. This concept is very useful for natural occurring materials, such as obsidian flakes, but ceramic material does not occur in nature. Hein et al. (2004b) show that the Provenance Postulate does not hold true in its most basic form when considering ceramic material. Hein et al. demonstrate that variation between sources of Neogene clay on the Aegean island of Crete is often less than intra-source variability. This means that the premise of the Provenance Postulate does not hold up when tested against natural source materials even before considering that ceramics are made from a mixture of natural raw materials, each with a distinct chemical composition. Clay mixing occurs frequently in the Mediterranean world and, at present, there are no means for separating the chemical composition of the separate components that make up a ceramic. This separation would be necessary in order to compare ceramic compositional data to reference or control groups. A ceramic object is neither a natural product nor a "metamorphosed sedimentary rock" (Williams 1983: 301; Stoltman 1991: 104), it is a product created by humans and thus must be treated as such during the course of analytic study.

Unlike lithics, raw material sources exploited for pottery manufacture in antiquity are rarely identified through chemical analysis. Day and Wilson (1998) point out that there are many problems with this principle, especially in areas of repeating geological sequences with similar geochemical signatures. To complicate things further, Buxeda i Garrigós (1999) warns against the use of over-fired kiln wasters, sure evidence of pottery manufacture, as production source related reference material, as the glassy nature of over-fired sherds leads to differential rates of mineral and chemical alteration upon burial. The fact of the matter is chemical analysis of ceramics is complex and requires additional kinds of information to link compositional groups to behavioural groups (Day 1988).

3.2.2 Integration

Over the past few decades there has been a shift in the way that provenance studies are conducted in the Aegean. Day et al.'s (1999) paper entitled "Group Therapy in Crete: A Comparison between Analyses by NAA and Thin Section Petrography of Early Minoan Pottery" identifies and summarises the points made above and presents an alternative method for provenance determination. In pointing out that the application of thin section petrography had been making headway in ceramic analysis for the past 40 years and had many applicable uses beyond the establishment of provenance, Day et al. decided to move forward and approach a method that promotes chemical and petrographic methods as complementary techniques that are mutually beneficial. Day et al. use petrographic analysis to discriminate ceramic fabric groups according to their mineralogical make-up and textural features. These groups had earlier proved difficult to separate by chemical composition alone. Detailed mineralogical data proved to separate chemical groups into smaller groups that demonstrated significant archaeological meaning.

A question that arises from this discussion might ask the difference between chemical composition and petrographic analysis. What are the kinds of questions that researchers may ask of them in ceramic studies? Chemical compositional studies are used to generate quantitative elemental data. The elemental compositions are calibrated against materials with known compositions in order to monitor both precision and accuracy of any measurements produced. Calibrated elemental compositions are further treated as unique chemical signatures or "fingerprints" that are subjected to sophisticated statistical tests in order to observe chemical similarities and eventually, archaeological groups. The kind of statistical treatment of the data is crucial for the final archaeological interpretation. Chemical analysis has also been used to witness certain technological features of ceramic production, including use of non-plastic matter for tempering (Neff et al. 1988; 1989; Cogswell et al. 1998), clay mixing and the refinement of clays (Kilikoglou et al. 1998) and the effects of firing temperature (Cogswell et al. 1996).

Thin section petrography involves the examination of slices of ceramic material to characterise the mineralogy, petrology and textural features of a ceramic paste using a polarised light microscope. Fundamentally, this technique is used to:

- Characterise groups of ceramics based on mineralogical and textural criteria,
- Reconstruct technological practice and
- Where possible, identify places of pottery production according to fabric composition and technological tradition.

Raw material identification is the first step in reconstructing the technological process in ceramic manufacture. It is also the main objective for the purposes of provenance determination.

Both chemical and petrographic investigations produce data that are compared with regional reference groups to discriminate potential source locations. However, petrographic descriptions afford additional observations of technological practice such as raw material modification, addition of non-plastics as temper and clay mixing through descriptions of the micromass and grain size distribution (Whitbread 1995). In the past, chemical analysis would be compared to "control groups" or groups of pottery that were deemed to have a local production according to relative archaeological information. As more data became available, it became apparent that many of the sites considered as producers of pottery in the Aegean were actually large-scale *consumers* (Day and Wilson 1998). The problem was not with the analytic techniques used but with the theoretical constraints of the applied research methods and problematic assumptions about the manufacture and exchange of pottery in the past. What Day and Wilson (1998) were able to demonstrate in their questioning of archaeologically derived control groups illuminated the need not only to question how these controls were defined, but to consider the relationship between geochemical and mineralogical aspects of ceramics. This relationship is fundamental for provenance discrimination because it is not specific to analytic technique, a particular ceramic technology, or study region (Day et al. 1999: 1028). Moreover, it provides a visual continuum for observing socially meaningful aspects of ceramic production (Wilson and Day 1994: 54).

The end of the 20^{th} century marked a paradigm shift in how and, more importantly why scientific analysis was applied to the study of ancient ceramics, at least in the Aegean. A combination of the development of analytical techniques in addition to changes in the kinds of questions being asked of material culture have led researchers away from the near impossible task of locating discrete raw material sources in a geological landscape, to investigating production groups and then their probable origin (Hein et al 2004a). Places of production are located in geographic space and have distinctive geologic composition; however they have been transformed into discrete places of human related activity (Ingold 2008). Ingold (1993) explains this transformation as the creation of a taskscape or a place with ascribed social meaning where interrelated activity are linked to a common goal, i.e. social organisation. Using ceramic material as a tool for locating these places of social activity seems a more fruitful use of analytic techniques than for finding the locations of specific raw materials that may be spread over large spans of geographic space (cf. Hein et al. 2004a).

3.3 Chaîne Opératoire

The *chaîne opératoire* approach consists of deconstructing the physical tasks required to perform a technique of interacting with matter. This enables fine resolution for observing each individual component of a technological sequence. Dissecting a technique into elemental components distinguishes variation independent of that which make up the invariable fundamental technical process. The identification of variation that is independent of the basic product of a specific technology, at first glance, recalls the old style-versus-function debate that came with the beginning of the New

Archaeology (Binford 1978, 1981, 1986; Dunnell 1978; Sackett 1982; 1986), where variation of this kind is chalked up either as stylistic or non-functional. However, with the understanding that stylistic and functional are difficult to tease apart, it is better to conceive independent variability as *technological choice* or actions completed by the technician that were influenced, knowingly or not, by social constructs. Lemonnier (1993: 7) states that technological choice "emphasizes the sorting out of possibilities on which the development of a technical system is *de facto* based, although in an unconscious and unintentional way. Also, it refers to the process of selection and to its results."

With this perspective the *chaîne opératoire* of a technique is regarded as a sequence of socially bound choices where each action (or choice) is understood to be an embodiment of socially constructed phenomena. This embodiment is a representation of knowledge that has been transmitted through modes of learning such as replication of gesture and spoken word. Actions in an operational sequence of a technique are directly linked to a wider context where choices are reflections of social phenomena (cf. van der Leeuw 1984, 1993). The study of technology has thus become the study of the social control of strategic elements (van der Leeuw 1993: 241) with avenues leading towards more cognitive approaches involving the intellectual and conceptual processes of technology. This thesis incorporates a *chaîne opératoire* approach as a means of observing technological choices made in ceramic systems of Late Bronze Age Greece and their wider implications. This is done in such a way that it does not merely quantify raw materials or tools to presuppose the technician as an intermediary between these two components. Instead, it will pursue an argument that elevates the role of the potter as a key element in a ceramic system illuminating that the potter's knowledge and decisions are present in each stage of production. Providing that this approach is successful, this body of research will show further that "*it is not nature, but culture, that is the main constraint of technique*" (van der Leeuw 1993: 241, original emphasis).

3.4 Technology

Moving beyond the location of producers and consumers within a society, technological reconstruction is useful to identify variability over time and space, especially the development and transmission of cultural traditions. The present study uses multiple analytic techniques to observe the kinds of materials used and how they are transformed from attributes of local geology into products laden with social meaning. Thin-section petrography, as previously discussed, is a means for characterising raw material choice and the processes of producing ceramic fabrics. Bulk chemical analysis examines these ceramic fabrics as a whole entity, creating chemical signatures that represent a ceramic group, a feature useful for mapping distributions across space. These two techniques are generally complementary, but do not provide sufficient information on the technological process of decoration nor on the pyrotechnology that transforms clay pastes into ceramic objects.

3.4.1 Scanning Electron Microscopy

The possibility of estimating firing conditions in ceramic production by scanning electron microscopy (SEM) is a method that has over thirty-five years of development. Early studies of ceramics by SEM uncovered a correlation between the degree of vitrification (the transformation phases of clay platelets into glassy particles) and pore structure of the groundmass to the temperature reached in the firing stage of production (cf. Maniatis and Tite 1978, 1981). Experimentation with re-firing ancient vessel fragments at different temperatures and atmospheric conditions provided the initial evidence needed to generate estimations of firing temperatures used to produce ancient ceramic vessels (Maniatis and Tite 1981). Providing that the amount of calcium is known, a firing temperature can be estimated by observing the state of the microstructure of a freshly broken ceramic cross-section through comparison with laboratory produced and standardised control material. Calcium concentrations are a significant factor in such estimations, as the concentration of calcium oxide (CaO) within a sample is inversely related to the amount of glassy filaments found in the microstructure. Thus in ceramics with lower concentrations of CaO there will be a coarser matrix of glassy filaments within the microstructure where a high concentration of CaO will lead to finer filaments (Maniatis and Tite 1981). This is perhaps due to the amount of oxygen that is escaping during the firing process. With high concentrations of CaO, it is likely that as temperature rises, more and more oxygen is released causing a network of smaller pores formed in between previously formed glassy filaments.

This method of estimating equivalent firing temperatures has been refined several times (e.g. Kilikoglou 1994; Shaw et al. 2001:120-124) and has proved to be useful in the reconstruction of ancient ceramic technological practice. Kilikoglou demonstrates that estimations of firing temperatures and atmospheres in both the microstructure as viewed through the SEM (2000x) are reflected in the optical activity of the clay micromass as observed through thin-section petrography (25-100x) (Maniatis and Tite 1981).

However, firing temperatures and atmospheric conditions can vary widely in ceramic production as both Gosselain (1992) and his colleague Livingstone-Smith (2000) have shown through ethnographic study of traditional potteries. Both scholars suggest that the estimation of firing conditions and especially firing temperatures is questionable due to the irregularity of the temperature within a single firing event (both at the level of variability within the individual pot and between different vessels in the same firing event). Indeed, different clay types can reach similar levels of vitrification at different temperatures and it is these microstructural features that reveal key aspects related to the performance of functional ceramics (Kilikoglou et al. 1998; Hein et al. 2008; Müller et al. 2013; Müller et al. 2014; Müller et al. 2015). However, the patterning observed in vitrification microstructures of Aegean pottery are far from random and the information generated through SEM about the potential firing conditions provides a wealth of technical information about ancient ceramic production processes.

Surface modifications, such as additions of paints or slips and even burnishing, reflect some of the final stages of the production process. SEM systems with a combined energy dispersive spectrometers (EDS) or energy dispersive X-ray analysers (EDAX) offer the ability to examine both the microstructure and elemental composition of such surface treatments. This has the added advantage of being analysed together with the vitrification of the ceramic body described above. Freshly fractured cross sections are useful identifying the degree of sintering and vitrification of paint and slip layers, particle size (coarse or fine) and the level of adherence of paints and slips to the body (Aloupi and Maniatis 1990: 460). In addition, most SEM systems permit the simultaneous qualitative and semi-quantitative bulk and spot chemical analyses of the body and surface of a ceramic in a polished section (Tite and Maniatis 1975; Aloupi and Maniatis 1990). From this information we can characterise and attempt to identify raw materials and their physical properties (Aloupi and Maniatis 1990: 460).

In the case of red and black painted or slipped pottery, both monochrome and dark-on-light, secondary electron analysis of a fresh fracture in SEM enables observation not only of the degree of vitrification, the relative grain size and thickness of the decoration, but also details of the adhesion of the paint onto the vessel body. Small cracks can occur between decoration layers and the ceramic body. Maniatis and his colleagues (Maniatis et al. 1993) suggest that these cracks are the result of weathering and are propagated during the preparation of the sample. Aloupi (pers. comm.) suggest that this is a problem that initiates during the firing sequence, such as when the temperature rises too high during an oxidation-reduction-oxidation (ORO) firing regime, while others contend that this phenomenon is the result of differential shrinkage of different materials during the drying and/or firing stage (Maniatis and Tite 1981). The high temperatures cause the colloidal solution to slightly lift off the surface, approximately 1-2 microns, but this does not cause complete failure of decoration. This may cause flaking or paint cracking over time. Cracks, such as those just described, may be reflective of failed attempts at an ORO firing sequence to create Fe-black or differential shrinkage caused by firing temperature fluctuation (Kilikoglou pers. comm.).

3.5 Summary

Observing the types of raw materials and techniques used for production is a useful method to recreate the chaîne opératoire of decoration. This provides a basis for understanding the final stage before firing of the complete production sequence, thus allowing for a complete technological reconstruction of particular manufacturing centre. The aim of this section has been to demonstrate the value of integrating multiple analytic techniques to form a comprehensive methodology for reconstructing ceramic technology and the effects of technological choices made in past societies. Each technique has a separate set of applications with the common goal of reconstructing ceramic technology from the end of the Mycenaean phase of Greek prehistory. The next section will detail the analytical protocol employed by this study in an attempt to put the theoretical guidelines expressed above into practice.

Chapter Four: Programme of Analysis

4.1 Introduction

Coastal Attica, the islands of Salamis and Aegina, Corinthia, Methana and the islet of Dokos lying on the edge of the Argolic Gulf are all areas with clear Mycenaean presence, however none are prominently represented in the archaeological record. The Saronic Gulf can then be argued to be a prime location to study the interregional economic structure and interaction in the mature Mycenaean period. It is a place of active seafaring and product mobility in the Late Bronze Age as represented by shipwrecks from the well-studied site off the coast of Point Iria (Phelps et al. 1999) and the more recent discovery of a ship wreck off the shores of the islet of Modi, near Poros (Agouridis 2011). A comparison of these underrepresented regions to those areas that are more heavily studied, i.e. the Argolid and Messenia, enriches the overall resolution of Mycenaean politico-economic structure and interaction from a variety of archaeological contexts and geographic scale while still managing to appreciate the different structures of different Mycenaean polities.

The sampled pottery assemblages have been subjected to an integrated, multi-technique analysis. This framework is employed to group pottery by fabric and chemical composition, reconstruct technologies of production and to identify places of pottery production and consumption within an archaeological landscape. Petrographic fabric and chemical compositional groups are evaluated against traditional typological information, including vessel shape and surface decoration, to assess the production locations and technologies utilised for various pottery types. Reconstructions of ceramic technology form units to gauge differences in technological practices that occur at different, contemporary places of production, thus providing a sense of organisation and structure. Reconstructing pottery technologies from broad assemblages from contemporary sites across the Saronic Gulf and subsequently determining their place of production, exposes a number of insights into the operations of Mycenaean economic systems.

4.2 Archaeological context

Samples were selected from sites within the Saronic Gulf with readily available ceramic material from either systematically excavated contexts or surface surveys with typologically diagnostic assemblages dating to Late Helladic IIIB, Late Helladic IIIB-transitional IIIC early and Late Helladic IIIC early[2]. Although sampling was mainly based on the availability of relevant contemporary material from the area of study, sample selection was guided by colleagues' meticulous typological study defined by morphological features and decorative traits coupled with macroscopic assessment of ceramic fabrics. The aim of the sampling strategy has been to select a representative sample of fabric types across a broad spectrum of vessel types from wide variety of archaeological sites that exemplifies many of the kinds of social activity that occurred across the archaeological landscape. The contexts of the selected sites vary significantly and include the remains of urban centres at the Athenian Acropolis[3] (Northeast ascent and Mycenaean Fountain) and Kanakia, to the small settlements of Dokos, Lazarides and Stiri, a port settlement at Kalamianos, ritual and cultic space at Ayios Konstantinos and Eleusis, burials from the Euripides' Cave and Lazarides and finally the industrial site at Kontopigado.

The transition from LH IIIB into LH IIIC early in Attica has recently been a topic of widespread interest as it provides a wealth of opportunities to understand regional variation of products, organisation and social structure during the period that marks the transition from the palatial period into a post palatial era (Mountjoy 1995a, 1997; Rutter 2003; Vitale 2006; Marabea 2012). In this light, the Saronic Gulf is a prime location as it offers several opportunities to study pottery assemblages from contemporary regionally distinct archaeological sites. Kalamianos, Stiri in Corinthia and Ayios Konstantinos in Methana were selected to represent the western shores of the gulf. Four sites were chosen from central Attica, including Eleusis, the Athenian Acropolis, Plaka and Kontopigado. Kanakia and Euripides' Cave on the island of Salamis, Lazarides on Aegina, with its settlement and burial contexts, were sampled from the Saronic Gulf island communities. Dokos represents the southern boundary and the connection with the Argolic Gulf and south western Peloponnese.

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[2] Material from Kalamianos and Stiri comes from surface collection. Without secure excavated context this material was dated according to stylistic typological elements including shape and decoration where possible.

[3] Evidence for a Mycenaean style palatial complex atop the Athenian Acropolis is based on the presence of cyclopean-type masonry below the Classical Temple of Athena Nike, a well containing pottery dating from LHIIB through LHIIIC-middle and the pottery excavated by Broneer (1933) from the North Slope deposit. Evidence for Mycenaean building complexes on the plateau of the Acropolis has been reconstructed (Hurwit 2000: 67, Figure 48; see Privitera 2013 for most recent reconstruction and dating) and was likely to have been removed during one of the many construction phases during the Archaic and Classical periods (e.g. the building plan of Pericles).

4.2.1 Chronology

The period of study for this thesis spans from LH IIIB through to Late Helladic IIIC early, roughly 1300-1130 BC, a period that marks both the height of Mycenaean culture and its eventual collapse. Since its initial split into LH IIIB1 and LH IIIB2, new studies and excavations have provided evidence to further divide LH IIIB2 (Vitale 2006: 178; see also Kilian 1988: 118; Mountjoy 1999a: 32, 1999b: 514) and the LH IIIC period is no different (cf. Vitale 2006; Middleton 2010: 9-14). Rutter (1977) introduced a series of criteria that would split LH IIIC into five phases with Phase 1 corresponding to the latest period examined in this thesis, LH IIIC early. Noticing some overlap of the ceramic shapes and decorative motifs from LH IIIC early, or Rutter's Phase 1 into LH IIIB2, Mountjoy (1995a, 1995b, 1997, 1999a, 1999b), specifically with three types of deep bowls, developed an alternative dating scheme suggesting that there must be a transitional phase leading from LH IIIB2 into LH IIIC early. The overlap between LH IIIB2 and LH IIIC early led Vitale (2006) to introduce the phase LH IIIB2 Late which is not part of the transitional period. Rutter (2003: 255) disagrees with the "transitional" aspect of Mountjoy's terminology and contends that LH IIIB2 concludes with the destruction horizons of the Argive palaces at Mycenae, Tiryns and Midea and any phase that follows forms the beginning of LH IIIC without the need for transitional phase. Demakopoulou (2003: 91) also rejects the addition of the new transitional LH IIIB2-IIIC early on the grounds that she can find no stratigraphic evidence for such a phase in Midea. She further states that overlap should be expected between LH IIIB2 and LH IIIC early as they are modern chronological constructs imposed onto past continuous traditions and cautions again the creation of a new chronological period based solely on changes in ceramic tradition (Demakopoulou 2003: 91).

In Attica, much of the evidence comes from the pottery form the North Slope and architectural features of the defensive system on the west end of the Acropolis (Broneer 1933, 1939; Iakovides 1962: 104; Wright 1994: 348). Broneer (1939: 349) believed that the Mycenaean Fountain was built in LH IIIB and was very short lived with the suggestion that it took approximately 25 years before the staircase began to collapse on itself due to the steep slope. The pottery from both the Mycenaean Fountain and the Northeast ascent has recently been restudied by Walter Gauss and Jeremy Rutter (Gauss 2003; Rutter 2003). Gauss (2003: 102) indicates that the Mycenaean Fountain was constructed in LH IIIB and fell out of use in LH IIIC Phase 1. Both Rutter (1977: 1-

2, 2003) and Gauss (2003: 102) contend that the purely Mycenaean levels of the Northeast Ascent are of LH IIIC Phase 1. Mountjoy (1997: 118-120; 1999a: 36-37) has dated this material to her transition LH IIIB2-IIIC early phase. As the debate stands, at least in Attica, it is clear that Mountjoy's transitional LH IIIB2-IIIC early and Rutter's LH IIIC Phase 1 are demonstrating identical chronological phenomena.

This compares well with the dating of the architecture of the defensive system on the Acropolis. Iakovides (1962: 104) originally dated these features, specifically the five terrace walls below the Classical Temple of Athena Nike, to LH IIIA1 to LH IIIA2 and Wright (1994: 348-349) contends that additions were built later in the established LH IIIB period. More recently, Privitera (2013) has re-dated the terrace walls in which Iakovides places his palace to approximately a century later, well into LH IIIC Phase 1, a sentiment in which Rutter concurs (2013). This later date matches well with the final use of the fountain house on the north slope and suggests that the end of the palatial period in Attica spanned from LH IIIB into LH IIIC Phase 1, much later than is witnessed in areas such as the Argolid and Boeotia.

At Kanakia, Marabea remarks that with the majority of the pottery assemblage originates from Aegina, Attica and Corinthia. Kanakia has deposits in the buildings on the acropolis that date to LH IIIB1, LH IIIB2 and LH IIIC early (Marabea 2012; for more detailed discussion on these pottery phases see French 1967, 2011; Kilian 1988; Mountjoy 1995a, 1995b, 1997, 1999; Rutter 1976; Thomas 2005). On neighbouring Aegina, deposits representing LH IIIA1 and later are barely visible at the Bronze Age settlement of Kolonna (Lindblom 2001: 129; Tartaron 2014: 234). The dating of the acropolis at Kanakia and the lack of LH III deposits at Kolonna adds further evidence to the notion in which the destruction and abandonment events in the Argolid that mark the end of the LH IIIB phase and dictate the chronological phases elsewhere on the Greek mainland ***do not*** coincide with similar acts of destruction and abandonment on Salamis, at Kolonna and in Attica (Kilian 1988; Lindblom 2001; Marabea 2012; Mountjoy 1997; Rutter 2003)**.**

In this thesis it has been impossible to select one chronological system for every site. The pottery was selected from assemblages designated as LH IIIB, LH IIIB1, LH IIIB2, transitional LH IIIB-IIIC early, LH IIIC early and LH IIIC Phase 1 by those that studied the material original, thus the attribution to the transitional LH IIIB-IIIC early, LH IIIC early and LH IIIC Phase 1 is dependent upon where the pottery was sampled. In the case of pottery assigned to either the transitional LH IIIB-IIIC early or LH IIIC

Phase 1 terms, it is clear that they are referring to the same chronological sequence. Although personally, I tend to use the system proscribed by Rutter, for purposes of clarity within this thesis will use the term “Late Mycenaean” as this terminology reflects each chronological phases mentioned above, from the acme of Mycenaean civilization in LH IIIB (1 and 2) through to the end and aftermath of the palatial period in LH IIIC early.

Ceramic Phase	Abbreviation	Reference	
Late Helladic IIIB1	LHIII B1	French 1967, 2011; Kilian 1988; Mountjoy 1995a, 1995b, 1997, 1999; Rutter 1977	Late Mycenaean
Late Helladic IIIB2	LHIII B2	French 1967, 2011; Kilian 1988; Mountjoy 1995a, 1995b, 1997, 1999; Rutter 1977	
Late Helladic IIIB2 Early	LHIII B2 Early	Stockhammer 2008	
Late Helladic IIIB2 Late	LHIII B2 Late	Stockhammer 2008	
Late Helladic IIIB-transitional IIIC early	LHIII B2-transitional IIIC early/LHIII B2-LHIII C early	Mountjoy 1995a	
Late Helladic IIIC early	LH IIIC early	Mountjoy 1995a, 1999	
Late Helladic IIIC Phase 1	LH IIIC Phase 1/Phase 1	Rutter 1977, 2003	

Table 4.1: Pottery phases and chronology of the Late Mycenaean period. Phases highlighted in orange refer to the same chronological period.

4.2.2 Sites

4.2.2.1 Plaka, Athens, Attica

The excavations at 4 Rangavas Street in the neighbourhood of Plaka were part of a rescue effort by the 1st Ephorate of Prehistoric and Classical Antiquities, the

Mycenaean material from which forms part of the on-going doctoral research at the University of Ioannina by Apostolos Papadimitriou[4], supervised by Professor Yannos Lolos. The excavated area lies underneath a newly constructed house on Rangavas Street, on the eastern slope of the Athenian Acropolis below the Cave of Aglauros. The excavation revealed continuous habitation from the Middle Helladic period through Byzantine times with extensive Mycenaean occupation dating to the LH IIIB and LH IIIC Early. The position of this site so near to the Acropolis suggests it is part of the urban fabric of the settlement of Mycenaean Athens. Papadimitrou (pers. comm, 2012) posits that Athens, during the Mycenaean period, was not limited to a small area centred near the Acropolis, but extended further to the east and south with the western limit at the ancient Street of the Tripods. It has emerged that the deposits of the Rangavas Plot, in addition to those in the adjacent areas to the south and southeast, are not isolated. Rather it appears that Mycenaean Athens was a large populated settlement which may have played the role of a major political centre in the region of Attica.

The sample consists of forty (n = 40) typologically dated ceramic sherds. It contains vessels of various shapes and sizes, coarse and fine. There are domestic vessels, including cooking vessels and other utilitarian kitchen wares, storage jars, water jars, and large tubs. This type of assemblage, with an apparent purpose to meet the toils of everyday life, present in an urban context below a topographic feature prominent in Mycenaean settings is of clear use for this study. Plaka represents only a small glimpse into the urban structure of Mycenaean Athens, yet offers substantial information about common consumption practices in an urban setting.

4.2.2.2 Acropolis, Athens, Attica

Unlike the extensive remains of major palatial sites that occur in the Argolid, Messenia, Lakonia or Boeotia to the north, the Acropolis at Athens bears little witness to such monumental construction. Indeed, the remains of Mycenaean activity on top of the Acropolis at Athens are limited with the greatest amount of attention directed at the West Entrance where there stands a wall of Cyclopean masonry dating to LH IIIB (Hurwit 2000: 80) and a large bastion sitting atop five terrace walls (Dinsmoor 1980; Iakovides 1962; Privitera 2013; Wright 1994) and the well deposits (more commonly

[4] All of the information concerning the Rangavas Plot and Plaka were provided via personal communication with the excavator, Apostolos Papadimitriou, now of the 21st Ephorate of Antiquities in the Cyclades at the Ministry of Culture, Education and Religious Affairs.

referred to as the Mycenaean Fountain) on the north slope (Broneer 1933, 1939; Hansen 1937). As mentioned above, Privitera (2013) has redated at least two of the terrace walls to LH IIIC Phase 1, suggesting that if a palace were to stand on the rock of the acropolis, it would have been erected much later than those in the Peloponnese to the west and Boeotia and Thessaly to the north. Hurwit (2000: 67, Figure 48) illustrates the location of all identified Mycenaean remains atop the acropolis, including the potential location of a megaron structure beneath the Erectheion.

The two defensive features coupled with other distinctive architectural features such as the large column base (Mountjoy 1995: 41-42; Iakovides 1983: 86-87) infer that not only was there a Mycenaean presence atop the Acropolis, but people were taking specific defensive measures much like those attested at the Argive citadels (Hurwit 2000: 79). That there is no evidence of fire or damage attributed to an attack of any kind perhaps means that no such invasion ever came to fruition. That the fountain on the north slope, probably built to gain access to water in case of such an invasion, went out of use only a few decades after its initial construction also suggests that the prospect of danger had ended by early in LH IIIC (Hurwit 2000: 82). Thus, unlike the citadels at Thebes, Pylos, Tiryns or Mycenae, the Acropolis was not destroyed at the end of the Bronze Age (Hurwit 2000: 82).

Whatever the condition of the citadel, the question still remains as to whether Attica can be considered a united political *state* during this period and if the seat of central power resided atop the acropolis at Athens. It has been suggested that Attica was not united until the very end of the Late Bronze Age and more localised ruling factions could have existed at places such as Thorikos in the east and Menidi approximately 10 km north of Athens (Hurwit 2000:79). Thorikos was a place of wealth that controlled the lead and silver ores of Mt. Laureion (Hurwit 2000: 79; Mountjoy 1995) and Menidi boasts a wealthy tholos tomb dating to LH IIIB. It therefore could be possible that there were several Mycenaeanised factions during this formative period in Attica. Whether or not Attica was under the rule of a single patron or ruled over by stronger neighbours, the construction on top of the acropolis and the implantation of defensive measures indicate that it too feared the destructive forces that worried the Mycenaean people in the Argolid (Hurwit 2000: 81).

The pottery sampled for this study was selected from the Fountain deposit (n = 3) and the North Slope excavations (n = 34) that occurred while trying to reach the well shaft from the bottom. Though representative of a refuse dump, both the Fountain and

North Slope deposits, this assemblage presents a means to look at the types of pottery used by those that inhabited or made active use of the acropolis during this particular chronological phase. Assuming that a Mycenaean palace stood atop the acropolis at Athens, this material is a pathway to characterising patterns of consumption practices in an elite context with what is likely the regional epicentre of Attica. This assemblage is likely to look different than those of smaller settlements and places of pottery production, but may pose some similarities to places of cultural significance, including those where cultic ritual occurred. This is the only assemblage related to Mycenaean elite in Attica thus promising the only present information about elite structure and organisation within this region in addition to relationships with other polities further afield.

4.2.2.3 Kontopigado, Alimos, Attica

Excavations by the 2nd and later 26th Ephorate for Prehistoric and Classical Antiquities of the Greek Archaeological Service under the supervision of Konstantina Kaza-Papageorgiou occurred as a result to the construction of the Alimos Metro station in the area of Kontopigado, Alimos. Kaza-Papageorgiou (2011: 265) notes that extensive residential and workshop remains dating to the Early and Late Helladic periods were discovered as result of this project. The workshop lies approximately 300 m south of the settlement and measures over 3000 m^2, however the extent of the site has not been fully excavated and it could be much larger. The sheer size of the workshop area puts it on par with the major works of the era (Kaza-Papageorgiou 2011: 266). The majority of the pottery from both workshop and settlement contain dating from the LH IIIA2 to the early LH IIIC period, coinciding with the material from the North Slope and Mycenaean Fountain deposits of the Athenian Acropolis, the Ayios Kosmas settlement and the Phaleron port (Kaza-Papageorgiou 2011).

Although no kiln has been found to date, among the LH IIIB2 to LH IIIC early material is a large amount of misfired pottery sherds, and part of an axle housing from the base of a potter’s wheel providing clear, primary evidence for pottery production at Kontopigado. Much of the material from the installation area was found in shallow wells, or pits, that line up on the sloping foundation of the workshop area. These pits are linked up with long channels cut into the bedrock and extend approximately 60-80 meters running the entire length of the site and beyond as the terminal points run into a major road. Kaza-Papageorgiou (2011: 266) suspects that these channels and pits were used in the retting stage of processing flax fibres to turn them into linen cloth. Lime and pigment found on some ceramic sherds suggests that other stages of flax linen production were also at work (Kaza-Papageorgiou 2011: 266).

The importance of Kontopigado is emphasized by its location, approximately five kilometres south of Athens' acropolis, and evidence for the production of both flax linen, a material well known for being connected to the political economies of Mycenaean elite elsewhere, and production of pottery. The role of linen production in Mycenaean palatial politics is fairly well understood through interpretations of Linear B inscriptions at Pylos and Knossos, the relationship between palatial elite and pottery production is much less understood. Thus the pottery assemblage from Kontopigado is of paramount importance to this project. With the primary production evidenced by misfired wasters, it is now possible to generate a reference group for Attic production that appears to have direct connection with the palatial elite from the Acropolis. The location and size of the Kontopigado production installation coupled with the presence of a flax linen processing make it difficult separate it with the political authority of Athens or polity of Attica.

Control over pottery, or any other craft production has been a major feature in the discussion of Mycenaean political economies and reconstructions of Mycenaean social structure. Kontopigado offers up a window of opportunity to investigate the relationship of pottery production and Mycenaean political economics from a local, regional and interregional perspective by tracing the extent of the pottery movement with the Saronic Gulf. Thus a representative sample (n = 129) of the entire pottery assemblage, including over fired kiln wasters, has been sampled for analysis. Further still, this assemblage enables a stable platform to reconstruct the technological practices employed by potters at Kontopigado giving new insight into Mycenaean pottery production as a whole.

4.2.2.4 Sanctuary of Demeter, Eleusis, Attica

The town of Eleusis sits near the southeastern boundary of the Isthmus of Corinth on the northern coast of the Saronic Gulf. This is the site of the Sanctuary of Demeter and the Eleusinian mystery cult of the Classical period. During excavations happening in the early 1930s a rectangular structure was uncovered beneath the Peisistratian Telesterion by Kourouniotes and his colleagues, Mylonas and Threpsiades

(Cosmopoulos and Ruscillo 2014: 257). The structure resembles that of a Mycenaean megaron style structure and has been dubbed "Megaron B" by the excavators. The completed building is dated to LH IIIB and consists of a roughly 6 by 10 m room with a portico extending nearly three meters path the interior wall and was accessed by two flights of steps on either side (Cosmopoulos 2014: 404; Cosmopoulos and Ruscillo 2014: 257). At the end of the portico stands a platform dating to LH IIIA1 and LH IIIA2 (Cosmopoulos and Ruscillo 2014: 257). Three more rooms were added in the LH IIIB1 period enclosed by a peribolos wall, thus finishing off what Cosmopoulos and Ruscillo (2014: 257) call the "Megaron B Complex" or "MBC."

Cosmopoulos (2014: 414-418) argues that, although earlier scholars were divided as to the function of the MBC, it has specific features that indicate a religious or cult use. The platform at the end of the portico has a distinctive Π-shape and presents a fairly large and raised flat surface, likely an altar of sorts. Cosmopoulos contends that it does not resemble any other retaining wall feature with the Sanctuary of Demeter and that the peculiar Π-shape makes it unsuitable for acting as such. Cosmopoulos and Ruscillo (2014) reconstruct this feature as an altar used in the ritual sacrifice of animals, particularly pigs as there is a large assemblage of burnt pig bones that were found on the ground beside the platform. Cosmopoulos (2014) argues further that there is a peribolos wall surrounding the MBC thus delimiting it as separate space from the surrounding area. These two features, an altar, with burnt animals bones found in its immediate vicinity and a peribolos wall present sufficient evidence to link the Megaron B Complex at the Sanctuary of Demeter to Mycenaean religious or cultic activity.

Pottery was selected from a mixed deposit that was dated to the LH IIIB and LH IIIC early periods through typological features, specifically surface decoration and shape (n=17). The pottery assemblage is comprised of vessels related to transport, serving and consuming liquids, and considering the context of the finds, were part of the ritualistic events that took place at Eleusis. As a place of cult or religion, Eleusis is distinct from other Mycenaean sites and thus it may play a different role in the wider economic fabric of society. There is no known place of pottery production at Eleusis, or even nearby. Previous study indicates that the site has been importing its cooking pottery from Aegina and other vessel types from both sides of the isthmus, northeast Peloponnese and Attica (Cosmopoulos et al. 1999). The pottery selected for this study enable a new glimpse into the consumption patterns of a place of Mycenaean cult, one of the least understood areas of Mycenaean studies.

4.2.2.5 Kanakia, Salamis

Kanakia is located on the island of Salamis at the northeastern corner of the Saronic Gulf between Corinthia to the west, the isthmus of Corinth to the north and Attica in the east. Kanakia lies on the southwest tip of the island. The main phase of the settlement dates to late in LH IIIB period with the settlement abandoned shortly after in LH IIIC early (Lolos 2010). The site is an on-going excavation that began in 2000 under the direction of Yannos Lolos from the University of Ioannina (Lolos 2003, 2005; Lolos et al. 2007). The settlement at Kanakia is extensive, reaching around 13 acres, and is comprised of a lower town and an acropolis with monumental buildings, defensive fortifications and an administrative building complex complete with a twin megaron structure (Lolos 2010). The site is set near two natural harbours, one in the Bay of Kanakia and the other in the Bay of Pyrgiakoni (Marabea 2007a) and has been identified by Lolos (2007, 2010) as "Old Salamis lying towards Aegina and the south winds" mentioned by Strabo in his *Geographica* (XI.1.9) and the location of the capital of the hero Ajax from Homer's *Iliad* (Lolos 2010: 37). Seated prominently on the southwestern tip of the island, this Mycenaean centre on Salamis may have acted as the administrative site of this Mycenaean polity and controlled sea traffic and trade.

This coastal settlement at Kanakia, though smaller than other contemporary centres, is a major settlement during the Late Mycenaean period. The location and character of Mycenaean Kanakia makes it a focal point in the Saronic Gulf. It has views of neighbouring Aegina, Attica and even the southeastern Corinthian coast. Marabea's macroscopic study of the pottery (2007b; 2010) indicates that much of the assemblage from the acropolis has been imported from its neighbours in Aegina, the northeast Peloponnese and Attica while other material, including a bronze ingot of Cypriot origin and the scale from a Near-Eastern style bronze corselet inscribed with an Egyptian cartouche spelling out the name of Rameses II in hieroglyphics, suggest links to further abroad (Lolos 2010). As Lolos (2010: 37) points out, the settlement at Kanakia provides a new lens to view the formation, control and structure of palatial power in the 13th and early 12th century BC.

With an explicit interest in expanding Marabea's earlier research on macroscopic fabrics of the ceramics from the acropolis sherds were selected for analysis (n = 105). Marabea's work (2010, 2012) corroborates this conclusion as she has tentatively identified the production origins of much of the fineware based on typological information and the cooking vessels, based on macroscopic fabric yet could not identify any locally produced. Pottery sampled from Kanakia has been suggested to provide insights into the structure and organisation of palatial power outside the Peloponnese in the Late Mycenaean period (Lolos 2010: 37).

4.2.2.6 Cave of Euripides, Salamis

Systematic excavation of a large cave in the area of Peristeria on Salamis, led by Yannos Lolos of the University of Ioannina in cooperation with the Ephorate of Palaeoanthropology and Speleology, has revealed several layers of human activity dating to at least five different periods of Greek prehistory and history, as early as the Late Neolithic, or around 5300-4500 BC to as late as the Frankish occupation of Greece, circa the 14th C. AD (Lolos 1998: 16). Lolos (1998: 16) states that there is an extensive presence during the Late Mycenaean period (c. 1400-1200 BC). The cave is ascribed to be the same used by the famous playwright Euripides during the 5th C. BC to write some of his tragedies?? (Lolos 1998: 16). It is located up a steep and rocky slope that looks onto the Bay of Peristeria with a small opening that leads down into a series of underground chambers (Lolos 2012). In Chamber 8, Lolos and his team discovered several burials of Late Mycenaean date with various objects including small bronze sword, bronze tweezers, steatite beads and buttons, rock crystal beads and ceramic vessels of various types, such as deep bowls (skyphoi), painted vases (Lolos 2012) and even coarse cooking vessels. The assorted drinking vessels, vases and cooking vessels are highly suggestive of a feasting event that took place as part of a burial or ancestor cult ritual (cf. Wright 2004).

The Euripides' Cave assemblage selected for analytic sampling (n = 21) is a fairly standard feasting assemblage for burials; however the location of the burials and the feast that took place during the ritual are not. The use of a cave for burial is peculiar for it is not a common cultural practice for the Mycenaean period (for details on Mycenaean burial practice see Cavanagh and Mee 1998; Boyd 2014). The macroscopic study suggests that the cooking vessels in addition to more fine vessels with ornate decorations are likely imported to the site and to the island of Salamis. This corresponds to the assemblage from Kanakia as not one sherd appears to be from a local production. Understanding where these vessels originate will provide some detail surrounding their social value and the relationship of where pottery is obtained and the practice of how it is used. Moreover, this assemblage is a useful means of comparing burial assemblages with other contemporary ritual and non-ritual assemblages from the Saronic Gulf.

4.2.2.7 Lazarides, Aegina

The small settlement of Lazarides is located 10 km from the port of Kolonna on top of a plateau in the central mountainous region of the island of Aegina. The settlement and burials have been excavated under the supervision of Panagiota Sgouritsa of the University of Athens since 2002. The settlement covers approximately 3500 m^2 of the plateau on which it sits and is comprised, thus far, of three building complexes dating from MH through to LH IIIC early (Morgan 2011). The site was occupied from the MH through to the Byzantine period (Sgouritsa 2010), but abandoned for a period at some point in the early 12th century BC for reasons unknown, as there are no signs of fire or destruction (Morgan 2011). The buildings are mainly domestic in nature with the finds indicating that some craft activity took place at a very localised scale.

Lazarides is a small island mountain hamlet that in its approximately four hundred years of occupation during the Bronze Age. Though not the economic hub that Kolonna was in its prime, Lazarides was clearly partaking in the trade networks of the Saronic Gulf and beyond (Sgouritsa 2012). There have been many metallic and stone objects discovered at Lazarides, some of which are quite rare for the LH IIIB and LH IIIC periods. Among these are eight lead objects from the cemetery, one group of Siphniote origin and the other, which includes an ingot, is from Lavrion in nearby Attica (Sgouritsa in Morgan 2011). Back in the settlement, a few discoid weights, a duck shaped lead weight in Cypriot or Near-Eastern style (Sgouritsa in Morgan 2011), a number of bronze objects and a seal stone have been found. The combination of these finds together in a small mountain hamlet in the middle of Aegina is very significant, and as Sgouritsa suggests in an unpublished field report, “The affinities of this rare [lead ingot] with weights from Cyprus and the Middle East, in contrast to the Aegean origin of the lead used, show that even minor Aegean settlements, as Lazarides, participated in the Mediterranean long distance trade network” (Sgouritsa in Morgan 2011).

While Siphniote lead objects and eastern style lead weights demonstrate that Lazarides had some role in long distance exchange, the lead ingot from Lavrion illustrates that communication and relations with neighbouring Attica were taking place as well. Pottery was selected for analysis from both the settlement and burial contexts (n

= 29)[5] in order to look at the role of a Mycenaean settlement, such as Lazarides, in the more local region of the Saronic Gulf. Unlike metal objects, pottery is a commonly found material and can provide more detailed information about small settlement consumption practices and how they procured the vessels that were used both on a daily basis in addition to the rituals associated with burial.

4.2.2.8 Korphos Kalamianos and Stiri, Corinthia

Surface survey, conducted as part of the Eastern Korinthia Archaeological Survey (Tartaron et al. 2006), uncovered remains of a sizeable settlement in Kalamianos, approximately 2.5 km southeast from the modern harbour town of Korphos, with walls and building foundations of Mycenaean type during the 2001 season (Tartaron et al. 2011). The finds instigated an intensive survey of Kalamianos and the surrounding region entitled "Saronic Harbors Archaeological Research Project (SHARP) under the co-direction of Daniel J. Pullen (Florida State University) and Thomas F. Tartaron (University of Pennsylvania). The site sits on the coastal lowlands of the western Saronic Gulf, with both steep, rocky cliffs and access to coastal plains and beaches with several small off-shore anchorages for small vessels (Tartaron et al. 2011: 562). Reconstructions of the ancient coastline by Tartaron et al (2011: 574-575) indicate that the small promontory, Akrotirio Trelli, was once connected to a bedrock outcrop that now lies under the waterline creating two shallow bays. During the Mycenaean period Akrotirio Trelli would not have been connected to the bedrock outcrop, but there would still have been several safe places for a ship to weigh anchor and transport goods back and forth from the mainland via smaller vessels (Tartaron et al. 2011: 574; Tartaron 2014: 244).

Over the course of three field seasons, SHARP documented over 50 structures and building complexes, hundreds of walls and other built features, nearly all of which date to the LH IIIB period (see Figure 11 in Tartaron et al. 2011: 275). Though some may be dated back to the LH IIIA period, there is a significant lack of material dating to LH IIIC, the posited *terminus ante quem* for the site (Tartaron et al. 2011: 275). Thus Kalamianos appears to be a thriving harbour town during the height of the Mycenaean period. The short span of habitation in the Late Bronze Age suggest to co-directors of the survey that Kalamianos was a planned community set on the coast of the Saronic

[5] NB: only decorated deep bowls, kraters and jars from Lazarides could be selected for analysis because they were the only vessels that could be securely dated at the time of sampling.

Gulf to provide access to its waters for more prominent Mycenaean communities further inland, namely the citadel at Mycenae in the Argolid (Pullen and Tartaron 2007; Tartaron et al. 2011: 628; Tartaron 2014: 262). Recently Tartaron (2014: 262) has argued that the settlement of Kalamianos was originally settled as by emigrants from Mycenae in the 14th C. BC who, over a few generations, built a harbour and developed the lands in the immediately surrounding area. Tartaron (2014: 262) admits that the connection to Mycenae is tenuous, having been derived through circumstantial evidence, yet suggests that there is enough evidence from architecture and pottery to substantiate his claim.

The SHARP survey expanded beyond Kalamianos into the immediately surrounding areas with significant finds in the area of Stiri. The Mycenaean settlement at Stiri is located on a ridge that overlooks the sea to the east and Kalamianos to the south. There are several building complexes with distinctive architectural features constructed in a similar manner as Kalamianos, but at 1.7 hectares, Stiri is only one fifth its size (Tartaron 2014: 258-259). Stiri is smaller and does not have the same monumentality of Kalamianos, though its central building boasts over 35 rooms, and it appears to have been constructed later with all of the recovered material dating securely to LH IIIB (Tartaron 2014: 259). Tartaron (2014: 259-262) suggests that the significance of Stiri lies in its location. From the site there is a continuous view of the main site at Kalamianos, however the extent of the viewshed extends to Methana in the south, Kolonna, Aegina to the southeast and even that of Kanakia on Salamis to the northeast and Attica further east thus being able to monitor sea traffic in much of the Saronic. This position perhaps allowed for signalling information back to Kalamianos or to Kolonna or Kanakia on the nearby islands. Opposite the sea, Stiri overlooks a large fertile basin to the west that has the potential for pastoralisation and other forms of agriculture (Tartaron 2014: 260).

There is sizeable evidence to indicate that the Korphos region, the area that encompasses Kalamianos and Stiri, must have played a significant role during the height of the Mycenaean period in Corinthia and the wider Saronic Gulf. It is clear that the production origin of the pottery is critical for connecting Kalamianos with the palatial centre at Mycenae and its relationship with the rest of the Saronic Gulf. Thus pottery was selected for analysis from both Kalamianos (n= 38) and Stiri (n = 8) to investigate further the production origins of the LH IIIB pottery assemblage. The resulting information is used to evaluate the claims of the SHARP project of being the harbour settled by emigrants from Mycenae in addition to characterising the ceramic ecology of both Kalamianos and Stiri. The dating of the sampled pottery assemblage was derived through typological information, including shape and decoration and with cooking pottery being studied by Debra Trusty, a PhD candidate at Florida State University under Daniel Pullen, only the fineware vessels were included in this thesis.

4.2.2.9 Ayios Konstantinos, Methana

The small Mycenaean village of Ayios Konstantinos is situated high on a ridge overlooking the southeastern coast of the Methana peninsula. The remains of the Late Helladic settlement were first discovered in 1990 by the 2nd Ephorate of Prehistorical and Classical Antiquities of the Greek Archaeological Service under the supervision of Eleni Konsolaki-Yiannopoulou. Methana itself is a small mountainous peninsula located on the southeastern coastline of the Argolic peninsula, north of the island of Poros (ancient Calauria) in the region of Troezenia. The excavated structures are found in the courtyard of the modern church of Ayios Konstantinos and Eleni in the southwestern part of the top terrace of the hill of Ayios Konstantinos and are part of the wider settlement (Konsolaki 2002). Tartaron (2014: 240) notes that Ayios Konstantinos had no access to the sea, unlike either Kalamianos or Kanakia, and therefore “probably supported an agropastoral community exploiting terrestrial resources and routes.” Pottery dates the structures to the LH IIIA to LH IIIB periods. It is pertinent to note that Konsolaki (2002) did not find a single LH IIIC sherd during the original study of this pottery.

Among the structural remains lie quite a remarkable sanctuary with a large hoard of figurines, a pig head rhyton, cauldrons, tripod cauldrons, kylikes, a triton shell and a number of other objects suggestive of ritual undertakings. Tartaron (2014: 240) suggests that this sanctuary is important for several reasons: it is located inconspicuously within a small coastal mountain village, the remains were discovered *in situ* allowing chronology, ritual space and action to be reconstructed and lastly, that the cult objects demonstrate local variability rather than chronological difference (cf. Hamilakis 2003; Hamilakis and Konsolaki 2004; Konsolaki 2002; Konosolaki-Yiannopoulou 2001, 2003). A study of the bones found in the ash deposits near the stone platform that held the majority of figurines revealed a number of burnt pig, sheep and goat bones, which has lead Hamilakis (2003; Hamilakis and Konsolaki 2004) to conclude that ritual animal sacrifice was taking place here. The wider significance of burnt animal sacrifices in the

Mycenaean period is argued elsewhere (Hamilakis 2003; Hamilakis and Konsolaki 2004; Konsolaki 2002; Whittaker 2008), however this context must be taken into context with the large round bottom and tripod cauldrons and other pottery that were found nearby.

Ayios Konstantinos presents a unique opportunity to study pottery from the context of cultic ritual which includes burnt animal sacrifices and ceramic objects used as part of the cult ritual, i.e. figurines. The cauldrons, round bottomed and tripod, from the cult building are much larger than the cooking pottery found in other archaeological settings, but appear to be made in the same macroscopic fabric as those known to be produced on Aegina. Though similar in shape, these cauldrons are much larger than any other cooking vessel observed throughout the course of this study suggesting that they may have been constructed specifically for the cultic ritual performed at Ayios Konstantinos. The constituent materials of the fabric, identified macroscopically, indicate that they were made from a red firing, micaceous clay with large gritty volcanic rock fragments. Linking these vessels to an Aeginetan production seems appropriate if, however, the Methana peninsula was not the remains of a now extinct volcano with nearly identical volcano-clastic and pillow lava formations as those found on Aegina (see Dorais and Shriner 2002; Dorais et al. 2004). Many of the cauldrons, a hand formed ceramic "offering table" and several other vessels (n=65) were selected for analysis as means to investigate their production origins and the links they pose to other areas on the Mycenaean Saronic Gulf. The cooking vessels are of specific interest here as recently Dorais et al. (2004) have suggested that Methana amphiboles are chemically distinguishable those of Aeginetan origin through microprobe analysis and that pottery can be sourced through this method. With no current evidence of pottery production occurring on Methana during the entire Bronze Age, this thesis will consider Dorais et al.'s hypothesis for local production of the cooking pottery against a direct comparison to cooking vessels of known Aeginetan origin. Additionally, the bovine figurines are of critical importance to this site and offer the opportunity to assess whether they are from a local production or were imported to take part in local ritual. Lastly, the pottery assemblage *in toto*, much like that of Eleusis, offers a chance to examine the consumption patterns and, more broadly, the regional and interregional relationships of a Mycenaean sanctuary.

4.2.2.10 Myti Kommeni, Dokos

Dokos, ancient Aperopia, is a small uninhabited island set between the coast of Hermionid, the southwestern tip of the Argolic peninsula and the island of Hydra at "the crossroads between the Saronic and Argolic Gulfs" (Lolos 1995:66). The island is most well-known for the Early Bronze Age shipwreck discovered by Peter Throckmorten of the Hellenic Institute of Marine Archaeology (HIMA) off of the point of Myti Kommeni in the mid-1970s (Papathanassopoulos 1990). Point Myti Kommeni is on the northeast side of the Bay of Skindos and is the location of a large LH IIIB settlement. The settlement, established in the EB II period, offers strategic control of sea traffic between the Saronic and Argolic Gulfs (Lolos 1995:69) for a ship would be forced to pass through the straight between it and the mainland coast. The Mycenaean settlement is relatively large, taking up the majority of the promontory and boasting a tripartite building complex, Building MK, of the Megaron type (Lolos 1995: 69, Lolos and Marabea 2004: 66, Figure 3). The finds from this building reflect that of a stone workshop with raw materials, partially finished objects, tool implements and debris all co-existing in the same room, subsequently name the Lapidary Room (Lolos and Marabea 2004:68). Other rooms of the MK building contained masses of unused red (Limonite and Haematite) and white (Lead) pigment, groundstone grinders and querns, obsidian blades, bronze, lead lumps and a few spindle whorls with a very limited assemblage of pottery (Lolos and Marabea 2004: 66-67). Lolos and Marabea (2004; see also Lolos 1995) suggest that Building MK is a small-scale and part time workshop. There are few raw materials located on the island itself, thus the craftsmen would have had to go to the Mainland or neighbouring Hydra in order to collect supplies. All of the pottery sampled for this study comes from Building MK (n = 10).

4.2 Ceramic Thin-section Petrography

Ceramic thin-section petrography comprises the recording of observations of mineralogical, petrological and textural features of ceramic fabrics through polarised light microscopy. The method of analysis employed here was originally borrowed from sedimentary petrology, subsequently Ian K. Whitbread (1989; 1995: Appendix III) proposed the use descriptive terminology developed for soil micromorphology to accurately describe observations concerning the three major features of a ceramic fabric, i.e. matrix, inclusions and voids, in systematic and detailed manner appropriate to the description of thin sections. In essence Whitbread proposed a formal language to communicate specific features in ceramic thin sections with a direct relationship to provenance, technology and other aspects cultural in nature, e.g. identity. Beyond this, the method is essentially derived from petrology where minerals and rocks are identified through their optical properties in order to place them within a geological landscape.

Thin sections of sherds are grouped into ceramic fabrics according to their inclusions, groundmass (matrix) and voids (Table 4.1) with additional notation concerning discrete textural features in the form of pellets, striations and amorphous concentration features. Observations are reported systematically in formal descriptions that are located at the end of this thesis (Appendix I). Fabric groups are subsequently compared to relevant reference material, where available, that may reflect regional production through mineralogical and technological features. If possible, fabrics are classified by geographic provenance for purposes of tracking the movement. Technical information is synthesized and again related to vessel types to observe any correlation between typological and technological characteristics. This process is completed for each site assemblage individually at first with a subsequent regional comparative study. Regional comparison of ceramic fabrics is used to generate an understanding of pottery movement in the Saronic Gulf and if possible the identification of regional production

Petrographic Grouping Criteria
• Mineralogical and petrological composition • Grain size, shape and distribution • Void shape, size and distribution • Groundmass texture and colour • Optical activity • Textural concentration features

locations and places of consumption.

Table 4.2: These criteria are the major components of petrographic groups according to Whitbread (1995). There are several other factors that may play a role in the final grouping decisions and they will be explained on a case by case basis in Appendix

4.3 Chemical Analysis

Neutron activation analysis (NAA) is used to generate elemental compositions of all analysed materials. Bulk composition studies are completed in two general stages of analysis: generation of elemental composition values and the manipulation of those values into meaningful archaeological groups through statistical processes.

4.3.1 NAA

The main operation of NAA is the bombardment of a sample with slow neutrons causing the transformation of the atomic nuclei of the present elements into unstable radioactive isotopes. Each isotope decays into more stable isotopic forms releasing gamma rays of specific energies. The energy released is characteristic of unique parent or constituent elements. The intensity of this energy is relative to the quantity of that specific element within a sample. The identification of gamma ray energies and the determination of their energies enable a quantitative and qualitative analysis of the respective sample to be made. The requirements to perform this analysis are a nuclear reactor to provide the neutron flux, the appropriate instrumentation to detect and measure the gamma ray intensities, a database comprised of relative gamma ray intensities for known elements and the detailed knowledge of the reactions that occur during the bombardment of neutrons on a specific material type (Kilikoglou et al. 2007).

The method of analysis is that used by NCSR Demokritos, Athens in collaboration with the Missouri University Research Reactor (MURR) at the University of Missouri, Columbia. Current protocol maintains that ceramic samples be cleaned of any potential contaminants, by removal of the surface layer, crushed and homogenised into a fine powder (Kilikoglou et al. 2007). Approximately 130 mg of powdered sample is dried and carefully weighed into polyethylene vials. Once sealed, the vials are subjected to one long irradiation of about 45 minutes to one hour in a reactor pool at a thermal neutron flux of approximately 6×10^{13} n $cm^{-2}s^{-1}$. Samples subsequently go through two stages of compositional measurement on a Ge γ-detector with an energy range calibrated to 80-1600 keV. The first measurement normally takes place after seven to eight days to quantify short-lived radionucleides (As, Ca, K, La, Lu, Na, Sb, Sm, U and Yb). Each sample is counted twice at one hour each count. The second count takes place after twenty days from the original irradiation for the longer-lived radionucleides (Ba, Ce, Co, Cr, Cs, Eu, Fe, Hf, Nd, Ni, Rb, Sc, Ta, Tb, Th, Zn and Zr). Samples in the second count are measured twice for two hours each. All of the above mentioned elements are typically measured in ceramic materials.

Several standardised reference materials are measured for the sake of precision and accuracy. The normal standards used are SOIL-7 from the International Atomic

Energy Agency (IAEA). Often this standard is combined with SRM-278 Obsidian Rock from the US National Institute of Standards and Technology (NIST). Calibrations of ceramic compositions are often carried out using the standards SRM 679 (brick clay, NIST), SL-1 (IAEA) and SRM 2711 (Montana soil, NIST). Demokritos uses two in house standards, the “Bonn standard” and the “Perlman and Asaro standard”.

NAA continues to be the most sophisticated and powerful elemental analytical technique that is applied to the study of archaeological ceramics. It has the capability to compile data for 40-50 elements simultaneously (Pollard et al. 2007:132). The major strength of NAA is its ability to measure both very high and very low concentrations of a wide range of elements with extremely high precision (Pollard et al. 2007: 132). The problem then lies in the need to process large quantities of compositional data, an issue that will be discussed in the following section. NAA has a long history in the analysis of archaeological ceramics in the Aegean, beginning with Sayre and Dodson (1957) and continuing to present day. The widespread use of this method has generated large databases of analyses and many inter-laboratory standardisations of methodologies and calibration calculations (Pollard et al. 2007: 132; for more on interlaboratory method and calibration comparisons see Hein et al. 2002a; Hein and Kilikoglou 2012).

4.4 Statistical treatment of data

Analyses of ceramic materials usually produce elemental concentration values for 33–34 elements. Some elements are present at or below the detection limits for neutron activation using our current procedures. If greater than 50% of specimens are missing values for a particular element or there is a significant problem in elemental variation, this element is removed from consideration in the analysis. Statistical analyses are carried out on base-10 logarithms of elemental concentrations. Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements, such as Na, and trace elements, such as the rare earth or lanthanide elements (REEs). Transformation to base-10 logarithms also yields a more normal distribution for many trace elements. Though the utility of log transformations is debatable, this step puts data of all factors (i.e. per cent, ppm, ppb) on a level playing field expressed as a logratio (Neff 1992; Buxeda i Garrigós 1999).

The interpretation of compositional data obtained from the analysis of archaeological materials is discussed in detail elsewhere (e.g. Baxter and Buck 2000; Bieber, et al. 1976; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000) and is only summarized here. The main goal of data analysis is to identify distinct homogeneous groups within the analytical database. The locations of sources can be inferred by comparing unknown specimens of ceramic artefacts to known geological or archaeological reference material. Production locations can also be deduced by indirect methods such as the “criterion of abundance” (Bishop, et al. 1982) or by arguments based on geological and sedimentological characteristics (e.g., Steponaitis, et al. 1996; Whitbread 1995). The ubiquity of ceramic raw materials, or clays, usually makes it impossible to sample all potential “sources” intensively enough to create reference groups for comparison to unknown ceramic specimens.

Before source determination can be determined, analysed specimen are generally formed into groups. Groups are viewed as clusters of data points in the compositional hyperspace described by the measured elemental data. Groups are characterized by the locations of their centroids and the unique relationships (i.e., correlations) between the elements. Decisions about whether to assign a specimen to a particular compositional group are based on the overall probability that the measured concentrations for the specimen could have been obtained from that group.

In order to form groups certain procedures are followed in order to observe the overall structure of the dataset. One technique for such exploration fundamentally estimates existing geochemical variability in compositional data by determining the total variation of the dataset (Kilikoglou et al. 2007). Following Buxeda i Garrigós and Kilikoglou (2003; see also Buxeda i Garrigós 1999), this method produces a series of variation matrices. The sum of the variances in each column of the matrix is examined and contributes to the total variation of the element in question which is then used as a devisor against all other elements (Kilikoglou et al. 2007). A high ratio indicates low variability (Buxeda i Garrigós 1999). In principle after the total variation has been estimated for an entire assemblage, the distribution of the total variations should provide a preview of the number of expected groups in the dataset (Buxeda i Garrigós and Kilikoglou 2003; Kilikoglou et al. 2007). Following Buxeda i Garrigós and Kilikoglou, once all of the total variations in each assemblage has been calculated, the variance matrices were calculated for a random number of randomly selected samples from the original dataset. These were then used to model the distribution of the total variation within entire assemblages and again for all assemblages in this study (Buxeda i Garrigós and Kilikoglou 2003).

Other methods for data exploration use pattern recognition techniques that can be applied to multivariate data. These techniques include cluster analysis (CA), Principal Component Analysis (PCA) and Discriminant Analysis (DA). Each technique has its advantages and disadvantages that may depend on the type and quantity of available data. The variables, or measured elements, in ceramic datasets are frequently correlated and often large in number. This makes handling data and interpreting patterns rather difficult. Therefore, it is often useful to transform the original variables into a smaller set of uncorrelated variables in order to make data interpretation easier. PCA is a technique that transforms from the data from the original correlated variables into uncorrelated variables most easily.

Principal components analysis creates a new set of reference axes arranged in decreasing order of variance subsumed. The individual PCs are linear combinations of the original variables. The data can be displayed on combinations of the new axes, just as they can be displayed on the original elemental concentration axes. Generally, compositional differences between specimens can be expected to be larger for specimens in different groups than for specimens in the same group, and this implies that groups should be detectable as distinct areas of high point density on plots of the first few components.

Principal components analysis of chemical data is scale dependent, and analyses tend to be dominated by those elements or isotopes for which the concentrations are relatively large. As a result, standardization methods are common to most statistical packages. A common approach is to transform the data into logarithms (e.g., base 10). As an initial step in the PCA data are transformed into log concentrations to equalize the differences in variance between the major elements such as Al, Ca and Fe, on one hand and trace elements, such as the rare-earth elements (REEs), on the other hand. An additional advantage of the transformation is that it appears to produce more nearly normal distributions for the trace elements.

Using transformed data, the next step is to evaluate and define group membership of individual data points and data clouds formed using PCA biplots and elemental bivariate plots (Baxter 1992). One way to do this is through estimating the distance between points in a three dimensional space. This provides an estimate of the inclusion or exclusion of a datum on the simple idea of being similar of dissimilar

(Kilikoglou et al. 2007). Most laboratories suggest that the Mahalanobis distance is the most efficient method for estimating similarity because it takes into consideration the inhomogeneous nature of ceramic materials in addition to statistical errors (Bieber et al. 1976; Beier and Mommsen 1994). Mahalanobis distance is a generalized distance that makes it possible to describe separation between groups or between individual data points and groups on a multitude of dimensions. The Mahalanobis distance of a sample from a group centroid (Bieber et al. 1976; Bishop and Neff 1989) is defined by the equation:

$$D^2_{y,\,x} = [y - \bar{X}]^t \, I_x \, [y - \bar{X}]$$

where y is the 1 × m array of logged elemental concentrations for the specimen of interest, x is the n × m data matrix of logged concentrations for the group to which the point is being compared with X¯being it 1 × m centroid, and Ix is the inverse of the m × m variance–covariance matrix of group x. Because Mahalanobis distance takes into account variances and covariances in the group of multivariate data, it is similar to expressing distance from a univariate mean in standard deviation units. Like standard deviation units, Mahalanobis distances can be converted into probabilities of group membership for individual specimens. However this method requires a large dataset. In the case of a dataset too small to apply Mahalanobis calculations, it may be better to apply a modified method of Euclidean distance squared (Kilikoglou et al. 2007).

Lastly, once groups have been fixed, it can be useful to submit the data to a “best relative fit” test (Harbottle 1976; Beier and Mommsen 1994; Hein et al. 2002a; Mommsen and Sjöberg 2007). This procedure adjusts for particular differences between two individual datasets by examining datasets for variation in elements related to specific phases of ceramic technology. In other words, one can use this technique to correct for any variation introduced through the addition of tempering materials or natural variability that occurs within any number of production events, that is if such dilution effects can actually be quantified. Though it is impossible to take out the human action of creating the ceramic by statistically correcting for the variation in inclusions within a ceramic matrix (*contra* Steponaitis et al. 1996), the best relative fit calculation strengthens the precision of defined compositional groups.

4.4.1 Data mining

Data generated by NAA will be inducted into the ceraDAT relational database for archaeological ceramics hosted by NCSR "Demokritos" (cf. Hein and Kilikoglou 2012). Using the statistical model described above, samples from this study will be compared with large numbers of archaeological ceramics in the attempt to mine potential locations of production for samples whose provenance cannot be identified by other means. The ceraDAT database is composed of nearly all published studies of ceramic analysis in the Aegean and eastern Mediterranean, thus allowing for data to be compared to previously analysed material in ways that have not been available until recently (Hein and Kilikoglou 2012).

4.5 Scanning electron microscopy

Scanning electron microscopy (SEM) is a useful tool for observing microstructural features of ceramic fabrics. The analytical protocol in ceramic technology studies is two-fold. The first stage is an assessment of equivalent firing temperatures reached during the firing stage of a production sequence. The second phase is assessing the types of materials used, how they reacted to the firing process in order to reconstruct the technologies involved in production of decorative materials and their application to pottery. The following is a description of the analytical protocol employed in this thesis.

4.5.1 Firing Conditions and Equivalent Firing Temperatures

This protocol for studying ceramic firing conditions has been explained in detail elsewhere (Tite and Maniatis 1975; Maniatis and Tite 1978; Maniatis and Tite 1981; Kilikoglou 1994; Shaw et al. 2001), though there are discrepancies in both terminology and data reporting methods. Thus, this section puts in one place all of the necessary stages of the analytical procedure for future reference. Terminology is explicitly defined with visual descriptions of vitrification development in ceramic material in association with meaning in archaeological contexts. Further to this, certain images have been included to demonstrate the relationship between firing atmosphere, calcium concentration and various stages of vitrification which are in turn used to estimate the equivalent firing temperature[6].

[6] A note of caution: nearly all clays react slightly different when heated to temperatures needed for the vitrification process to occur. The best method is to record the degree of vitrification in the

The stages of vitrification development are observed as temperature increases in a specific ceramic type. A microstructure that does not exhibit any sign that the vitrification process has begun is described as non-vitreous (NV) with an equivalent firing temperature estimate of <750°C in reduction atmosphere and <800°C in an oxidising conditions irrespective of calcium concentration. The initial stage of vitrification (IV) is very similar in both calcareous and non-calcareous ceramic materials with typical firing temperatures occurring in the 800-850°C in an oxidising atmosphere. After the initial vitrification stage, the abundance of calcium in the compositional matrix is significant in the final estimations of firing temperatures as non-calcareous ceramics tend to vitrify at lower temperatures in both oxidising and reducing atmospheres. Calcium is measured semi-quantitatively by EDS or EDAX.

For non-calcareous clays, those with <6% CaO (Tite and Maniatis 1975) content in the clay matrix, isolated areas of the fracture surface exhibiting initial vitrification will have expanded as temperature is increased. Though this is the case with all ceramics, the difference between initial vitrification and continuous or total vitrification in non-calcareous matrices is only 150°C (Maniatis and Tite 1981). Firing in a reducing atmosphere lowers the temperature ranges approximately 50°C and at the extensive vitrification stage (V) fine bloating pores will be introduced into the matrix. The reducing of temperatures for the melting stage in a reduction atmosphere is due to the equilibrium phase relationships of the stable crystalline phase in the ceramic matrix (Muan 1957; Naslund 1976). In a reduction atmosphere, minerals with lower melting points, such as fayalite, act as fluxing agents to form a glassy microstructure. Whereas in oxidising atmospheric conditions the crystalline phase is more ferrous causing a higher melting point and thus raising the temperature at which vitrification occurs (Maniatis and Tite 1981). Total vitrification is reached at above 950°C in oxidising and between 900-1000°C in reducing atmospheric conditions. This stage is reached when equilibrium of vitrification across the fracture surface is observed. Bloating pores are likely to be present, with size dependent upon both mineralogical composition and firing atmospheric condition.

Atmospheric conditions are determined by the colour of body, core and decoration. Reddish and brown body colour is used to indicate an oxidising atmosphere (O) where a buff or grey coloured body indicates a mixed or reduction atmosphere (R).

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archaeological sample and subsequently subject the same sample to a series of re-firing experiments to observe any changes in the level of vitrification. This will give the most accurate results.

Dark coloured decoration on light bodies indicates an oxidation-reduction-oxidation firing regime (ORO). Temperature estimates are lowered by approximately 50°C because the advancement of the vitrification is probably a result of FeO present in in the matrix which acts as a flux (Maniatis and Tite 1981: 61; Shaw et al. 2001: 120).

It has been shown that, on a general scale, ceramics with higher calcium concentrations reach the vitrification stage at higher temperatures (i.e. Tite and Maniatis 1975; Maniatis and Tite 1978; Maniatis and Tite 1981; Kilikoglou 1994). Maniatis and Tite (1981:65) indicate that the presence of calcium alumina-silicates, such as anorthite and gehlenite, and calcium/magnesium silicates, including diopside and wollastonite, inhibit vitrification through the formation of crystalline structures with high-temperature melting points. This presents a problem in that the stable extensive vitrification stage (V) ranges for about 200°C, from 850-1050°C (see Table 4.2).

Equivalent firing temperatures are reported as estimates (Maniatis and Tite 1981) and are used as qualitative data in assessing patterns of firing technology present in ancient ceramic production sequences. These patterns are compared to petrographic and chemical groups in order to interpret the kinds of pyrotechnology that were used in the manufacture of a particular ceramic fabric. Fabric groups dominated by NV but range into higher levels of vitrification can be suggestive of a low degree of control over the firing process. Conversely, fabrics that demonstrate a high degree of vitrification across a single fabric may represent extensive knowledge of pyrotechnology firing and control over the firing event of a production sequence.

Relationship of Vitrification Stage to Estimated Equivalent Temperature and Atmosphere					
Vitrification Stage	Abbrev.	Temperature range NC-O, ˚C	Temperature range NC-R, ˚C	Temperature range C-O ˚C	Temperature range C-R, ˚C
No Vitrification	NV	<800	<750	<800	<750
Initial Vitrification	IV	800-850	750-800	800-850	750-800
Extensive Vitrification	V	850-950	(FB) 800-900	850-1050	850-1050
Total Vitrification	TV		(FB) 850-950 (MB) 900-1000		
Key: NC: Non-calcareous matrix (>6% CaO); C: Calcareous matrix (<6% CaO); O: Oxidising firing atmosphere; R: Reduction firing atmosphere; FB: Fine bloating pores (0.2-4μm diameter);					

MB: Medium bloating pores (2-10μm diameter).

Table 4.3: An explanation of the stages of vitrification and their relationship to ranges of firing temperatures in different atmospheric conditions. Based on Maniatis and Tite (1981) and Kilikoglou (1994).

4.5.2 Surface modification

Examination of the microstructure of the vessel surface requires observation of the degree of vitrification of the surface decoration. The differential shrinkage between body and surface leaves a gap which can lead to flaking of the decoration over time. Sintering and vitrification are related characteristics in that sintering is the densification of particles into a coherent mass through heating without melting (Tite 1969: 131) and vitrification is the transformation of silica-rich material into glass. Sintering indicates a fine layer of densely packed clay particles in the form of a colloidal solution (i.e. slip or paint) and vitrification is the process in which this layer is transformed into a semi-solid glass. In other words, the identification of a sintering layer (Figure 4.1) indicates the presence of a decoration layer. Vitrification of the sintering layer is observed in the microstructure, grain size and the presence of bloating pores (Figure 4.2). Kilikoglou suggests that the overall quality of the decoration is linked to the potter's ability to control firing temperature (Kilikoglou 1994; Shaw et al. 2001:123-4). Temperatures of over 800-850°C are needed to vitrify the sintering layer and create paints of a high quality. Consistent patterning of vitrified paint layers are used to assess whether this result was the intent of the potter or not. However in the case of undecorated pottery of the same fabric fired to consistently low temperatures, as they were in the study of the Kommos kiln in south east Crete (Shaw et al. 2001), suggests that temperature variation was intentional for the decorated vessels and not for those undecorated. For this reason the equivalent firing temperatures of undecorated pottery with the same fabric as decorated vessels are compared.

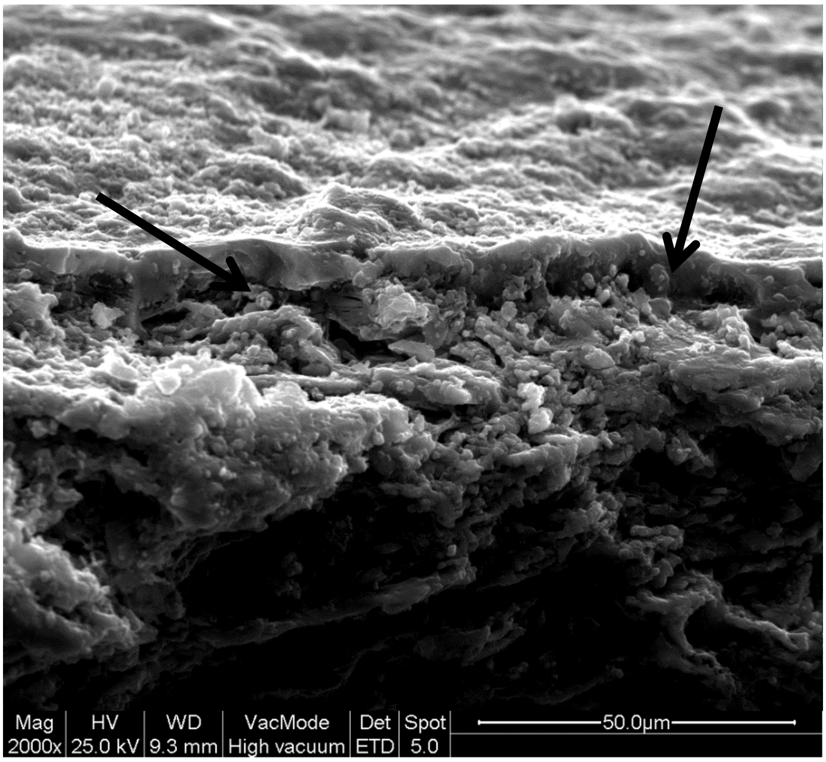

Figure 4.1: The sintering layer, in this case, is observed as the thick solid layer above the porous body layer. The gaps indicated by the arrows are due to shrinkage of both the sintering and body layers when fired. These gaps are relatively fine and do not affect the adhesion quality of the decoration.

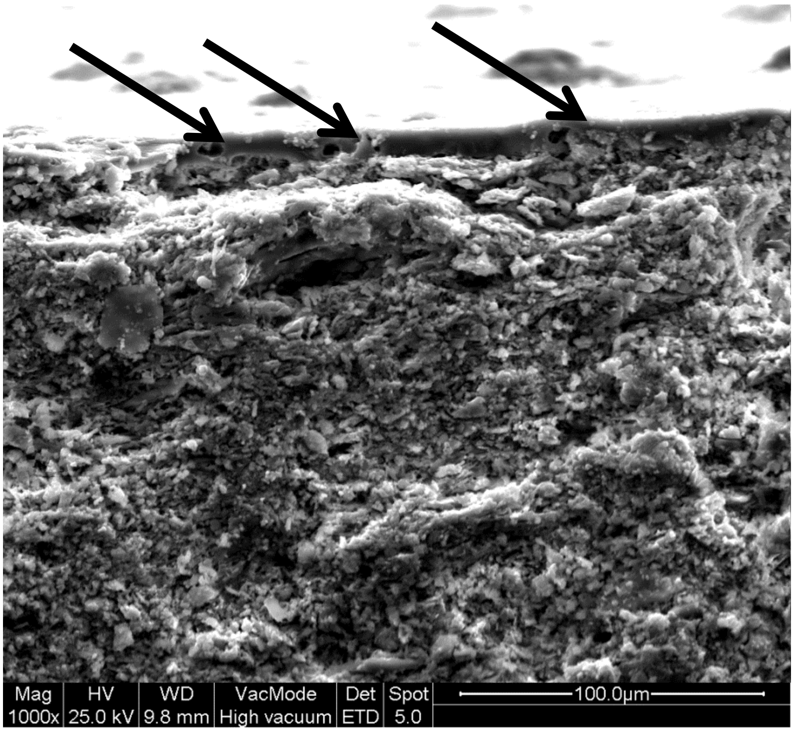

Figure 4.2: Bloating pores in the sintering layer indicate extensive to near total vitrification.

The first stage of analysis begins while examining the vitrification of the body and the vessel surface. If paint or slip is present, the vessel surface is analysed to obtain semi-quantitative elemental concentrations by EDS or EDAX attached to the SEM unit. The resulting spectrum is compared to a spot of analysis of the ceramic body to qualitatively distinguish whether they are constructed from the same or similar raw materials. Special attention is paid to the levels of Iron (Fe), Calcium (Ca), Aluminium (Al), Potassium (K) and Manganese (Mn). Noll (1978) demonstrated that a manganese based pigment is needed to create black decoration in an oxidising firing atmosphere. Iron-rich black paint has been observed in several archaeological contexts and has been shown to be the result of a reducing atmosphere. However, an iron-rich black found on top of a light coloured background is much more difficult to achieve. Through extensive experimentation it was discovered that this phenomenon is the result of an oxidation-reduction-oxidation firing sequence (Noll 1978; Aloupi and Maniatis 1990; Maniatis et al. 1993; Kilikoglou 1994). Thus in the case of black or brown paints it is necessary to identify the type of pigment used through chemistry. Noll et al. (1978) has indicated that the high degree of vitrification and thus the glossy nature of iron-rich black paint is due to the high amounts of FeO and K_2O which act as fluxing agents in the silica-rich clay sediment. The chemistry and microstructure of the decoration, combined with a macroscopic study of the vessel surface, are sufficient to recreate a large portion of the chaîne opératoire of vessel decoration. Paints and slips are generally clay-based colloidal mixtures which are the result of potters processing out impurities before separating the finest clay grains and suspending them in water. Unfortunately this reductive process makes it difficult to locate the source of the raw materials, though not impossible (cf. Duwe and Neff 2007).

4.6 Summary

Over the course of this chapter I have laid out the programme of analysis starting with the regional, temporal and contextual constraints, moving forward into the selection of the material and lastly, a description of the analytical techniques and their applications. Though not a step-by-step protocol, this description of the analytical process provides the necessary background to consider the kinds of topics and questions overviewed in Chapters Two and Three. The key to this programme is not the application of one single technique, rather it is the *integration* of all the techniques introduced here that provides enough information to create the kind of robust ceramic analysis that allows for both reconstruction of technical practice and tracing the movement of pottery over regional space. Though each technique runs independent of each other, the information gained at each analytical stage is beneficial to the one that follows. Once integrated, the resulting data are much stronger than those from a single technique.

Chapter Five: Geology and the ceramic landscape in the areas surrounding the Saronic Gulf

5.1 Introduction

Studies of geology and archaeology often overlap and this is certainly true in attempts to reconstruct pottery technology and provenance determination. Reconstructing pottery production technology and determining the location of production origins requires some knowledge of the types of raw materials available to the potter. Very briefly, pottery is made from a mixture of earth and water that is heat treated. Here, earth refers to the soils and sediments that become suitably plastic and malleable when mixed with water. "Clay" is the dominant term used to describe the types of earth used as ceramic raw materials, however the term "clay" in geology is a reference to a sediment with a grain size less than 4 micrometers in diameter according to the Wentworth Scale (Krumbein 1937). It is often the case that the sediment used to make a ceramic object does not match the grain size criteria needed to be defined as a clay. Thus, attempting to locate the raw materials used in pottery production within a geological landscape mapped and described by geologists requires caution. This is highlighted in discussion with traditional potters about the kinds of earths (sediments) they use to construct their pottery (e.g. Day 2004; c.f. Gifford and Myer 1984). Ethnographic research of this kind has indicated that potters often mix different types of soils and other sediments, creating a mixture that is not likely to be found naturally in geological deposits. Rather, the recipe for any given ceramic paste is the result of cultural process and raw materials used in this paste are often difficult to separate with enough clarity to determine a specific source location in geographic space.

On the other hand, using the methods described in Chapter 3, it is possible to determine the geological conditions which contribute to the components of a specific paste recipe. Mineralogy, geochemistry and knowledge gained from ethnographic research on pottery production may be used to determine the general location of a potential production facility in a landscape (e.g. Day et al. 1999). Knowing that the raw materials of ancient production are difficult to locate in a modern landscape, if they were not exhausted in the past, it has proved more useful to narrow down the search for places of production rather than geological deposits. In cases where places of production have yet to be discovered or are no longer visible archaeologically, they can potentially be "sourced" to a specific landscape through a comparison of local and regional geologies with the rock and mineral composition of the ceramic paste. Ideally, this process involves direct comparison with geological reference material, however this is not always necessary, especially in areas such as Greece that have a diverse geological composition.

5.2 The Saronic Gulf

The Saronic Gulf is located between the northeastern border of the Peloponnese, the western border of Attica and capped on the northern side by the Isthmus of Corinth that links these two regions. This body of water is rich in history from all periods of human occupation on the Greek mainland. Its waters have been a plentiful resource for food, raw materials and a means of transportation for both people and goods between central Greece and the Peloponnese. The topography and seascape of this region enables a unique network of intervisible islands and landforms, promoting a sense of connection for its many inhabitants. It was probably this intervisibility that led people to explore the islands and shores only to discover the many natural resources that have been so key to the development of this region and its respective civilisations. With such a long history of pottery production on all sides of the Gulf, especially in the later Archaic and Classical periods, it is worth noting that the abundance of pottery production and distribution during the Mycenaean period was not a unique phenomenon. In fact there is evidence to show that the Saronic Gulf was clearly a major transport route for people and trade alike, from at least the Neolithic onwards.

Iconography from wall paintings and on pots, small ceramic models of what are interpreted as boats and systematic excavations of shipwrecks all provide evidence for Bronze Age seafaring, and it is the sea that appears to be the main connection between social groups around the Saronic (Tartaron 2014). Looking at the evidence from the shipwrecks at Uluburun (Bass et al. 1989; Pulak 1998) and Cape Gelidonya (Bass 1973, 1991) in the north eastern Mediterranean and more locally with those at Point Iria (Phelps et al. 1999) and Modi (Agouridis 2011), pottery appears to be a significant part of sea travel during the LH IIIB period, both as a commercial commodity and transport container. Under the premise that pottery was transported on some form of sea craft, this chapter explores several geographic areas surrounding the Saronic Gulf the focus of this study.

This thesis will identify areas or locations of pottery production and the distribution around the Saronic Gulf of their products. In order to develop what could be termed an economic picture of active producers and consumers of the region, it is necessary to set up the basis for identifying this movement. Ultimately that involves assessing the compatibility of any given pottery fabric with its find spot, creating groups of similar composition and comparing these with regional geology. This chapter presents the geological landscape of the areas surrounding the Gulf in order to construct a geological backdrop for the comparison and interpretation of the pottery analyses in this study.

5.3 Regional geology and the location of suitable raw materials for pottery production

Pottery production requires natural resources in the form of workable clay-rich materials, tempering agents – including other clay-rich materials, water and fuel. Except for water and fuel, these materials are to be found in geological deposits. Greece is widely known for the production of ceramics in all time periods; and it is clear that it hosts geological environments rich in sediments suitable for pottery making. Attica, Corinthia and the Argolid, all areas that surround the Saronic Gulf, are three of the more prominent areas known for pottery making in antiquity; the most notable areas being surrounding Corinth and Athens in the Archaic, Classical and later antique periods. In the Middle and Late Bronze Age, Mycenae in the Argolid and the settlement of Kolonna on the island of Aegina are well known as prominent pottery producers. As the geology of the areas surrounding the Saronic Gulf host suitable raw material for ceramic production, this section explores its geological character in order to suggest the location of raw material sources. This information will be compared with the subsequent mineralogical and chemical analyses of the ceramic samples from this study.

5.3.1 Attica

The Attic peninsula (Figure 5.1) makes up the lower part of the Pelagonian isopic zone. This zone is formed mainly of shallow water limestone deposited during the Triassic and Jurassic periods. This zone extends into the Attic-Cycladic metamorphic belt (massif) to the south where the oldest forms of rocks are schist, gneiss and granites (Higgins and Higgins 1996: 18). There are four mountains in Attica, Aigaleos, Parnes, Penteli and Hymettos and all are rich in limestone, but Penteli and

Hymettos are much better known for the white marble deposits used in much of the construction of the Acropolis and city of Athens (Pike 1996). As with much of Greece, Attica has a geologic structure that is dominated by nappes formed during the compression movements of the Alpines (Higgins and Higgins 1996: 26). In the highest of this nappe series are the limestones of Aigaleos and Parnes to the northwest, to the south the nappe is formed of schist, chert and ophiolites, these are overlain by both metamorphosed and unmetamorphosed limestones and flysch sediments of the Cretaceous and Eocene age (Higgins and Higgins 1996: 26). The calcareous marls of the uppermost part of this nappe are what are often referred to as “Athens Schist” (Marinos et al. 1971; Papadopoulos and Marinos 1992). Athens schist is not a true schist, but is more generic term given to the flysch deposits of the lower Athens basin. Formed in the Upper Cretaceous, the Athens Schist is formed of clay-rich schists and phyllites, mica schists, sand stones with limestone lenses and ophiolitic masses (Papadopoulos and Marinos 1992: 111). The mountainous formations ceased to build during the Neogene and subsequently erosion and faulting began to form basins which were subsequently flooded by the sea. These basins were deposited with sandstone, shale, clay and limestone (Higgins and Higgins 1996: 26).

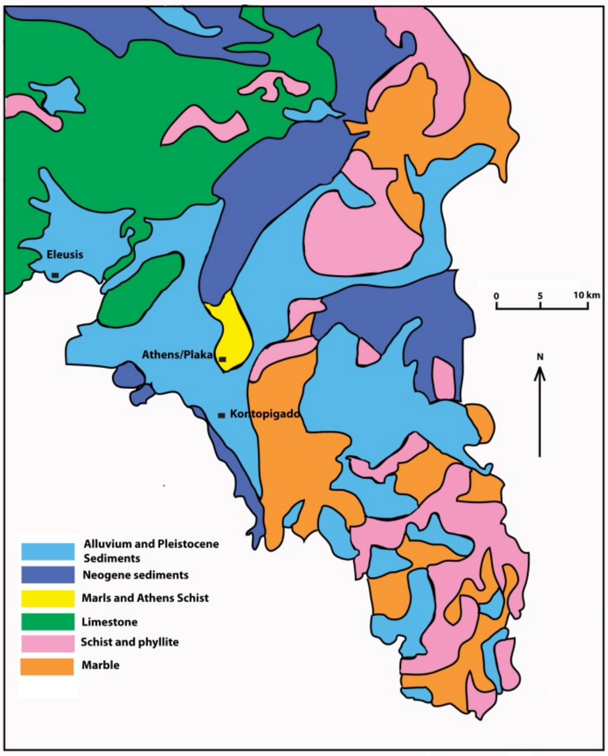

Figure 5.1: Geological map of Attica (after Higgins and Higgins 1996).

5.3.2 Corinthia, the Argolid and Methana

Across the Saronic Gulf from Attica is the Argolic peninsula, a landmass that makes up the northeastern corner of the Peloponnese. At the north of the peninsula is the region of Corinthia which borders a gulf by the same name and connects the Peloponnese to the rest of Greece via a narrow isthmus. South of the Corinthia is the region of the Argolid which comprises the majority of the entire peninsula. At the southern tip of the Argolid lies the area of Troezen where the smaller volcanic peninsula of Methana is attached. The Argolic peninsula is split by two isopic zones, the eastern most part of the Argolid and the majority of Corinthia is underlain by the Sub-Pelagonian Zone while the remainder of is formed by the Parnassos zone. Everything to the west of the Argive plain and the Gulf of Argos, also part of the Argolid, is formed by the Pindos Zone (Higgins and Higgins 1996: 19). The Sub-Pelagonian is made up of Triassic to Jurassic grey limestone and cherts that are associated with the ophiolites of this region. The Parnassos zone only crops out in this region of central Greece; the majority of the limestone here was formed mainly during the Triassic to the Palaeocene when the area was flooded by shallow seas. In later, much drier periods, tropical weathering produced bauxites which later formed the flysch deposits known in Troezinia (Higgins and Higgins 1996: 19). The Pindos zone crops up through central Greece and is mainly composed by deep deposits from the early formation of the earth's crust (Higgins and Higgins 1996: 19).

5.3.2.1 Corinthia

Corinthia (Figure 5.2) makes up the northeastern most part of the Peloponnese, connecting this peninsula to Attica and the rest of Greece through an isthmus. Ancient Corinth sits to the southwest of the isthmus, directly south of the ancient city lays the acropolis of Acrocorinth. To the north, land descends into the coastal plain through a series of terraces (Whitbread 1995: 261; see also Salmon 1984: 21). This region sits astride both the Sub-Pelagonian and Pindos isopic zones. It is characterized by generally sedimentary lithologies of dating to the middle Triassic and lower Jurassic periods interspersed with Pleistocene and Neogene sediments (Siddall In prep: 26-27; Whitbread 1995: 261). The Sub-Pelagonian zone contains shallow to moderately deep marine limestone and terraces of interbedded shale, chert and volcanic rocks (Siddall In prep: 27). This zone has not undergone deep burial events and thus there are no metamorphic rocks in the area (Siddall In prep: 26). Siddall (In prep: 27) notes that included in these beds are cuts of oceanic floor that have been thrust up and placed by tectonic movements. These are the ophiolite series that consist of serpentinites and extrusive igneous rocks (Siddall In prep: 27). The limestones make up the oldest geological deposits of the region and form the mountainous area of the region, Geraneia to the north of the isthmus, Acrocorinth and Penteskouphi in the center, the Oneia ridge running east-west to the east of Acrocorinth and Mt. Arachnaion in the south (Yannetakis et al. 1972; Papavassiliou et al. 1984a; Whitbread 1995: 261). The outcrops of ophiolitic rocks occur in the Middle and Upper Jurassic formation in the centre and western parts of the Geraneia Mountains (Whitbread 1995: 261; Yannetakis et al 1972). Found in association with the ophiolites are shale-sandstone-radiolaria deposits consisting of serpentinite, volcanic lavas, tuffite, sandstone, siltstone, shale and radiolarite (Whitbread 1995:261). Whitbread (1995:261) contends that these formations crop out at Ayioi Theodhoroi, Acrocorinth, Penteskouphi and the mountains near Arachnaion to the South.

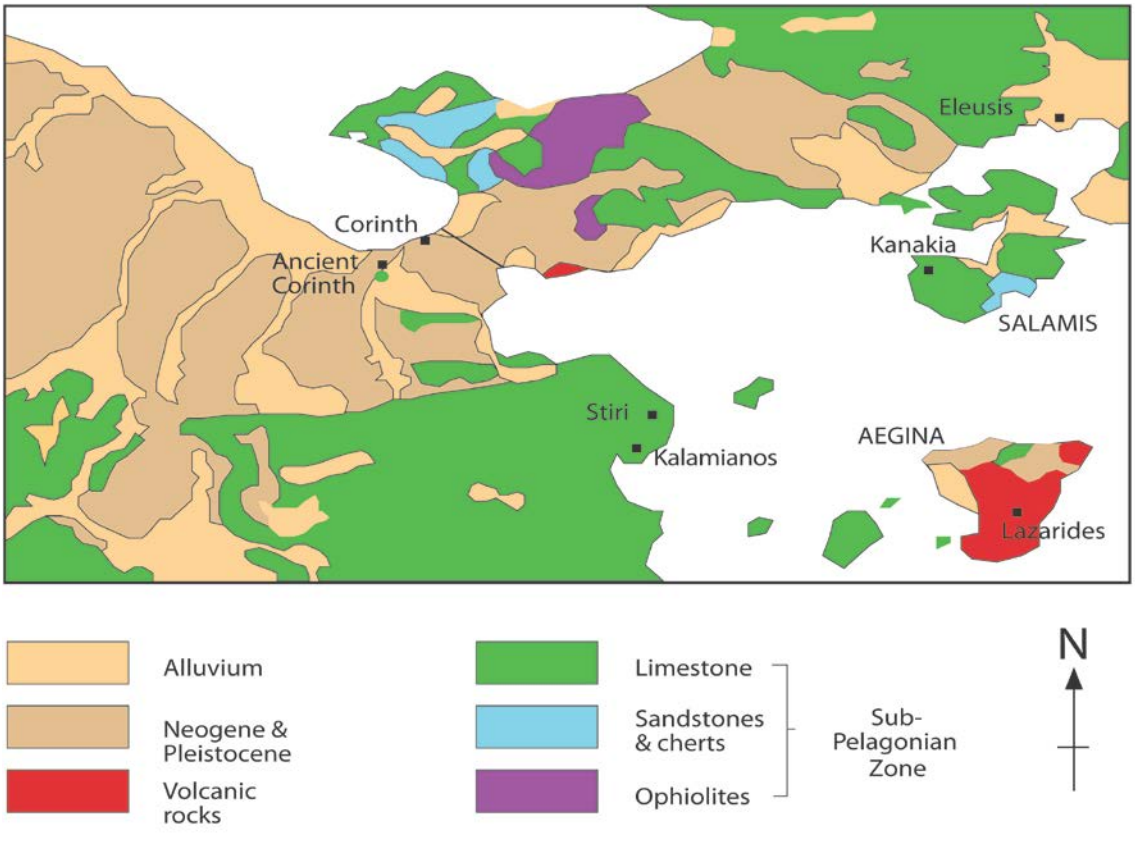

Figure 5.2: Geological map of Corinthia (after Sidall n.d.; Bornovas and Rondogianni-Tsiambou 1983).

Neogene and Pleistocene sediments are found interspersed with alluvium and beach deposits throughout Corinthia. These sediments are the result of the gradual filling in of the graben that is the Gulf of Corinth (Higgins and Higgins 1996: 40; Whitbread 1995:261). The Neogene deposits consist of marls, and conglomerates while Pleistocene sediments are marls, sands, marly limestones and conglomerates. These deposits are found in the terraces surrounding Ancient Corinth (Figure 5.3), while red clayey deposits are located between the ancient city and the isthmus (Whitbread 1995:261). The potter's quarter of the city, which produced pottery from the 7th-4th c. BC, lay 3km west, at the edge of the Ancient Corinth terrace, near a bed of Pleistocene marls this is beneath a cap of conglomerate (Higgins and Higgins 1996:44). This clay is well known for being used in the construction of transport amphorae in antiquity (cf. Whitbread 1995), and is a potential source of earlier pottery production in throughout the Bronze Age, however, it is unlikely to be the sole source as there are several suitable raw material sources for making pottery across the Neogene and Pleistocene deposits of Corinthia.

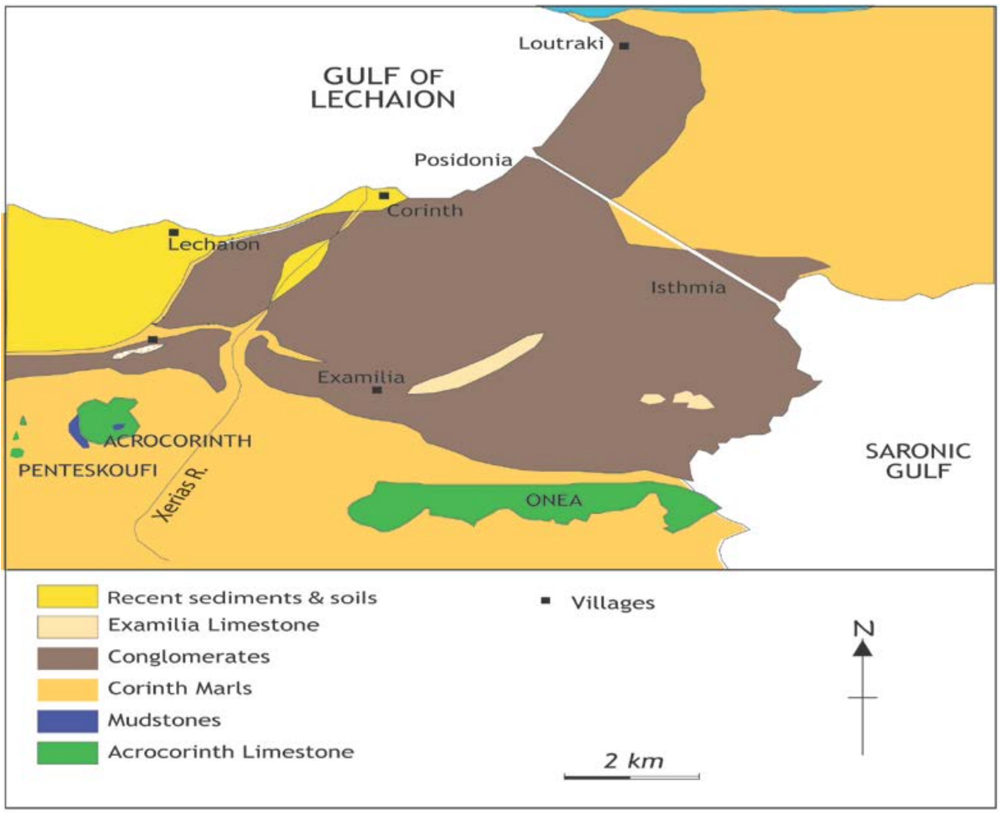

Figure 5.3: Geological map of region surrounding Ancient Corinth (after Siddall n.d.).

5.3.2.2 Argolic peninsula and Methana

The Argolic peninsula (Figure 5.4) extends south from the western terminus of the Corinthian isthmus, lying between the Saronic and Argolic gulfs. Geologically, it is the lower extent of the Sub-Pelagonian zone and transitions into the Pindos and Parnassos zones to the west. The area surrounding Sofiko, in southern Corinthia, on the northwestern coast of the Saronic Gulf, is composed mainly of limestone deposits. The limestones closest to Sofiko are dolomitic with various biomicrite-sparite outcrops. The dolomitic zone terminates approximately 200 km south from the town of Sofiko where large formations of biomicrite and biosparite extend south to Lygourio and east to Trachili (Papavassiliou et al. 1984a; Papavassiliou et al. 1985). There are several reddish clay beds found in small patches interspersed throughout the biomicrite-sparite limestone outcrops. It is not clear at present if these clays are useful for pottery production, but they are easily accessible from the area of Nea Epidavros and Kalamaki on the Saronic coast. On the eastern edge of the Arachnaion mountain range the limestone abuts the diabase-tuffite-chert series that leads back to the sea (Papavassiliou et al. 1984a). Within this formation there are several outcrops of serpentinite and tuffitic breccias and tuffitic breccioconglomerates (Papavassiliou et al. 1984a). The flysch sediments of this region reach their largest extent near Lygourio-Nea Epidavros. This sequence is composed of sandstones, shales, conglomerates, turbidites and intercalated limestones (Papavassiliou et al. 1984a). The flysch series in the Lygourio-Epidavros area transgresses abruptly onto the diabase-tuffite-chert series and Upper Cretaceous limestone (Papavassiliou et al. 1984a). This region is near the ancient site of Epidauros which does have a LHIII habitation site, but no pottery production in this area has been discovered of yet, though there was pottery production in the area in the Early Bronze Age, characterized by tuffites and other volcanic material (Burke and Day pers. comm.).

Further south along the coast lays the region of Troezinia and the Methana peninsula. The Pantokratorian limestone that begins just south of Lygourio continues south where it abuts the undivided flysch of Troezinia. The flysch consists of reddish or greenish marls, sandstone, breccia and conglomerate (Papavassiliou et al. 1984b). Flysch is the dominant geological deposit of this region and extends to the eastern tip of the Argolic peninsula. Opposite the town of Galatas is Poros, an island attached to the mainland by a narrow land bridge of grey limestone of the Barremian-Cenomanian period. The peninsula lies on the western most point of the South Aegean Volcanic Arc and comprises the remains of 27 small volcanoes. The last eruption was noted to have occurred near the northern village of Kameni Hora under the reign of Antigonus Gonatas (277-240 BCE) by the ancient geographer Strabo (*Geog. 1.3.18*). Methana is mainly made up of calc-alkaline volcanic products of dacitic-andesitic composition (Vougioukalakis and Fytikas 2005:163). Dacite with zoned plagioclase, clino- and orthopyroxene phenocrysts and basaltic andesite that displays a porphyritic texture are found in lava domes and flows interspersed around the entire landmass (Papavassiliou et al. 1984c). The majority of Methana is composed of volcanic agglomerates that have formed the crumbling domes and glowing avalanches (Papavassiliou et al. 1984c). In the northeastern corner, there are pyroclastic deposits with black tuffs. There are no clay deposits on Methana and no evidence for pottery production, however there needs to be more investigative work conducted in nearby Troezinia in order to understand the potential for pottery production in this region.

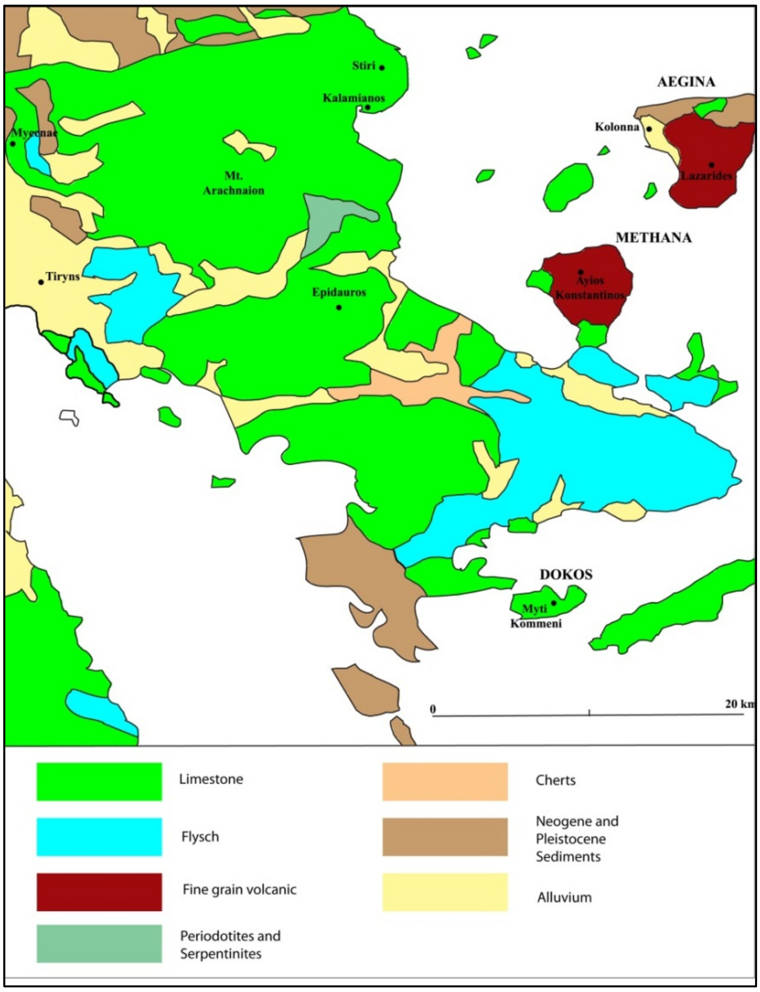

Figure 5.4: Geological map of the Argolic peninsula (after Higgins and Higgins 1996).

It must be noted that the volcanic hot springs of northeast Methana are mentioned by Pausanias (II. 34. I) to have been formed after a preceding eruption, the same eruption event mentioned above, thus they were not likely to have been accessible when the Mycenaean sanctuary of Ayios Konstantinos was in use (cf. Konsolaki-Yannopoulou 2001).

5.3.3 Islands

5.3.3.1 Aegina

Of all the areas within the Saronic Gulf region, the island of Aegina has the most complex geology (Figure 5.5). Further to this, the geology of Aegina has been extensively investigated for both geological and archaeological purposes. The most relevant of these investigations to this research is the study of Aeginetan ceramic landscapes by Kiriatzi et al. (2011: 71-92). Gauss and Kiriatzi's work surveyed the entire island to identify and characterise the geological materials used in pottery production from the Neolithic to modern times. Through a combination of traditional geological research and knowledge gained from interviews with modern potters of the island, Gauss and Kiriatzi were able to identify to the major raw material sources used in pottery production through time, in addition to mapping to the geological units of the island. They are exhaustive in their research, thus it is only necessary to present a brief synopsis of their results. All of the following information is taken from Kiriatzi et al. (2011: 71-92) unless otherwise noted.

The island is 87 km^2 in area and roughly triangular in shape. Its basement is formed from Mesozoic Sub-Pelagonian limestones, but these are barely visible on the surface. This autochthonous phase is nearly completely covered by the later Upper Cretaceous-Lower Eocene flysch and ophiolitic mélange that is interbedded with limestone and marls that are scarcely exposed on the surface. The marls are of a Pliocene age, are notably green and yellow in colour and are found mainly in the northern lower lands of the island on slopes facing towards the east and are only rarely exposed in Skotini gorge, the northwestern beaches of Marathonas, the northern bay of the islet of Moni and south of Perdika in Sarpa Bay. The mountainous landscape of the central and southern part of the island is shaped by the Pliocene-Pleistocene volcanic rocks. The white-yellow clays and volcanic rocks of the Pliocene-Pleistocene age are the most likely candidates for raw materials used in pottery production on Aegina.

There are several of these deposits on the island and thus Gauss and Kiriatzi (2011:72) suggest that texture must play a large role for identifying materials used by potters in antiquity.

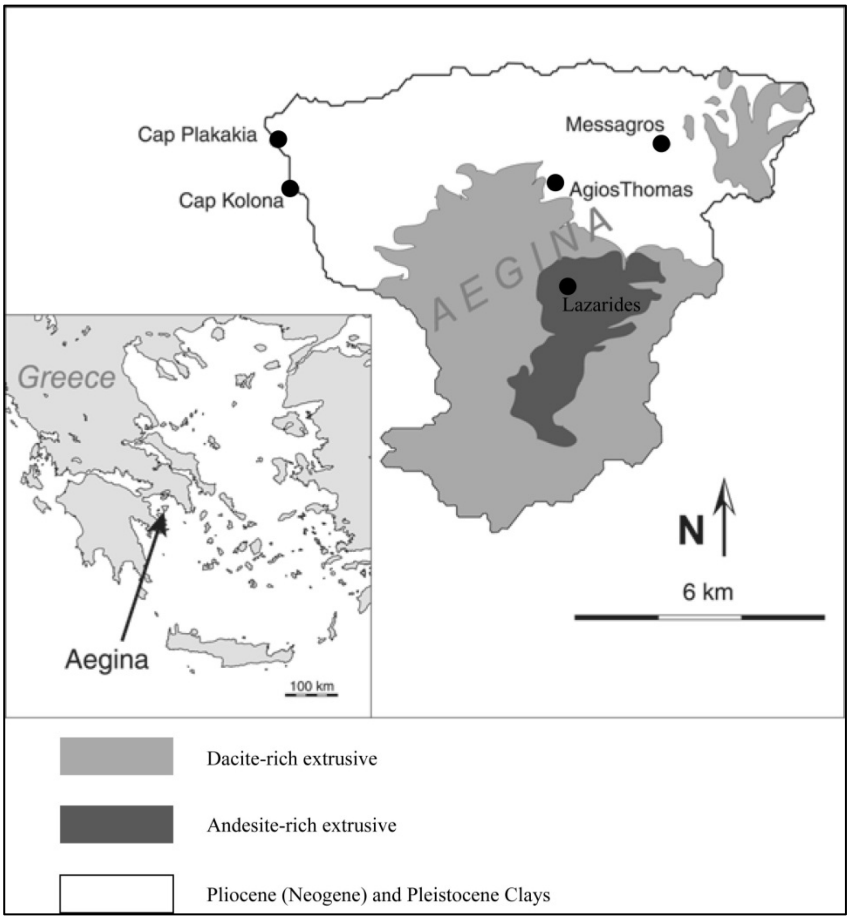

Figure 5.5: Simplified geological map of Aegina (after Hein et al. 2004c; see also: Dietrich et al. 1991).

There appears to have been two main phases of volcanic activity in the formation of the island; the first resulting in a dacitic lavas, while the latter resulted in more andesitic lavas (Dietrich et al. 1991; Gauss and Kiriatzi 2011:73). There are several types of lava, localized to specific areas of the island. The first volcanic event occurred during the Pliocene and has a felsic composition that resulted in the dacitic flows and volcaniclastic deposits of the central part of the island. These rocks are categorized as Hornblende Dacite (Koutalou type), Biotite Hornblende Dacite (Tourli type), Biotite Hornblende Dacite (Megali Korifi type), Biotite Hornblende Dacite (Kokkinovrachos type), Biotite Dacite (Palaiochora type) and Andesitic Dacite (Skotini type). The dacites are generally characterized by large phenocrysts of plagioclase feldspar, hornblende amphibole, biotite mica, quartz and clinopyroxene within a glassy or microlite rich matrix. These dacites can be separated into two broad groups according to the colour of the hornblende present. The Kokkinochora-, Palaiochora- and Skotini-type dacites are rich in green hornblende while the rest contain brown versions of the same mineral (Gauss and Kiriatzi 2011:74; Dorais and Shriner 2002; Dorais et al. 2004).

The second major volcanic event occurred during the Pleistocene resulting in andesitic lava flows. During the interval between the two phases of volcanism, within the Pliocene-Pleistocene transition, the marly clay formations and clays formed from the weathering volcanic rocks were deposited near Ayios Thomas, southwest of the village of Mesogros and between Marathovouno and Ayioi Asomatoi east of the Bronze Age centre of Kolonna, now the modern town of Aegina (Gauss and Kiriatzi 2011: 73). The volcanic phase of the Pleistocene resulted in mainly the Oros and Lazarides types of Andesite, however all five types of Andesites are listed here: Hypersthene Andesite (Oros- and Lazarides type), Andesite (Oros type), high-alumina Basalt to Basaltic Andesite (Oros type), Hornblende Andesite (Nikolaki type) and Rhyodacite (Kakoperato type). These rocks are composed of hypersthene or clinopyroxene, plagioclase and magnetite phenocrysts in a glass groundmass.

5.3.3.2 Salamis

The island of Salamis (Figure 5.6) is approximately 35 km^2 and lies around 7km west of Piraeus, the port of Athens. Although an island today, and during the Late Bronze Age, Salamis was connected to the Attic peninsula in the east and to Megara in the northwest by two land bridges until the Early Bronze Age, ca. 2550 BCE (Mariolakos and Theocharis 2001, 2003; Whitbread and Mari 2014: 81). The majority of the island is composed of overlying Middle to Upper Triassic limestones, dolomites, and marbles that are traversed by heavily altered paleovolcanic rocks and tuffs in the south near the Bays of Kanakia and Peristeria (Papavassiliou et al. 1984b; Whitbread and Mari 2014: 83). In the northeast corner of the island, that which is closest to mainland Attica, there are small outcropping of biomicrite limestone (Papavassiliou et al. 1982a). On the southeastern corner and in the central parts of the island are outcrops of Neopaleozoic to Lower Triassic sericite schists alternating with shales, phyllites, quartzites, sandstones and greywackes (Papavassiliou et al. 1984b; Whitbread and Mari 2014:82-3). Whitbread and Mari (2014) have shown that pottery was produced using sediments deriving from the metamorphic rock formations in the southern part of the island during Late and Final Neolithic while other fabrics are compatible with the ophiolitic deposits of the north. However, in the Late Helladic period, it does not appears as if pottery was produced using these sediments (Marabea 2012).

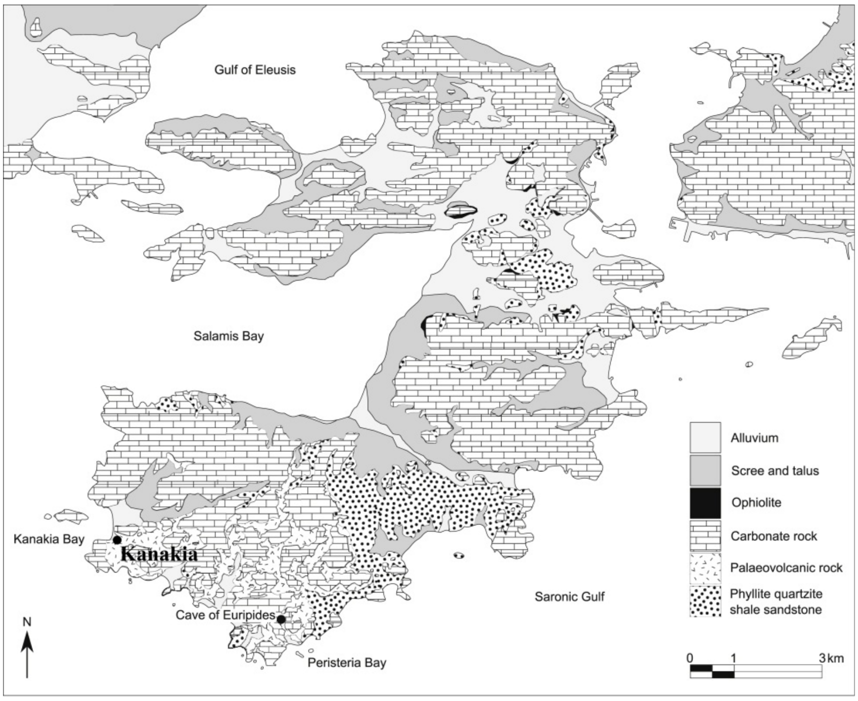

Figure 5.6: Geological map of Salamis (after Whitbread and Mari 2014).

5.3.3.3 Dokos

Dokos is a very small island off the west coast of Hydra south of the Argolic peninsula. It lies between the Saronic and Argolic gulfs (Figure 5.4). It is formed entirely by autochthonous Pelagonian limestone (Apostolides 1981).

5.4 Geology and ceramic analysis

This chapter has been an overview of the geological formations of central Greece and the islands of the Saronic Gulf with reference to the kinds of raw materials used in pottery production. While raw materials are one of the main focuses of ceramic studies, it is important to understand the wider geological landscapes that create these materials. Both petrographic and chemical studies of ceramics require at least some knowledge of local and regional geology for this is reflected by the ceramic fabrics and compositional groups. Generally, results of ceramic studies in the Aegean identify three categories of raw materials: terra rossa clays on the coasts and in the plains, calcareous pale clays of Neogene deposits and other “special ingredients” such as rock, sand or crushed pottery that can be as temper (Day et al. 1998; Hein et al. 2004a; Hein el al. 2004b; Hein et. al. 2004c; Kilikoglou et al. 1990; McDonald and Rapp 1972; Whitbread 1986, 1995). Information of this kind is necessary to link resulting petrographic and chemical groups to a general area within a geological landscape.

Ceramic studies of the Aegean have shown that a number of possible geological sources available within a given landscape, but ceramic fabrics belie several cases for mixing of raw materials making it difficult to match ceramic fabrics to any individual source (Hein et al. 2004a; Hein et al. 2004b; Hein et al 2004c). It is the onus of the researcher to identify discriminate natural variation in a material from alterations caused by people during production and later by the environment during the post depositional period. Thus before one can attempt to discriminate between possible sources one must perform an examination of all relevant variables, environmental *and* social.

In ceramic studies this is usually completed through comparison with known materials and geological references. Where comparative ceramic material is not available, or perhaps is overly ambiguous, determining the origin of ceramic fabrics becomes more reliant information drawn from geological resources of the surrounding regions. Moreover, chemical compositional data is often skewed by the natural alterations caused by environmental processes affecting the ceramic material after it has been deposited in the ground (Buxeda i Garrigós 1999; Buxeda i Garrigós and Kilikoglou 2003). It is of paramount importance to comprehend the chemical variation that can occur in specific geological environments in order to identify specific types of natural alterations that may affect the results of a composition study. Therefore in regional studies, such as that which forms this thesis, it is advantageous to incorporate a broad study of the geological landscape.

Chapter Six: Results of Analytical Study[7]

6.1 Introduction

Outlined in the following pages are the results of the petrographic and chemical analyses for the 487 samples from Saronic Gulf assemblages. The structure of this chapter sets the initial focus on the ceramic fabric groups resulting from the petrographic analysis. Petrographic fabric groups (FGs) are arranged according to their region of assigned provenance. Immediately following are petrographic fabric groups with no known provenance and groups where provenance has been hypothesized, which require more evidence before a production location can be deduced. Where possible, aspects of technology are reported for reconstruction in Chapter Seven.

After all petrographic fabric groups are reported the focus of this chapter turns towards the statistical analysis of chemical composition data generated through NAA. These groups are not organised by area of assigned provenance, rather they are in the order in which the groups were discriminated over the course of analysis. This means that the larger and best defined groups are presented first, followed by smaller groups and subgroups. Each chemical group description makes comparison with related petrographic fabrics and attempts to resolve any potential misclassification. Intragroup variation is discussed and explanations are offered for any sizeable variation, where possible. The resulting groups and their assigned provenance locations provide the foundation for observing inter-site movement of the sampled pottery vessels and subsequent archaeological interpretations.

6.2 Results of the petrographic study

The following ceramic fabric groups resulted from the petrographic study. Data has been recorded according to Whitbread's petrographic description system (cf. Whitbread 1995) described in Chapter Three. The resulting groups are organised according to the assigned region of production origin. The area of production was suggested through comparison with previously studied ceramic material and by comparing the mineralogical composition with the geological environments in the areas surrounding the Saronic Gulf, described in the previous chapter (Chapter Five). Many of the resulting fabrics are compatible to ones published previously or other comparative material held in the collections of the Sheffield/Demokritos group or Fitch Laboratory

[7]Full descriptions and images for each fabric group can be found in Appendix I.

of the British School at Athens. In instances of previously published material, the fabric name given in the prior publication has been kept in order to maintain continuity in the literature. Otherwise the fabric is named according to the major corresponding mineralogical, petrological or technical features. Each fabric is prefaced with a brief summary of the vessel types represented, the mineralogical and petrological composition and any significant technological features present.

The data are used in order to determine groups based on mineralogical, petrological and technological features, to reconstruct potters' selection of raw materials, which are the main factor for the determination of production origins. Both the technical and mineralogical information helps develop a reference group for a specific production centre and enables the tracking of vessel movement across the Saronic Gulf by identifying and differentiating of places of pottery production from those of consumption. Identification of production centres is important for a comparison of technological practice across different centres in the region, used in the production of vessels of similar shape and function.

6.2.1 Attic Fabrics

All of the fabrics assigned to a provenance in the region of Attica have several features in common. They are constructed using a mixture of red and yellow sediments, respectively micaceous and calcareous. The most distinctive inclusions are the pelitic low-grade greenschist facies and cataclastic metamorphic rocks found in conjunction with sedimentary rock such as arenites, arenaceous metasandstones, greywackes, siltstones and argillites. All of these rock types constitute what is often referred to as *Athens Schist*, however there are several limestone and marble outcrops located near additional deposits of low-grade greenschist facies metamorphic rocks throughout Attica (Gekas et al. 2003). There are a few ophiolite outcrops among the *Athens Schist* deposits in this region, which account for the rare serpentinite (Papavassiliou et al. 1982a). The fluviatile deposits near to the coastal region south of Piraeus, near Ayios Kosmas, are composed of conglomerates with intercalations of thin layers of breccia, sandstone, siltstone and red sandy marls cross-bedded with intercalations of yellow sandy marls (Papavassiliou et al.1982a) and are compatible with the red and yellow (calcareous) sediments that form the matrix.

6.2.1.1 Fabric group 1: Micaceous low grade schist and argillaceous rock

Group Members	Region of deposition	Vessel types
Acropolis 13/01,3-5,7,8, 11,13,15,18-24,26,28-30,32,33,38,39	Attica	Plain and painted jugs and jars, dippers, spouted and unspouted kraters, cups, tripod strainer, tripod cook pot, medium and fine stirrup jars, deep bowls, carinated and conical kylikes
Ayios Konstantinos 12/22,23,34,36-38,40,42-45,47,48,53,54,57,60,61	Troezinia	Painted basins, hydria, deep bowls, kylikes, jars, "open- and closed-vessels", a straight sided alabastron and a zoomorphic figurine
Alimos[8] 12/01-10,12-16,18-48,84,110-112,114-118	Attica	Painted and unpainted deep bowls, kraters, kylikes, kyathoi, basins, small basins, medium and fine stirrup jars, cups, jars, lids, dippers, amphorae, cooking pots, and "closed vessels"
Cave of Euripides 12/02-8,14,18	Salamis	Painted and unpainted amphorae, hydriae, jugs, deep bowls, kylikes and a "closed vessel"
Dokos 12/07	Argo-Saronic	Kylix
Eleusis 12/01,2,4,6,7,10,11,15-17	Attica	Amphorae, hydria, jars, dippers, kraters and basins
Kalamianos 12/06,14,25,27,42,44,45,61,64	Corinthia	Painted and unpainted kylikes, stemmed bowls, deep bowls, medium stirrup jars, jars
Kanakia 07/01-30,32,34,42 Kanakia 10/01-3,5,6	Salamis	Painted and unpainted amphorae, hydriae, jugs, spouted and unspouted basins, piriform jars, medium stirrup jars, spouted kraters, deep bowls and "closed vessels"
Lazarides 12/11-12	Aegina	Deep bowls
Plaka 10/07-16	Attica	Painted "closed vessels"
Stiri 12/100, 114	Corinthia	Stemmed and pedestal bowl

Table 6.1: Members of the 'Fine micaceous with low-grade schist and argillaceous rock fabric group.

Fabric Group 1 (Table 6.1) is a fine fabric composed of a groundmass consisting of fine mica laths, quartz and feldspar with inclusions of low grade metamorphic and sedimentary rock. The low grade metamorphic rock is identified as pelitic greenschist and the sedimentary rock features are argillaceous and fine grained lithic greywackes,

[8] Samples marked "Alimos XX/XX" refer to ceramics sampled from the settlement and installation contexts at Kontopigado. The sample ID has been kept here to preserve the integrity of related catalogues at each of laboratories where analysis took place.

arenites and arenaceous metasandstone. There is no evidence to suggest that any rock inclusions have been added as temper to the matrix, rather they are probably natural inclusions in the mixture of sediments that form this fabric recipe. The rock types are common in central and northern Attica where they make up part of the *Attic Schist* and other metamorphic formations. The last major component is a greyish-yellow calcareous sediment in the form of TCFs which is suggestive of the yellowish marls found near Ayios Kosmos (Papavassiliou et al. 1982a). The mineralogical composition is highly compatible with the geological landscape of Attica. The place of production can definitively be attributed to the site of Kontopigado, Alimos where over fired kiln wasters, i.e. Alimos 12/116 and 12/117, are found in this same fabric.

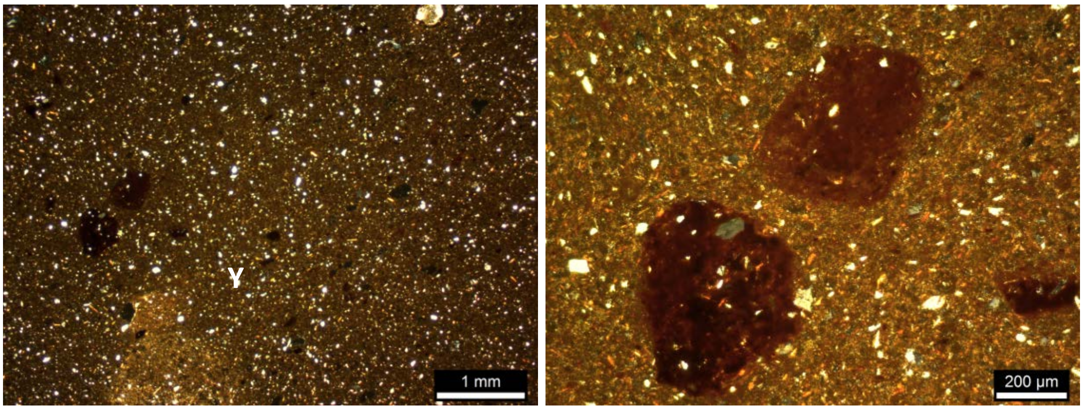

Figure 6.1: Sample Alimos 12/32 (left) XP demonstrates a typical example of FG 1 with red and yellow pellets (Y); A close up of the reddish brown clay pellets in the same sample, XP (right).

The red and yellow sediments (Figure 6.1) mixed to form the base material of this fabric recipe are suggestive of the Neogene deposits found in the region of Alimos, near Ayios Kosmas, including micaceous Miocene red and marly yellow fluviatile deposits. Clay mixing is not an uncommon practice at this time and can be attested at numerous sites through the Bronze Age Aegean (Day 1999; Shaw et al. 2001; Whitbread et al. 2007) and represents the second stage of the pottery production sequence, raw material processing. Both the red and yellow clay components are identified by the rounded, equant to elongate-amorphous clay pellets found in the fabric matrix. Other clay pellets in this fabric are reddish, denser biotite- and iron-rich sedimentary material, which is observed as clay striations within the groundmass and are, perhaps, natural inclusions.

This is the largest fabric group in the present study, has the widest distribution in the research area and is the only fabric that is found in every assemblage examined. The types of vessels it is used for are varied, but all have to do with the storage, serving, mixing and consumption of liquids. The shapes include hydriae, amphorae, jugs, jars, shallow bowls, basins of various sizes, deep bowls, stemmed deep bowls, cups, ladles and kylikes, both conical and carinated. This fabric includes both decorated and undecorated vessels alike. Decorative motifs are Attic in nature as defined by Mountjoy (1995a) and are described in detail by Marabea (2010, 2012) and Kaza-Papageorgiou and Kardamaki (2012).

6.2.1.2 Fabric Group 1Ac (Coarse)

Sample ID	Region of Deposition	Vessel Type
Plaka 10/06	Attica	Closed vessel
Plaka 10/17	Attica	Closed vessel

Table 6.2: Members of FG 1Ac (Coarse).

These samples (Table 6.2; Figure 6.2) are from two closed vessels. They are thicker walled vessels than any other in FG 1 and have been separated due to the greater abundance and increased packing density of inclusions. There is no doubt that they are constructed from the same raw materials and in the same technological tradition as FG 1.

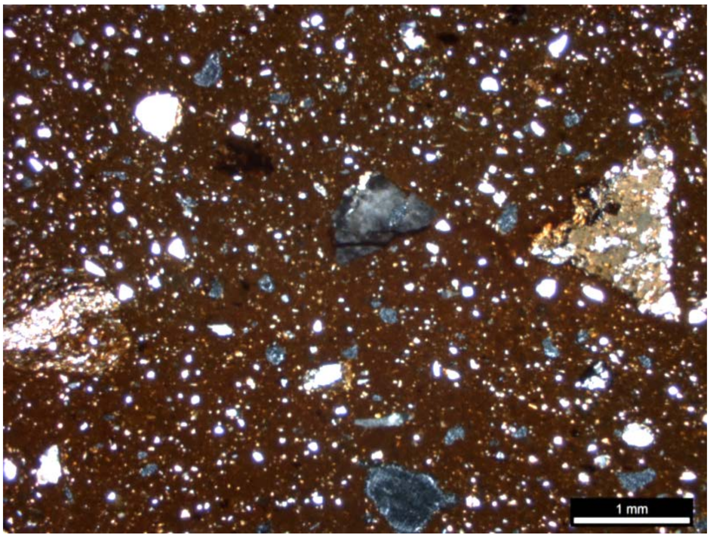

Figure 6.2: Fabric 1Ac in XP (Plaka 10/06).

6.2.1.3 Fabric Group 2 Metamorphic and sedimentary rocks with organic material

Group Members	Region of Deposition	Vessel Type
Alimos 12/49-59,63-65,68,81,82	Attica	Large tubs
Alimos 12/60	Attica	Griddle pan
Alimos 12/61,70	Attica	Lids
Alimos 12/62,66,67,69	Attica	Shallow pans

Alimos 12/83	Attica	Coarse Jar
Kanakia 07/67,68,71	Salamis	Large tubs
Plaka 10/32,33,35-39	Attica	Large tubs

Table 6.3**:** Members of the ‘Metamorphic and Sedimentary Rocks with organics’ fabric group.

Fabric Group 2(Table 6.3; Fig 6.3) is constructed of much the same raw materials as FG 1. It too displays a matrix that appears to be a mixture of micaceous clay with marl; however, these two fabrics differ in the relative size and abundance of the metamorphic rock inclusions and the addition of organic vegetal material as temper. The metamorphic rock inclusions have a cataclastic texture that is compatible with the “mylonitized schist” aspect of the *Athens Schist* outcrops in central Attica (Gekas et al. 2003). The sedimentary rock inclusions are similar to those in FG 1 and are, again, compatible with the *Athens Schist* outcrops. It is clear that FG 1 and FG 2 are produced at the same location. The large inclusions and the presence of voids resultant from fired out organic matter indicates that these vessels were tempered with two materials. The clays were mixed with the schist, sandstone and vegetal matter was added later, which resulted in curved, elongated voids post firing. There is some variation in the packing density and birefringence colour in this fabric group. The larger vessels tend to have a more loose packing than the shallow pans, lids and griddle pan, however the mix of the raw materials is fairly consistent throughout the group. The variation in the colour of the matrix has no relationship to large or small vessels.

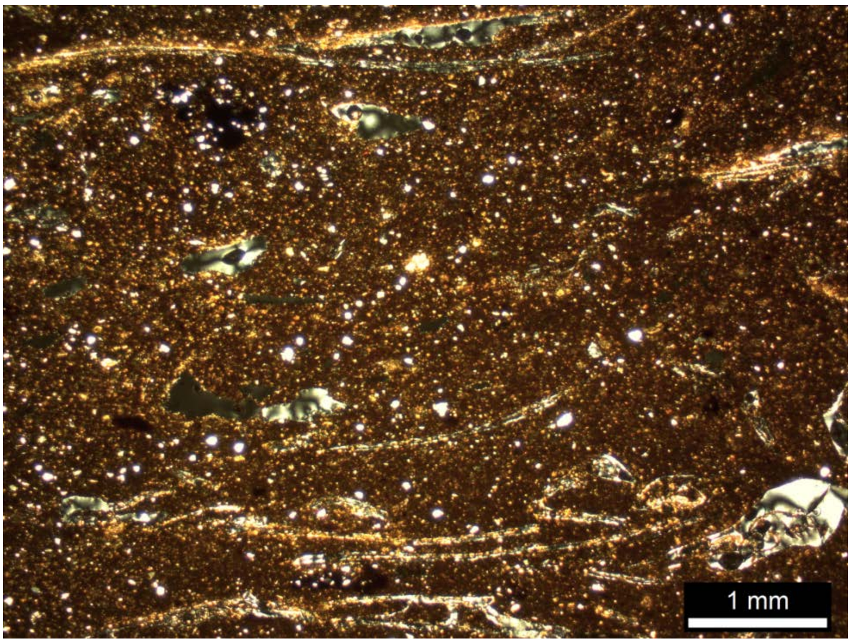

Figure 6.3: Fabric Group 2 in XP (Alimos 12/55). Curved voids are remains of vegetal matter. The yellowish matter inside the voids is secondary calcite.

6.2.1.4 Fabric Group 3: Low grade schist and marblised limestone

Group Members	Region of Deposition	Vessel Type
Alimos 12/76	Attica	Semi-globular kylix
Alimos 12/77	Attica	Pithoid jar
Alimos 12/78	Attica	Pithoid jar
Kanakia 7/84	Salamis	Pithos
Kanakia 7/85	Salamis	Pithoid Jar
Plaka 10/18	Attica	Pithoid Jar
Plaka 10/29	Attica	Pithoid Jar

Table 6.4: Members of the 'Low grade schist and marblised limestone' fabric group.

Fabric Group 3 (Table 6.4; Figure 6.4) is reminiscent of both FG 1 and FG 2 with a mixed micaceous and calcareous matrix, however it differs in that there is disproportionate mix of iron rich red clay and a lighter, calcareous clay with loosely packed coarse inclusions of low-grade schist and marblised limestone. The coarse fraction is composed of pelitic greenschist and limestone fragments that have been added as temper. Only one sample, Kanakia 7/85, has organic material added, the remainder of this group appears to have been tempered only using the schist and marblised limestone mix. All of the metamorphic rock fragments are compatible with an origin in Attica where pelitic schist is commonly found intercalated with outcrops of limestone and marble (Gekas et al. 2003). This fabric recipe is used mainly in the construction of large storage jars. Marabea (2010, 2012) refers to these vessels as "pithoid jars" as their exact shape is unknown. Curiously there is a single semi-globular cup also made in this fabric. The fabric is very distinct and is found only in Attica and at Kanakia.

Moderate optical activity, a relatively homogeneous matrix and reddish colour suggest that these vessels were firing to moderate temperatures and consistently oxidising. The control of firing, the mixture of marl and iron rich red clay and use of pelitic greenschist as temper are all similar technological choices as those made in FG 1 and FG 2 indicating that these vessels are most likely manufactured at the same location, Kontopigado, comprising a coarse fabric of the local repertoire.

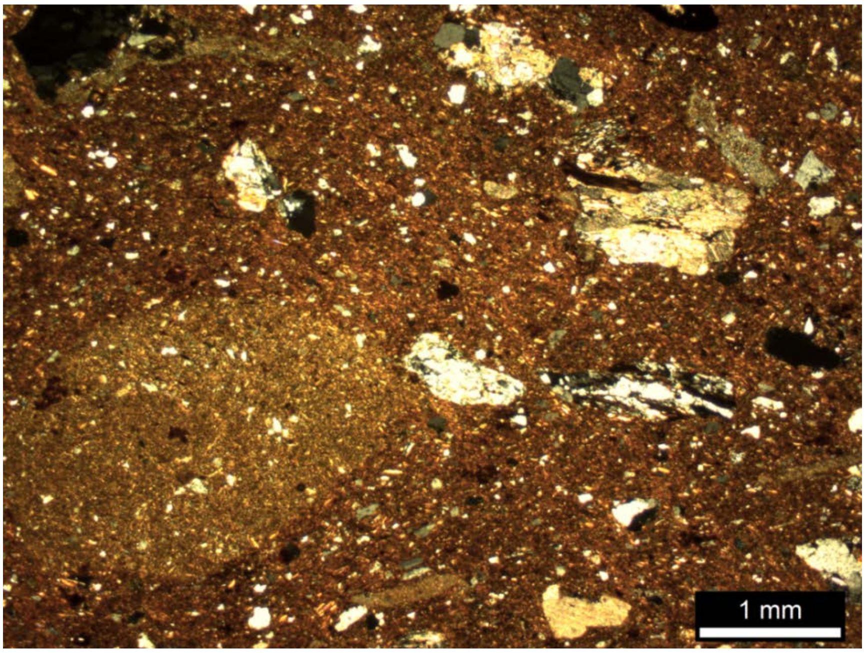

Figure 6.4: Fabric Group 3 in XP (Alimos 12/76).

6.2.1.5 Fabric Group 4: Very coarse with greenschist

Group Members	Region of Deposition	Vessel Type
Acropolis 13/34	Attica	Semi-globular kylix
Alimos 12/73	Attica	Pithoid jar
Alimos 12/75	Attica	Pithoid jar
Alimos 13/10	Attica	Pithos
Plaka 10/19	Attica	Pithoid Jar
Plaka 10/20	Attica	Pithoid Jar
Plaka 10/21	Attica	Pithoid Jar
Plaka 10/22	Attica	Pithoid Jar
Plaka 10/23	Attica	Pithoid Jar
Plaka 10/24	Attica	Pithoid Jar

Table 6.5: Members of the 'Very coarse with greenschist' fabric group.

Fabric Group 4 (Table 6.5; Figure 6.5) is a very coarse fabric that is characterised by a micaceous groundmass heavily tempered with low-grade pelitic greenschist. The majority of the other inclusions are disaggregated detritus of the schist or related to a marly material the presence of the rounded marl pellets in this highly micaceous matrix presents another case of clay mixing. The abundance of angular greenschist fragments in the coarse fraction and strong bimodal grainsize distribution indicates that the rocks were crushed and added to the matrix as temper. The composition of the greenschist is compatible with the Athens Schist formation in north and central Attica, in addition to other schist outcrops of the Plaka-Koropi area (Gekas et al. 2003). In terms of distribution, this fabric has a limited range as it has only been observed at Kontopigado and Plaka in the form of large storage jars and in the Mycenaean Fountain deposit on top of the Athenian Acropolis as a semi-globular kylix. Here, there is another single semi-globular drinking vessel made in a very coarse fabric used in storage jar production which could indicate that cups were made to go with the storage jars as part of a set, perhaps, due to their globular shape, as a large scoop.

The groundmass comprised of micaceous clay mixed with a marl and added pelitic schist temper are compatible with the geology of Attica and suggest that this fabric recipe of a local Attic production. Moreover, the technological features of mixing micaceous and calcareous clays with greenschist temper combined with the limited distribution within central Attica, suggests that this is a local product likely manufactured at Kontopigado. If this is the case, this would be the second storage jar fabric manufactured at this production site, begging the question of whether there are more than one group of potters producing storage vessels at this site.

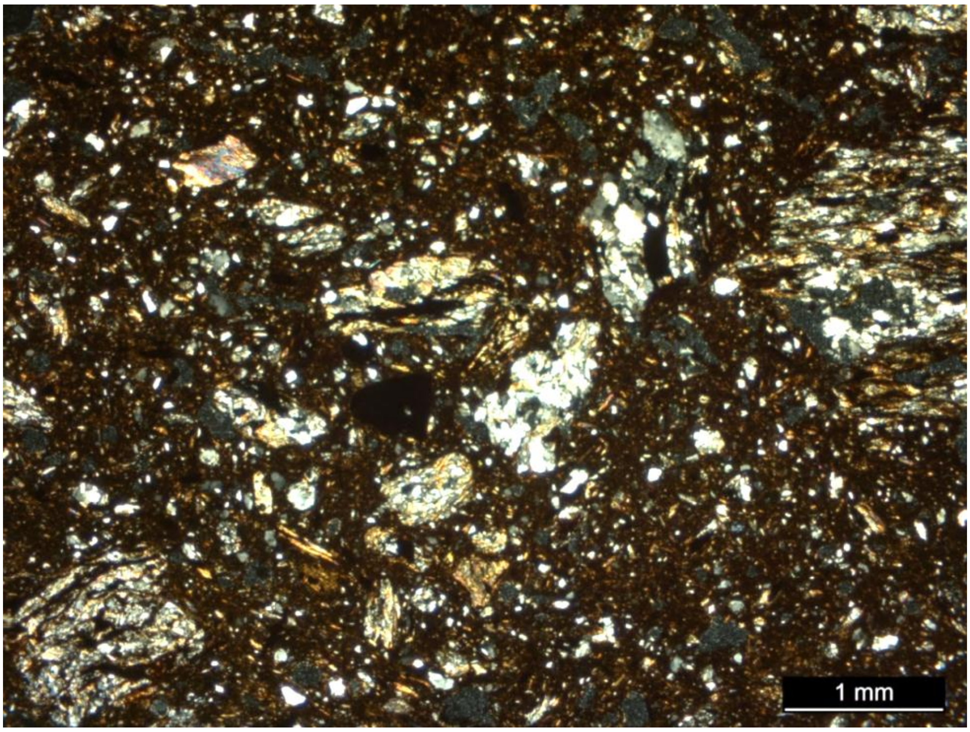

Figure 6.5: Fabric Group 4 in XP (Plaka 10/21).

6.2.1.6 Fabric Group 5: Micrite

Group Members	Region of Deposition	Vessel Type
Acropolis 13/35	Attica	Cup
Alimos 12/71	Attica	Pithoid jar
Alimos 12/72	Attica	Pithoid jar
Alimos 12/74	Attica	Pithoid jar
Alimos 12/80	Attica	Pithoid jar
Plaka 10/25	Attica	Pithoid jar
Plaka 10/26	Attica	Pithoid jar
Plaka 10/27	Attica	Pithoid jar
Plaka 10/28	Attica	Pithoid jar
Plaka 10/30	Attica	Pithoid jar
Plaka 10/31	Attica	Pithoid jar

Table 6.6**:** Members of the 'Micrite' fabric group.

Fabric Group 5 (Table 6.6; Figure 6.6) is another coarse micaceous fabric used predominantly in the construction of large storage jars and a cup (Acropolis 13/35). The groundmass is reddish-firing micaceous sediment derived from the weathering of pelitic metamorphic rock. It is unclear if the matrix is a mixture of clays similar to FG 1 and FG 2 because there is an abundance of secondary calcite in the groundmass distorts the optical properties of the matrix. However the same kind of marl inclusion from FGs 1-4 is in abundance indicating that clay mixing is probable. Furthermore, the secondary calcite alteration appears autochthonous (cf. Cau Ontiveros et al. 2002), in other words that the micrite aggregates come from the groundmass itself. This combined with the presence of TCF 2, the calcareous mudstone or marl further suggests the presence of clay mixing. The matrix shows moderate to high optical activity suggesting a low firing temperature. The reddish hue of the sections and the sherds themselves indicate a fairly consistent oxidising atmosphere was attained during the firing stage.

There are rare voids indicating that organic vegetal matter is observed in the microstructure as elongated macro- and megavughs present in the voids. The sparsity of the organic matter makes it difficult to discern whether it was added intentionally as temper or if it was a component from the raw material, however no roots are observed suggesting that it was added intentionally as temper. The matrix composition is compatible with a production origin in the region of Attica and again at Kontopigado where organic tempering of large vessels is common. Thus perhaps the organic matter was added intentionally, but more samples are needed to prove this. This fabric had been separated from FG 4 due to the low abundance of coarse inclusions, but it is made in the same manner.

This is the third storage jar fabric suggested to have been produced at Kontopigado and the third storage jar fabric that includes a cup or drinking vessel of some kind. In this case the vessel is a cup rather than a kylix which perhaps suggests that if potters at Kontopigado were producing a cup-like vessel for scoops to go with large storage jars as a set, this practice was not completely standardised. In this study there were no large storage jars sampled from the Mycenaean Fountain or the North Slope deposits from the Acropolis as much of the coarseware had not been studied in detail. Thus the lack of storage jars from the Acropolis is the outcome of the sampling procedure rather a lack of storage jars. Even more so, the use of a drinking vessel such as the kylix, a vessel with such cultural significance (Bendall 2004; Galaty 1999; Wright 2004) as a scoop in the administration centre of the Attic Mycenaean province is curious. That is unless the kylix, like the cup, is just another everyday ceramic vessel with multiple affordances. One method for determining if these cups and kylikes were used as a scoop is to investigate the rim surfaces for marks left by the repetitive abrasion that would have occurred during the scooping movements as evidenced by Lis (2013).

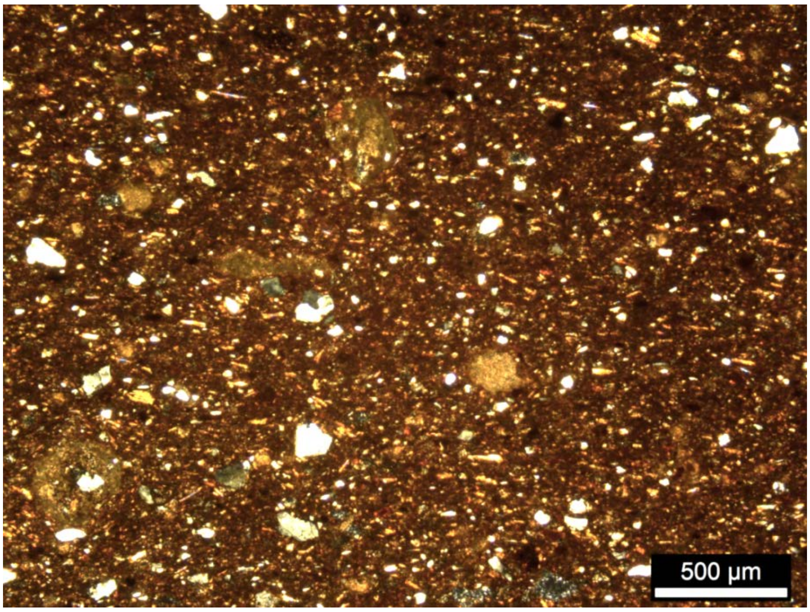

Figure 6.6: Fabric Group 5 in XP (Plaka 10/25).

6.2.1.7 Fabric Group 6: Cooking pot ware

Fabric Group 6 is used in the construction of cooking vessels such as tripod pots, one- and two-handled flat bottom cooking jars, flat pans, sieves, punch-base griddles and sieves in addition to an askos and a closed vessel. On the majority, the group is reasonably homogeneous, but it has been split into four subgroups in order to take into consideration the variation in the packing density of the silty inclusions within the fine fraction and the occurrence of certain sedimentary rock fragments in the coarse fraction. Generally, each subgroup exhibits the same types of sedimentary and metamorphic rock inclusions – siltstone, sandstone, greywacke, arenaceous metasandstone, phyllite and greenschist – in a coarse fraction that consistently makes up approximately 40% entire fabric recipe. Beyond inclusions, all of the subgroups of FG 6 are made using a crude mixture of micaceous and calcareous clays.

6.2.1.7A Fabric group 6A: Sandstone, metasandstone and micrite

Group Members	Region of Deposition	Vessel Type
Alimos 12/85	Attica	Chytra
Alimos 12/86	Attica	Chytra
Alimos 12/87	Attica	Chytra
Alimos 12/89	Attica	Chytra
Alimos 12/90	Attica	Griddle pan
Alimos 12/91	Attica	Chytra
Alimos 12/92	Attica	Chytra
Alimos 12/93	Attica	Chytra
Alimos 12/94	Attica	Askos
Alimos 12/97	Attica	Chytra
Alimos 12/108	Attica	Spouted krater
Alimos 12/109	Attica	Basin
Plaka 10/6	Attica	Closed vessel

Table 6.7: Members of the 'Sandstone, metasandstone and micrite' fabric group.

Fabric Group 6A (Table 6.7; Figure 6.7) is very similar to both FG 1 and FG 2 in both groundmass and inclusions. The main difference is the abundance of sedimentary features and the lack of pelitic greenschist. The sedimentary rock fragments are identical to those in FG 2. However this fabric does not demonstrate the characteristic voids found in that fabric. The micromass is consistent and has a reddish colour with low to moderate levels of optical activity, suggesting that the vessels were fired at moderate temperatures (800˚C +) in a consistently oxidising atmosphere. The matrix derives from a metamorphic environment, but the prevalent micrite inclusions may indicate clay mixing. Much like the groundmass, the inclusions are identical to those observed in FG 1 and FG 2 indicating that they are produced at the same location. FG 6 and all of the related sub-groups have a micaceous and calcareous matrix, nearly identical to FG 1 and FG 2, though it has much less micrite and has a more red firing colour. The subangular inclusions with a relatively strong bimodality in grain size distribution suggest that the sandstone and metasandstone may have been added to the matrix as temper.

Alimos 12/108 has been altered due to burning post manufacture. It is completely inactive optically and the birefringence colours have darkened, a feature that is likely the result of use as a cooking vessel. That cooking vessels are produced using the same kind of technical features as fine tablewares, large tubs and storage jars including mixing micaceous and calcareous clays fired to relatively high temperatures is significant, as it displays a different technological strategy than other producers of similar pottery assemblages in the Saronic Gulf as we will see in the following chapter. Moreover, it demonstrates coherence in the production strategy at Kontopigado.

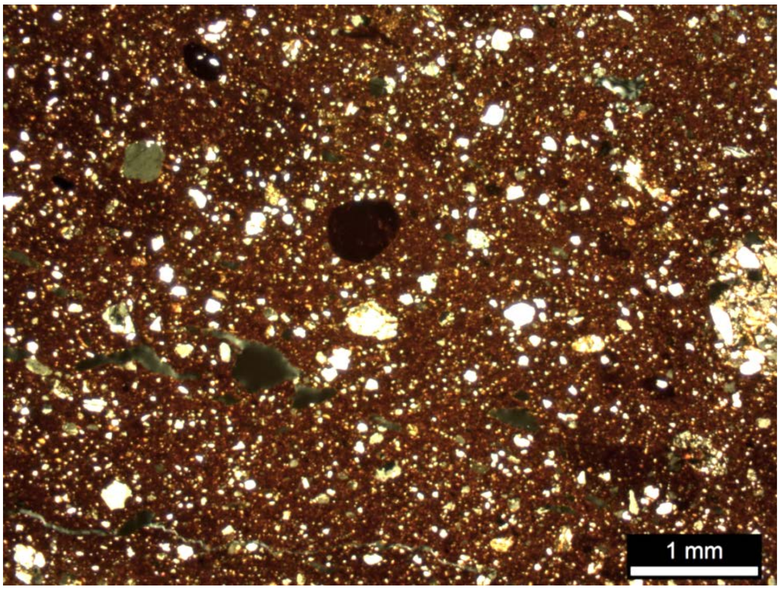

Figure 6.7: Fabric Group 6A in XP (Alimos 12/91).

6.2.1.7B FG 6B: Silty with metasandstone

Group Members	Region of Deposition	Vessel Type
Acropolis 13/9	Attica	Griddle pan
Alimos 12/88	Attica	Tripod cooking pot

Table 6.8: Members of the ‘Silty with metasandstone’ fabric group.

These samples (Table 6.8; fig 6.8) have been separated from FG 6A on the basis of the high density of inclusions <0.16 mm. There are several explanations for this, the raw clay material was not processed in the same manner as FG 6, the sandstone temper was disaggregated to a higher degree before it was added to the matrix or perhaps fine sand was added to the mixture during this manufacturing event. The most probable solution is that these vessels are from a different production event than FG 6 as the matrix and coarse fraction are the same. The matrix displays moderate optical activity and has consistent red-brown colouration suggesting moderate firing temperatures in a predominately oxidising atmosphere. The micromass is both calcareous and micaceous with silt sized quartz displaying undulose extinction and plagioclase (Figure 6.8, left). Acropolis 13/9 demonstrates clear signs of clay mixing in the form of striated textural concentration features (Figure 6.8, right).

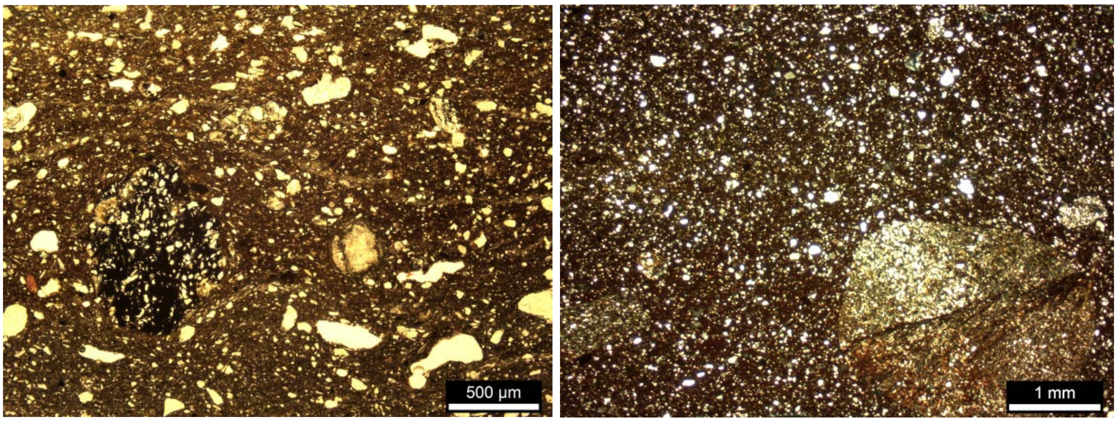

Figure 6.8: Fabric Group 6B. Left: Clay mixing striations in sample Acropolis 13/9 in PPL; Right: Metasandstone in Sample Alimos 12/88 in XP.

6.2.1.7C FG 6C: Greywacke, metasandstone and phyllite

Group Members	Region of Deposition	Vessel Type
Acropolis 13/36	Attica	Tripod cooking pot

Table 6.9: Member of the 'Greywacke, metasandstone and phyllite' fabric group.

This fabric (Table 6.9; Figure 6.9) is made of the same raw materials as FG 6A. However, it was split from the original group due to the occurrence of phyllite inclusions in the coarse fraction and the higher micrite concentration in the matrix. It is assuredly made with the same raw materials as FG 6; the addition of phyllite can be explained by natural variability in the raw materials. The higher concentration of micrite in the clay mixture suggests that this particular fabric was made with an increased proportion of marl to micaceous clay in the groundmass. This slight technical variation in the fabric may be chronological in nature, as this vessel comes from a well deposit on the Athenian acropolis which may be slightly earlier than that of the production horizon sampled from Kontopigado, the place where it was produced.

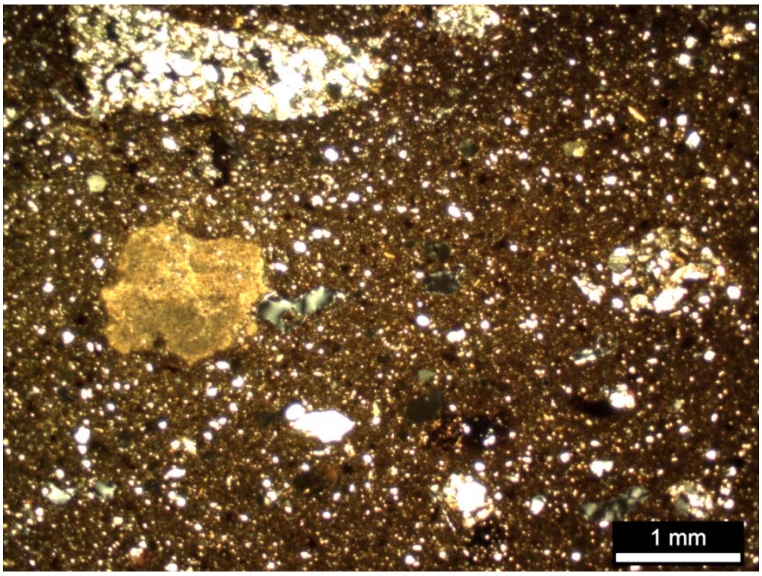

Figure 6.9: Fabric Group 6C in XP (Acropolis 13/36).

6.2.1.7D FG 6D: Silty with marl

Group Members	Region of Deposition	Vessel Type
Alimos 12/95	Attica	Cooking pot lid

Table 6.10: Member of the 'Silty with marl' fabric group.

This sample (Table 6.10; Figure 6.10) is from the lid of a cooking vessel. It has been split from the main fabric, FG 6A, due to the elongated voids that form a linear pattern. This pattern is likely from the addition of a new layer of clay added and smoothed over an existing layer. This could be from the attachment of the lid handle. Additionally, the marl inclusions in the coarse fraction indicate that the clay mixture was not fully combined during the processing phase of production. It is formed from the same raw materials as all of FG 6 subgroups and was manufactured in the same location.

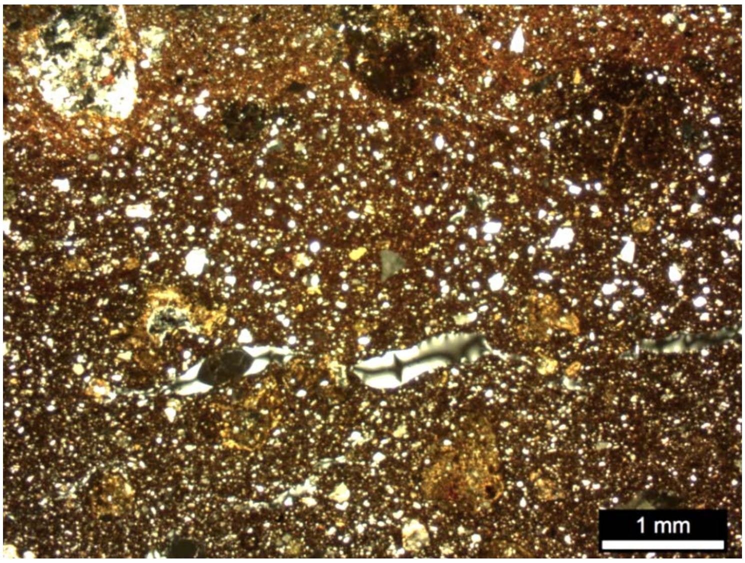

Figure 6.10: Fabric Group 6D in XP (Alimos 12/95).

6.2.1.8 FG 7: Poorly mixed micaceous with marl

Group Members	Region of Deposition	Vessel Type
Acropolis 13/10	Attica	Griddle pan/sieve?

Table 6.11: Member of the 'Poorly mixed micaceous with marl' fabric group.

Fabric Group 7 (Table 6.11; Figure 6.11) is composed of a mixture of coarse, iron-rich micaceous clay with silty marl. It has been separated from FG 6 because the mixing of the clays is very poor as evidenced by the large marl particles and the megavoids. The inclusions have a weakly bimodal grain size distribution with the coarse fraction consisting mainly of marl particles and large, subangular grains of quartz, feldspar, mica laths and opaques. The fine fraction is much more densely packed with well sorted grains matching the composition of the coarse fraction. It is compatible with a provenance in Attica and resembles the same raw materials used in all other Attic and Kontopigado fabrics. The section is from the flat base of a punched-based griddle/sieve with may explain the poor clay mixing and amorphous megavoids.

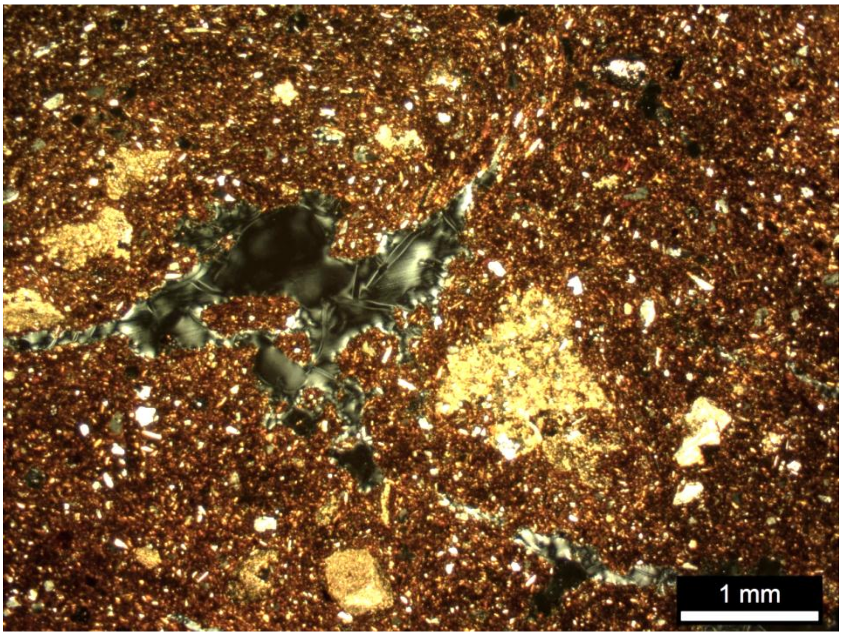

Figure 6.11: Fabric Group 7 in XP (Acropolis 13/10).

6.2.1.9 FG 8: Metasandstone, marl and shale

Group Members	Region of Deposition	Vessel Type
Acropolis 13/37	Attica	Tripod cooking pot

Table 6.12: Member of the 'Metasandstone, marl and shale' fabric group.

Fabric Group 8 (Table 6.12; Figure 6.12) is much more calcareous than FG 6 and has the addition of chloritic phyllite and epidote inclusions. The general fabric composition is compatible with greenschist known from Attica. This tripod cooking pot comes from a well deposit from the Mycenaean Fountain on the Athenian Acropolis and perhaps represents a diachronic or firing episode variation in raw materials collected for cooking pot production at Kontopigado.

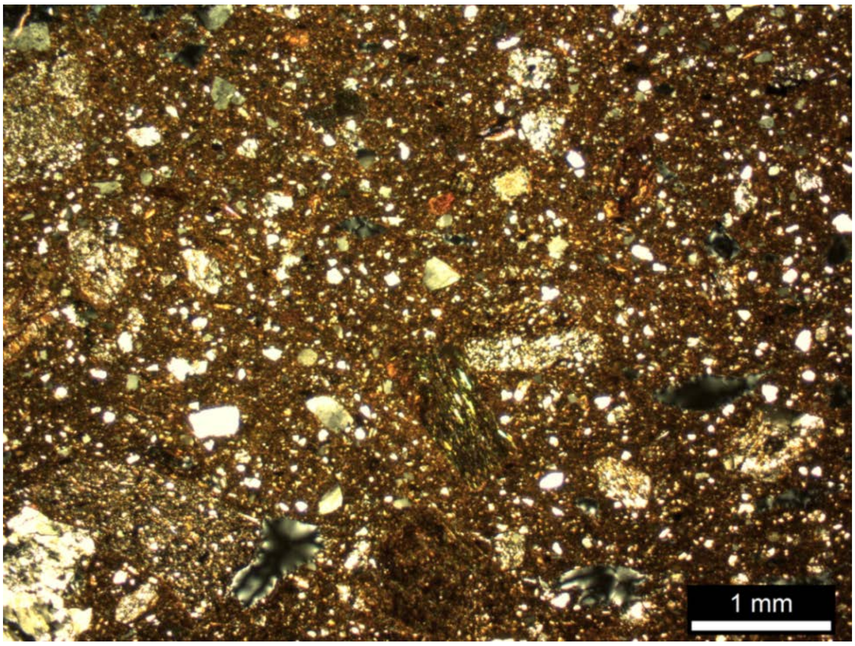

Figure 6.12: Fabric Group 8 in XP (Acropolis 13/37).

6.2.2 Aeginetan Fabrics

The following fabrics have been assigned a production origin on the island of Aegina according to their mineralogical composition and, where possible, a comparison to published fabrics assigned to a production on Aegina. There are two main groups: low calcareous volcanic and calcareous volcanic. These follow the same pattern as Fabric Groups 1 and 2 as published by Gauss and Kiriatzi (2011). The intermediate volcanic rock fragments, fresh plagioclase feldspar (*Andesine*) and brown amphibole (*Hornblende*) grains are all consistent with the raw materials available for pottery production on the island of Aegina (Gauss and Kiriatzi 2011: Dietrich et al. 1991). The production area can be narrowed down to the northern part of the island as this is where the majority of the Neogene sediments of a similar composition are found (Gauss and Kiriatzi 2011; Dietrich et al. 1991). The ancient site of Kolonna is well known for pottery production in past periods of the Bronze Age (Gauss and Kiriatzi 2011; Hein et al. 2004c; Mommsen et al. 2001; Zerner 1986, 1993), but there are few Bronze Age remains after Late Helladic IIIA (Gauss and Kiriatzi 2011; Pullen and Tartaron 2007; Tartaron 2014). This study, in combination with previous typological work demonstrates that, despite the apparent abandonment of settlement at Kolonna, production of the distinctive cooking vessels and fineware of Aegina continued into the transitional LH IIIB-IIIC early period and beyond.

In this Late Mycenaean period, Fabric Group 9A, ultimately used in the production of cooking vessels, is one of the most circulated ceramic fabrics in the Saronic Gulf illustrating the continued production for export in the northern part of Aegina. Beyond cooking vessels, the production of fineware vessels, including deep bowls, kylikes, etc. and storage vessels continues during this period, though the distribution is perhaps more restricted than the cooking vessels. Lastly, there is the addition of a new ceramic type added to the production repertoire at this period, the large tub (*asamanthos*). This vessel has no previous comparanda with Aeginetan origins and shares certain technological features with other large tubs produced in centres around the Saronic Gulf.

6.2.2.1A FG 9A: Low calcareous volcanic

Group Members	Region of Deposition	Vessel Type
Acropolis 13/02,6	Attica	Chytra, spouted krater
Alimos 12/98-106	Attica	Tripod cooking pots, chytras
Ayios Konstantinos 12/01-18,24,27,56	Troezinia	Chytras, tripod cook pots, jars, a "closed vessel" and an "offering table"
Cave of Euripides 12/13	Salamis	Tripod cooking pot
Dokos 12/01-4	Argo-Saronic	Amphora, cooking jar, chytra and jar
Kanakia 07/46-65,72-74,77 Kanakia 10/08-13	Salamis	Basins, cooking jars, chytras, tripod cook pots, lids, medium "closed vessels" and two pithoid jars
Plaka 10/01,3-5	Attica	Chytras

Table 6.13: Members of the 'Noncalcareous volcanic' fabric group.

Fabric Group 9A (Table 6.13; Figure 6.13) is the same fabric as the *Noncalcareous volcanic fabric* described and published by Gauss and Kiriatzi (2011: 93-99). It is manufactured using coarse, homogeneous, biotite- and amphibole-rich terra rossa clay that is tempered with porphyritic fine grained intermediate igneous rock fragments. These rocks are identified as Porphyritic Andesite and Dacite. The difference between the two is the proportion of glassy matrix, Dacite has a high ratio of quartz to feldspar and the matrix displays low 1st order birefringence, while Andesite has a high ratio feldspar to quartz and the matrix is nearly isotropic. These rock types are prevalent throughout the island of Aegina (Dietrich et al. 1991) and are present in pottery production since the Neolithic and Early Bronze Age (Gauss and Kiriatzi 2011; Burke et al. in press). In terms of firing conditions, the vessels are very red in colour and there is a moderate to high degree of optical activity in the groundmass indicating fairly low temperatures in a primarily oxidising atmosphere. The blackened areas of the matrix in many of these samples are due to post-production heating events such as cooking.

Though this fabric is primarily used in the production of coarse vessels used for preparing and cooking food, other shapes are produced including amphorae, basins, jars and pithoid jars. One of the most interesting artefacts produced in it is a hand-formed "offering table" from the sanctuary site of Ayios Konstantinos. Ayios Konstantinos is located on the Methana peninsula, whose rock formations are also rich in andesite and dacite. Indeed the "offering table" is constructed in an identical fashion as the cooking vessels, from the same raw materials, hand-made and is relatively low fired.

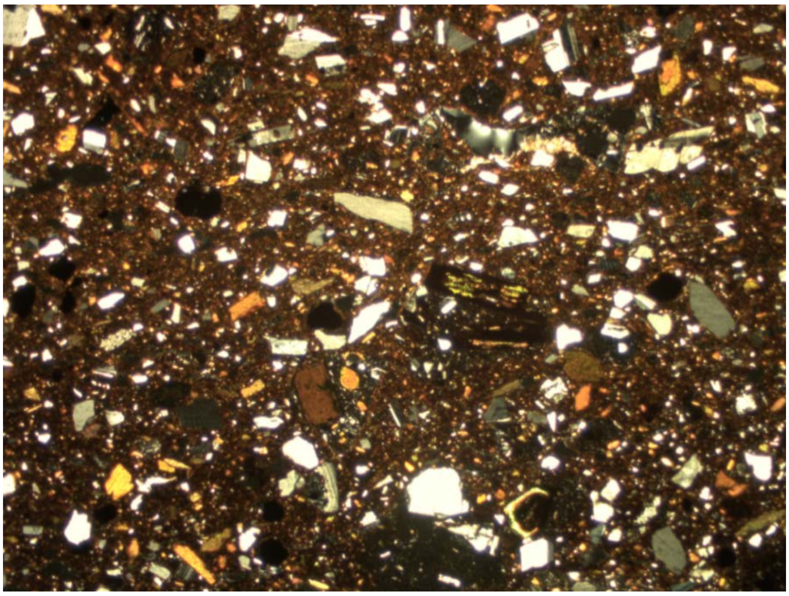

Figure 6.13: Fabric Group 9A in XP (Ayios Konstantinos 12/17).

From a technological perspective, this vessel, as well as all the cooking vessels and some jars found at Ayios Konstantinos were manufactured in the same manner as those vessels in this fabric from other sites in the Saronic Gulf. All are readily identified as being of Aeginetan production. There have been previous attempts to identify pottery production on Methana and nearby Poros with limited success (Dorais and Shriner 2002; Dorais et al. 2004; Shriner and Dorais 1999; Zerner 1986, 1993). None of these studies has demonstrated either that pottery production occurs on the Methana peninsula during the Bronze Age, or that amphibole rich clays used in the production of the cooking vessels comes from anywhere other than Aegina. The main analytical results of Dorais and his team have indicated that there is variation in the internal amphibole composition. However Hein et al. (2004c) have shown that the bulk chemical composition of these fabrics are compatible with production on Aegina, as have Gauss and Kiriatzi (2011) using ICP-OES. The results of the bulk chemistry of the vessels from Ayios Konstantinos in this study are compared to both those from around the Saronic Gulf and to the reference groups constructed by Hein et al. (2004c) in order to distinguish if there is any possibility that these vessels were produced anywhere other than on Aegina. This is to be certain there are not multiple centres of production with similar geology and geochemistry, however unlikely that seems given the long lasting technological tradition of cooking pot production on Aegina, the identical manufacturing technique of all cooking vessels from Ayios Konstantinos, including the handmade offering table. Ayios Konstantinos and the Methana peninsula have no record of production.

6.2.2.1B Fabric Group 9B: Low calcareous volcanic with organics

Group Members	Region of Deposition	Vessel Type
Ayios Konstantinos 12/20	Troezinia	Tub
Ayios Konstantinos 12/21	Troezinia	Tub
Ayios Konstantinos 12/25	Troezinia	Pithoid jar
Ayios Konstantinos 12/26	Troezinia	Pithos
Dokos 12/09	Argo-Saronic	Tub
Kanakia 7/75	Salamis	Pithos
Kanakia 7/76	Salamis	Pithoid jar
Kanakia 7/78	Salamis	Pithoid jar
Kanakia 7/79	Salamis	Pithoid jar

Table 6.14: Members of the ‘Noncalcareous volcanic with organics’ fabric group.

Fabric Group 9B (Table 6.14; Figure 6.14) is manufactured using the identical raw materials to FG 9A, with the addition of organic plant matter. The organic matter is observed in the void microstructure as elongated and curved macro- and megavughs. The shape of the voids, commonly with a rounded area on one side and the opposite end culminating in a point, indicates that these voids are made using chaff. The addition of organic temper to an existing fabric recipe in order to produce large vessels such as tubs or pithoi is technologically similar to the contemporary tub production at Kontopigado in Attica. Organic tempering of large vessels on Aegina is not a common practice and appears to come into practice during the LH IIIB-IIIC early transition. This coincides with the addition of the large tub as a vessel shape into the production repertoire. Since this phenomenon occurs within these two and other contemporary production traditions in this study, it seems that the development of this shape and the technological practice of organic tempering are introduced into the Saronic Gulf during this period.

As with the Attic tubs and storage jars, the distribution of these vessels is not widespread. They are found at Ayios Konstantinos and at the settlement of Myti Kommeni on the islet of Dokos, while the storage jars are found Ayios Konstantinos and on the acropolis at Kanakia. There are no large or coarse vessels that were studied as part of the Lazarides assemblage, thus it is unknown if these vessels, or the cooking vessels, are present at this Aeginetan settlement, however it is probably safe to assume that they were used there.

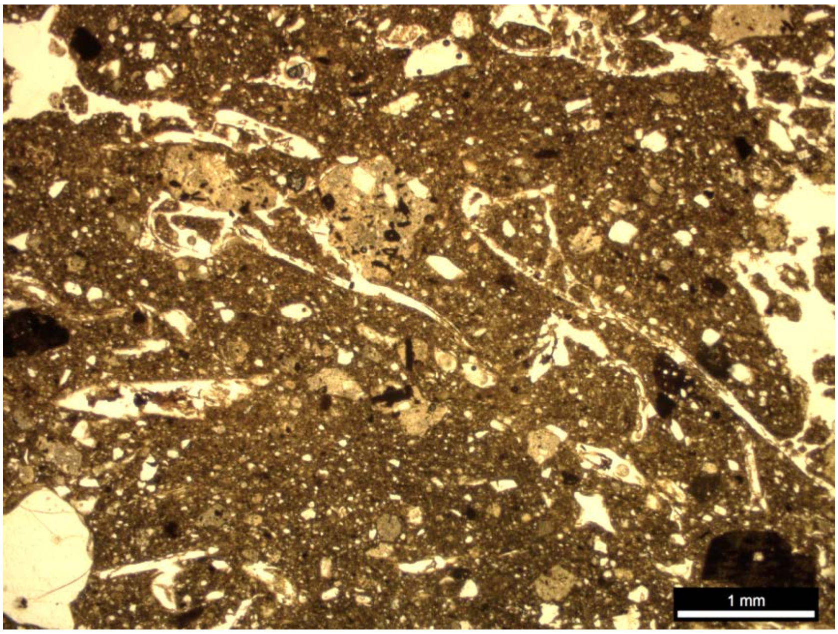

Figure 6.14: Fabric Group 9B in PPL (Ayios Konstantinos 12/21). Elongated voids are remains of organic vegetal matter.

6.2.2.2 Fabric Group 10, 10Af, 10Am and 10b: Calcareous volcanic fabric

Group Members	Region of Deposition	Vessel Type
Cave of Euripides 12/17	Salamis	Deep bowl
Kalamianos 12/21	Corinthia	Stemmed bowl
Lazarides 12/15	Aegina	Deep bowl

Table 6.15: Members of the ‘Fine calcareous volcanic’ fabric subgroup.

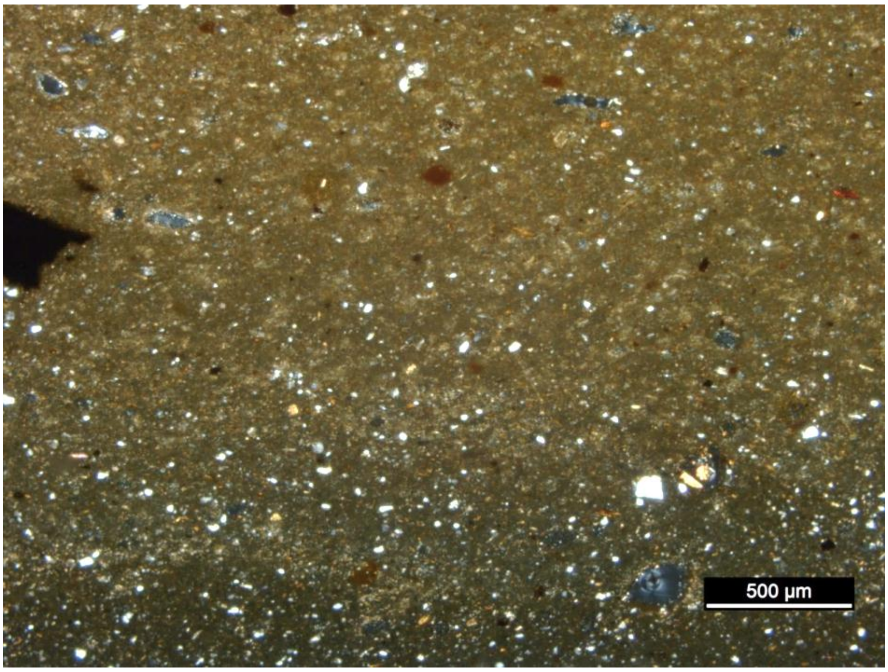

Figure 6.15: Fabric Group 10Af in XP (Lazarides 12/15).

Group Members	Region of Deposition	Vessel Type
Cave of Euripides 12/01	Salamis	Amphora/hydria/jug

Table 6.16: Members of the 'Moderately fine calcareous volcanic' fabric subgroup.

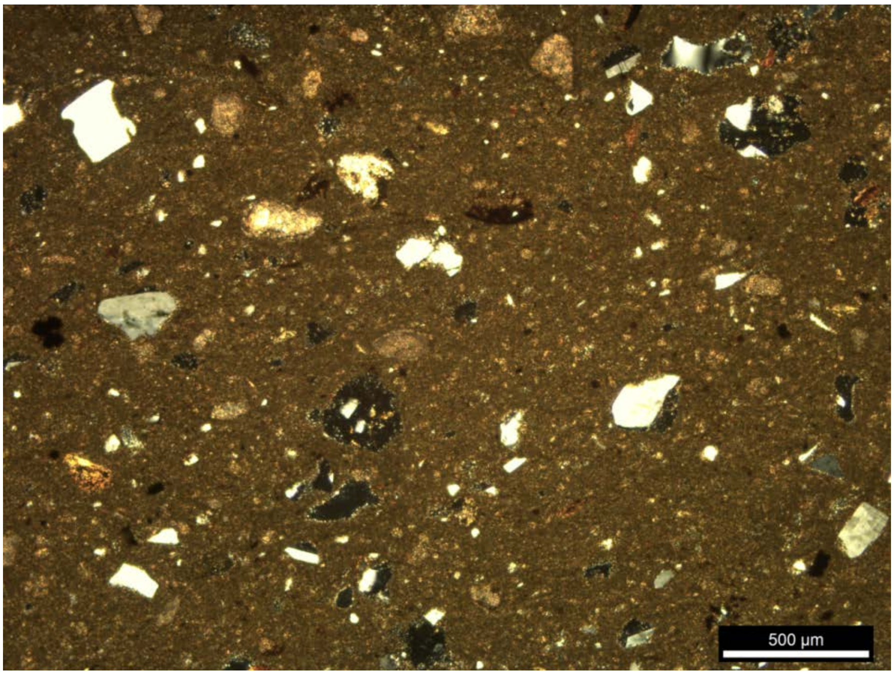

Figure 6.16: Fabric Group 10Am in XP (Euripides' Cave 12/01).

Group Members	Region of Deposition	Vessel Type
Ayios Konstantinos 12/52, 53,55,65	Troezinia	Deep bowl, carinated kylikes, jar,
Eleusis 12/05,12	Attica	Jar, hydria
Kanakia 07/31,33,40,44,83,90	Salamis	Deep bowls, kylix, basin, shallow bowl
Lazarides 12/01-5,7,8,10,14,17-23,25-27,30	Aegina	Deep bowls, kraters, a skyphoid krater and an amphora

Table 6.17: Members of the ‘Calcareous volcanic’ fabric subgroup.

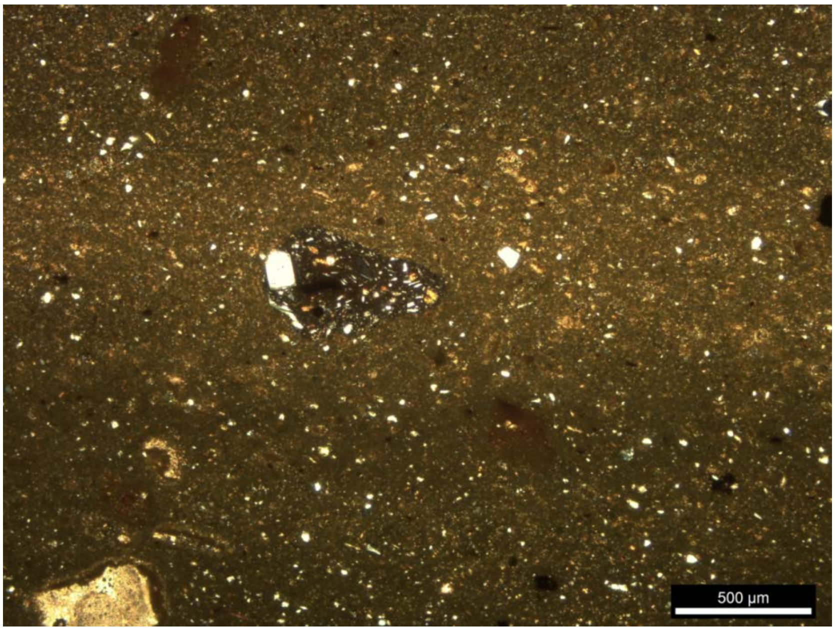

Figure 6.17: Fabric Group 10B in XP (Lazarides 12/02).

These three groups are subgroups of a single fabric that is identical to the *Calcareous volcanic fabric* described in Gauss and Kiriatzi (2011: 99-104). These three variations are originally published by Gauss and Kiriatzi as Fabric Group 2Af (fine) (Table 6.15; Fig 6.15), Fabric Group 2Am (moderately fine) (Table 6.16; Figure 6.16) and Fabric Group 2B (Table 6.17; Figure 6.17). The names and premise for sub grouping has been kept to maintain consistency in the grouping of regional ceramic fabrics in the Saronic Gulf.

This is a group of very fine to moderate fine fabrics with few inclusions (2-22%) in a moderately homogeneous calcareous and greenish firing matrix. Optical activity is low to inactive indicating high firing. The lack of inclusions in the matrix, or in the case of FG 10B the fine fraction, may suggest some form of subtractive processing occurred (i.e. levigation, sieving) before the forming stage of production. Inclusions are comprised of fine particles of volcanic rock, such as those observed in FG 9A and 9B and their constituent minerals, i.e. brown hornblende amphibole, plagioclase feldspar(andesine), pyroxene and quartz. Micrite is common, but other carbonate forms are more rare; these include microfossils such as foraminifera and shell. Although Gauss and Kiriatzi (2011: 99) mention the presence of siliceous microfossils (e.g. sponge spicules and diatoms), they have not been observed in these samples. The volcanic inclusions are compatible with the amphibole andesite and rhyodacite outcrops found on the north half of the island of Aegina. Looking at the technological detail begs the question of whether this group is produced by the same workshop that makes FGs 9A and 9B. These vessels are made from heavily processed calcareous clays and are high fired, while those from FGs 9A and 9B are coarse textured are low fired. This question will be addressed in detail in Chapter Seven.

There are two main subgroups, FG 10A and FG 10B, which are divided mainly due to the abundance of overall inclusions and grain size distribution. FG 10A has been further subdivided in order to account for the predominant lack of inclusions in FG 10Af (fine). Therefore FG 10Am represents a medium coarse version of FG 10Af, but has a lower inclusion density than FG 10B. The whole of FG 10 has a rather limited range of distribution with the bulk of these samples occurring as part of the local Lazarides assemblage. Few examples are found abroad, but those that are provide indirect details towards understanding the extent of the shapes being produced in this fabric.

6.2.3 Possible Corinthian Fabrics

There are six fabrics that have evidence to suggest that they are produced in the region of Corinthia, probably at or near Ancient Corinth. It must be stressed however, that the following fabrics are representative of regional geology in Corinthia and have not been linked to any specific production site. The first fabric group is also the largest and consists of fine drinking, mixing and serving vessels with the addition of five bovine figurines from the sanctuary at Ayios Konstantinos. The next group is also used for the production of fineware vessels while the subsequent four fabrics represent both tub and large storage jars. These fabric groups have been attributed to the region of Corinthia based on a comparison of their mineralogical composition with the geological formations local to this area. Corinthia encompasses both the isthmus and the northeast corner of the Peloponnese and is very diverse geologically. The fabric groups exhibit a similar geological diversity in their mineralogical composition ranging from green calcareous bodies to bioclastic limestone to silicified volcanics to ophiolites. Much of the inclusions observed in these fabrics are compatible with the Shale-Sandstone-Radiolarite formations that crop out near the Geraneia Mountains, in the vicinity of Haghioi Theodoroi, Penteskouphia and Acrocorinth (Whitbread 2003: 2-3). Farnsworth (1970) and, more recently, Whitbread (2003) have completed rigorous systematic studies of the clays surrounding the area of Corinth finding it very difficult to match the modern clays source to the clays used by ancient potters. Yet they were able to find several green to yellow firing calcareous clays near the ancient potter's quarter and at Acrocorinth.

Although rarely mentioned in the literature as major pottery producers during the end of the Late Bronze Age, petrographic analysis of several pottery assemblages indicates that Ancient Corinth indeed played the role of producer in this period. It seems that in addition to green firing finewares, Ancient Corinth was also producing large coarse vessels such as tubs and pithoid jars. These fabrics are characterised by the presence of mudstone or tuffites and heavily altered, perhaps silicified, volcanic rocks. The tubs are produced using a combination of the mudstone and tuffites, altered volcanic rock and vegetal temper while the large jars are produced either with both altered volcanics and mudstone and tuffite or mudstone and tuffite temper alone. Serpentinite is common in the ophiolitic outcrops of near the Geraneia Mountains and at Acrocorinth and there are known serpentiniferous fabrics, considered local from Korakou in the EBA (Burke at al. in press).

6.2.3.1 Fabric Group 11: Fine greenish firing with biotite

Group Members	Region of deposition	Vessel type
Acropolis 13/12,17, 25,27	Attica	Carinated kylix, krater, "open" and "closed vessels"
Ayios Konstantinos 12/28,31-33,35,37,46,51,62,63	Troezinia	Bovine figurines, deep bowls and "open vessels"
Alimos 12/11,17,113	Attica	Alabastron, kalathos, deep bowl
C.of Euripides 12/19-21	Salamis	Fine stirrup jars and stemmed bowl
Dokos 12/06,10	Argo-Saronic	Kylix, squat stirrup jar
Eleusis 12/03,8,14	Attica	Jar, kylix, stirrup jar
Kalamianos	Corinthia	Kylikes, carinated

12/16,18,20,24,29,31-37,39,41,43,47,52,59,62,73-75		kylikes, deep bowls, stemmed bowls, fine jars, an askos, a piriform jar, kraters
Kanakia 7/36-39,41, 43	Salamis	Deep bowls, stemmed bowl, kylix and a fine stirrup jar
Lazarides 12/28	Aegina	Kylix
Stiri 12/101,102,105,108,109,125-127,137	Corinthia	Deep bowls, stemmed bowls, kylikes

Table 6.18: Members of the 'Fine green firing with Biotite' fabric group.

Fabric Group 11 (Table 6.18; Figure 6.18) is very fine, with very rare coarse inclusions, and is used in the production of high quality drinking and mixing vessels. The extremely fine nature of the inclusions perhaps suggests that the raw materials used to produce this fabric underwent subtractive preparation (i.e. sieving or levigation). The fine grain size of the inclusions make it difficult to determine a production origin, however, there are noticeable serpentinite, calcareous microfossils, siliceous radiolarian microfossils and calc-silicate sandstone. These inclusions are highly compatible with the Shale-Sandstone-Radiolarite formations of the Corinthia. Sedimentary formations are common throughout both the Argolid and Corinthia, but the Shale-Sandstone-Radiolarite formations of Corinthia are known to be exploited by Corinthian potters throughout prehistory and historical periods, suggesting a plausible production origin at Corinth. This group has previously been published by Gauss and Kiriatzi (2011) as their FG 10, which they have tentatively assigned to the Argolid as it has a chemical composition corresponding to the Mycenae-Berbati group (Asaro and Perlman 1973; Perlman and Asaro 1969; Mommsen et al. 2002). With the present mineralogical evidence, this fabric is assigned a provenance in the region of Corinthia, probably near Ancient Corinth. In order to test this assumption, the geochemical data of this group are compared to the original Mycenae-Berbati reference group and the Corinth reference group (Farnsworth et al. 1977) to determine if it is possible to chemically discriminate Corinthian fine fabrics from those of the Argolid.

Determining a production location for this group is important in understanding Ancient Corinth's role during this period of the Late Bronze Age. This fabric represents a major portion of the entire assemblage in this study and has a very broad range of distribution. It is found in every major context and makes up the majority of the studied assemblages from Kalamianos and Stiri in the nearby southwest Corinthia, and at Ayios Konstantinos on the Methana peninsula to the south. It was used in the production of five out of the seven studied bovine figurines found at Ayios Konstantinos showing a clear link between Corinth and this religious sanctuary. Beyond Corinthia and Methana, this fabric is found at Lazarides on Aegina, at Kanakia and in the Cave of Euripides on Salamis and at the sanctuary at Eleusis, the Acropolis in Athens, the production site at Kontopigado, Alimou and as far away as Dokos off the southern tip of the Argolic peninsula. The breadth of its distribution suggests that its producers were manufacturing these fine vessels with the intent of export at least within the trade networks of the Saronic Gulf.

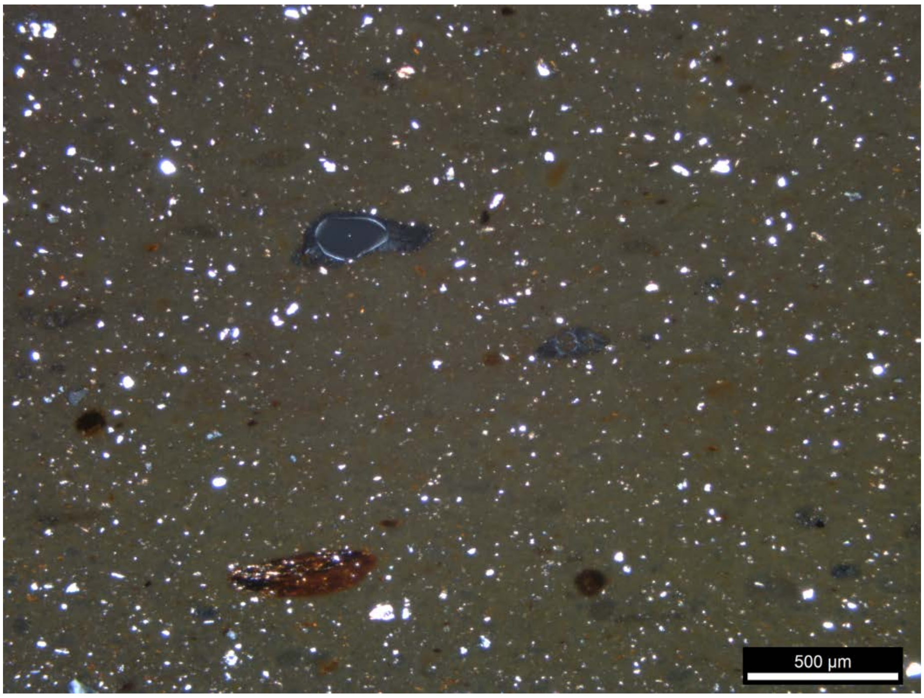

Figure 6.18: Fabric Group 11 in XP (Euripides' Cave 12/20).

6.2.3.2 Fabric Group 12: Bioclastic limestone

Group Members	Region of Deposition	Vessel Type
Cave of Euripides 12/10	Salamis	Medium stirrup jar
Cave of Euripides 12/12	Salamis	Deep bowl

Table 6.19: Members of the 'Bioclastic limestone' fabric group.

Fabric Group 12 (Table 6.19; Figure 6.19) has a fine matrix. The red amorphous TCFs may indicate that the matrix is a mixture of more than one clay body. However, there are not enough data to be sure of that these TCFs are not natural inclusions. There are calcareous wackestones in the coarse fraction which may be part of the matrix raw material. The majority of inclusions in this fabric are derivative of bioclastic limestone and appear to have been disaggregated. Bioclastic limestone found in the Geraneia Mountains near Perachora and fossiliferous limestone is present throughout the region of Corinthia, including at Acrocorinth (Whitbread 2003; Whitbread et al. 2007). Although the secondary calcite deposits obscure much of the matrix, the groundmass is optically inactive, leading to the conclusion that the two vessels that make up this fabric are high fired while their buff exterior appearance and yellow-brown birefringence colour indicate a controlled oxidising atmosphere.

These two vessels from the Cave of Euripides are the only of this fabric within the study. The fabric probably originates in the region of Corinthia, but there is not enough data to indicate the exact production location and there are other areas where biomicrite occurs, including northeast Salamis (Papavassiliou et al. 1982a). The two vessels are a medium stirrup jar and a deep bowl, two types also represented in the main Corinthia fineware group, FG 11. Technologically, this group and FG 11 are distinct from one another, but both are compatible with Corinthia suggesting that there are more than one fineware producer in this region.

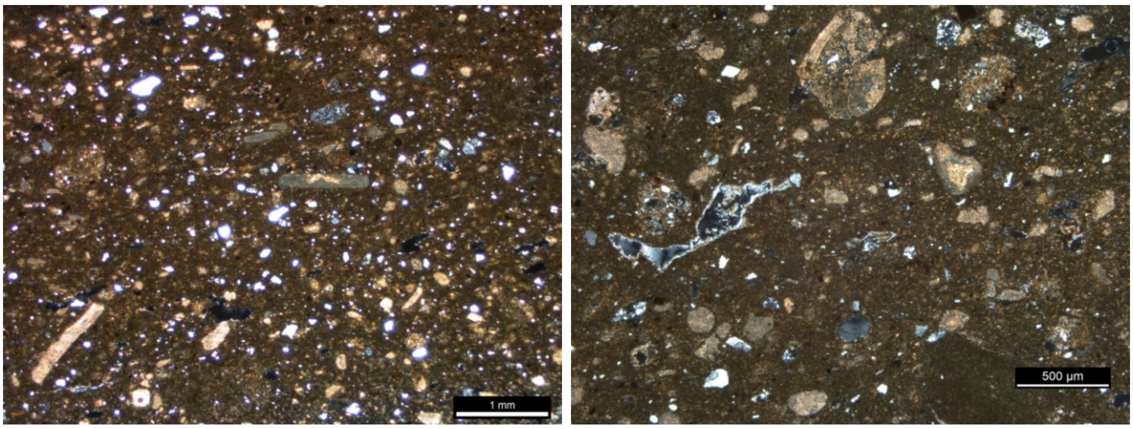

Figure 6.19. Variants of Fabric Group 12 in XP. Euripides' Cave 12/10 (left); Euripides' Cave 12/12 (right).

6.2.3.3 Fabric Group 13: Serpentinite

Group Members	Region of Deposition	Vessel Type
Kanakia 7/66	Salamis	Tub
Kanakia 10/15	Salamis	Tub
Plaka 10/40	Attica	Tub

Table 6.20: Members of the 'Serpentinite' fabric group.

Fabric Group 13 (Table 6.20; Figure 6.20) is defined by coarse serpentinite rock fragments, tuffaceous mudstone and altered igneous rock set in a coarse matrix. The raw materials are derived from deposits of tuffaceous material that is grading into mudstone and serpentiniferous deposits from ophiolite outcrops. These raw materials are compatible with the region of Corinthia, specifically the Shale-Sandstone-Radiolarite formations near Acrocorinth, as those outcrops contain altered igneous and tuffaceous rock types (Whitbread 2003: 3) in addition to being near ophiolitic deposits (Yannetakis et al. 1972). Plaka 10/40 is higher fired and lacks the heavily altered plutonic rocks and the elongated macrovughs that are characteristic of organic temper. However, the micromass and serpentinite are compatible with the other samples within this fabric group, hence it was included in this fabric. This fabric is used to produce large tubs, similar in shape to those produced on Aegina and at Kontopigado, and is similar in composition to a fabric produced near Korakou in southwestern Corinthia during the Early Bronze Age (Burke et al. in press).

This fabric is found at Kanakia on Salamis and at Plaka in Athens, Attica. Both of these sites have large tubs from more than one producer in their pottery assemblage. Moreover, both of these sites are closer to the production sites at Kontopigado and on Aegina. Tubs are very large and cumbersome to transport, even if the majority of the journey was by sea. , Thus the practicalities, motives and mechanisms of exchange are worth considering. Why were similar vessels from the local tub production not used at Plaka, for instance?

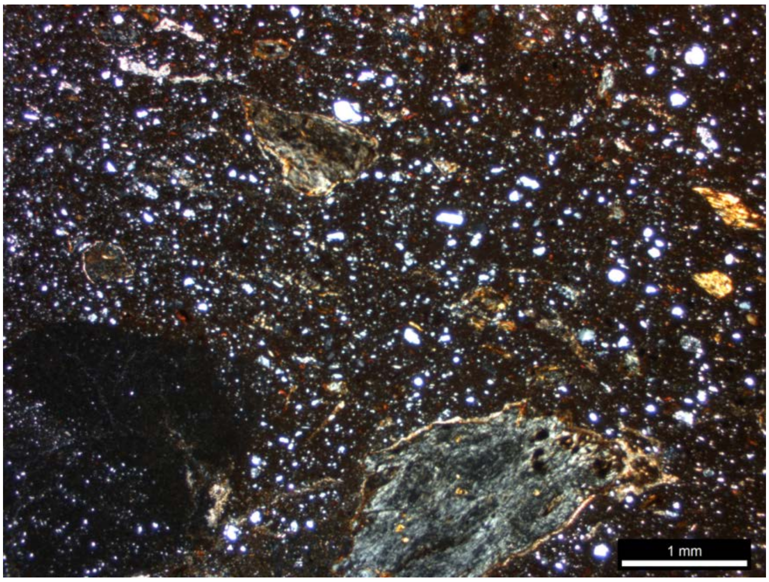

Figure 6.20: Fabric Group 13 in XP (Plaka 10/40).

6.2.3.4 Fabric Group 14: Volcaniclastic with vegetal temper.

Group Members	Region of Deposition	Vessel Type

Kanakia 7/69	Salamis	Tub
Kanakia 7/70	Salamis	Tub

Table 6.21: Members of the 'Volcaniclastic with vegetal temper' fabric group.

Fabric Group 14 (Table 6.21; Figure 6.21) is constructed with a mixed matrix and tuffaceous rock, mudstone and micritic limestone inclusions added as temper. There is a lithicwacke sandstone that is related to these other inclusion because it contains all three within a Fe-rich matrix. The geological deposits that these inclusions come from are related to the volcaniclastic and ophiolite formations of the Corinthia (Yannetakis et al. 1972), likely near Acrocorinth as suggested by the serpentinite and altered (sericitised?) igneous inclusions. This fabric is used in the production of large tubs and contains elongated macrovughs in the microstructure that are characteristic of organic temper. This is the fourth tub fabric in that Saronic Gulf and the fourth tub fabric that includes organic temper. That these vessels derive from near Ancient Corinth indicates that there are at least two different tub productions coming from this area. More so, the use of organic temper in a fabric used to produce tubs is highly significant as this indicates that the technical practice of organic tempering of large vessels is spread throughout the Saronic Gulf. This fabric is manufactured in the same manner as FG 15 and shares the same origin of production. Lastly, these tubs were found at the acropolis of Kanakia on Salamis and represent the third tub fabric imported to that site.

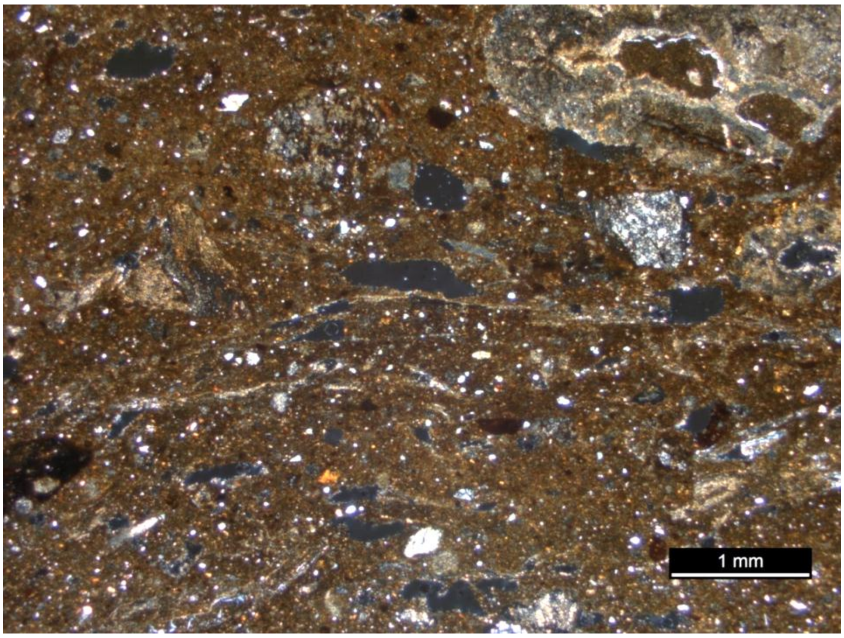

Figure 6.21: Fabric Group 14 in XP (Kanakia 07/69).

6.2.3.5 Fabric Group 15: Volcaniclastic

Group Members	Region of Deposition	Vessel Type
Kanakia 7/81	Salamis	Pithoid jar
Kanakia 7/82	Salamis	Pithoid jar
Kanakia 10/14	Salamis	Pithos/pithoid jar

Table 6.22: Members of the 'Volcaniclastic' fabric group.

Fabric Group 15 (Table 6.22; Figure 6.22) is related to the heavily altered igneous rocks (Tuffite) and vegetal temper fabric (FG 14). It is manufactured using identical raw materials, in terms of the matrix and rock temper, with the only difference being the lack of organic temper in FG 15. It derives from the tuffaceous deposits in Corinthia and is the third large storage jar fabric found at Kanakia. The high degree of optical activity in the groundmass suggests that these vessels were low fired, another feature consistent with FG 14.

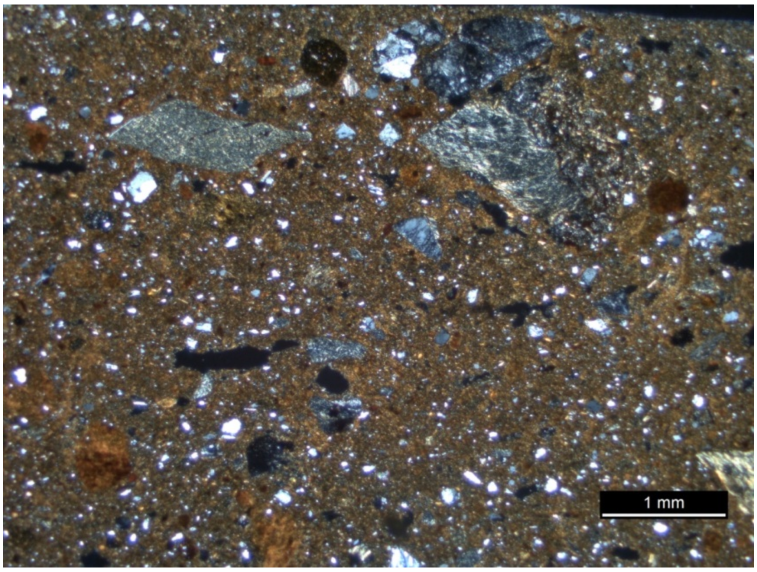

Figure 6.22: Fabric Group 15 in XP (Kanakia 07/81).

6.2.3.6 Fabric Group 16: Tuffaceous and altered basic igneous rock

Group Members	Region of Deposition	Vessel Type
Kanakia 7/80	Salamis	Pithoid jar

Table 6.23: Member of the 'Tuffaceous and altered basic igneous rock' fabric group.

Fabric Group 16 (Table 6.23; Figure 6.23) is another coarse storage jar fabric with tuffaceous rock temper. The tuffite in this fabric is compositionally different from those in FG 14 and FG 15. These are angular, elongated greyish tuffites with mineral relic structures. The tuffite inclusion in this sample has microfossil inclusions as well.

The altered basic igneous rock, however, is similar to that found in FG 14 and FG 15. The lack of optical activity suggests that this sample was fired at relatively high temperatures while the greyish colouring of the core implies that this vessel was subjected to a reduction atmosphere at some point during the firing. Though definitively different, this fabric is related to both FG 14 and FG 15 and has an origin in Corinthia according to the composition of the inclusions. This is the fourth storage jar fabric found at Kanakia and the second from Corinthia.

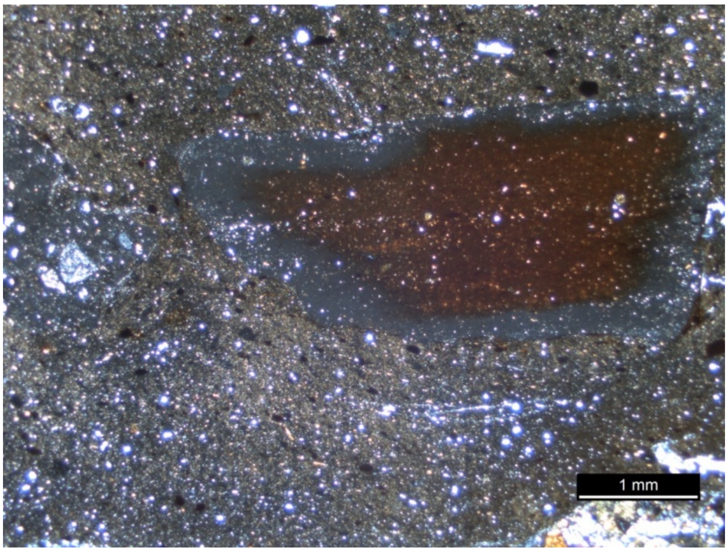

Figure 6.23: Fabric Group 16 in XP (Kanakia 07/80).

6.2.4 Kean fabrics

There are two samples that can be suggested to have a production origin on the Cycladic island of Kea, comparable to fabrics from Ayia Irini. Kea is an island that sits on the Attic-Cycladic Metamorphic belt (Massif). There are several outcrops of blueschist facies metamorphic rocks on Kea as a result of the regional metamorphism that form the island (Papavassiliou et al. 1982b). Both samples are made from a highly micaceous groundmass with inclusions of blueschist fragments. They have been split here according the abundance, size of the inclusions, optical activity and firing horizons. Ayia Irini has a long standing tradition of pottery production (Wilson 1987) and contacts with Attica and the mainland are evident from very early on (Day, Hein and Douni pers. comm.) thus it is not surprising to see that Kean vessels are incorporated into the Attic and, perhaps, the wider Saronic Gulf exchange networks.

6.2.4.1A Fabric Group 17A: Medium blueschist

Group Members	Region of Deposition	Vessel Type
Alimos 12/96	Acropolis	Chytra

Table 6.24: Member of the ‘Medium blueschist’ fabric group.

Fabric Group 17A (Table 6.24; Figure 6.24) is characterised by a medium coarse matrix derived from a mica-rich metamorphic parent rock material with very coarse to fine sand sized subangular blueschist facies metamorphic inclusions. The constituent materials are suggestive of the blueschist that occurs in areas of regional metamorphism such as the lower part of the Attic-Cycladic Metamorphic belt (Georgakopoulos et al. 2007). At present there is no comparative material from the relevant geological zones, including southeastern Attica or southern Evvia, where rocks of this type crop up, however upon comparison with pottery Ayia Irini Phase II and III (Day. pers. comm.) in the northern part of the Cycladic island of Kea, several samples produced using very similar raw materials were identified. Local geology of Kea includes outcrops of blueschist with a similar composition to those fragments found in this fabric, potentially indicating local production. A bimodal distribution of subangular disaggregated fragments of the rock material suggests that the schist was added to the matrix as temper. Homogeneous colour and texture combined with the high optical activity of the matrix indicate that this vessel was low fired in a consistently oxidized atmosphere. This is the third cooking pot fabric present within the Kontopigado assemblage, including the cooking vessels produced locally and is not presently found in any other context in the Saronic Gulf.

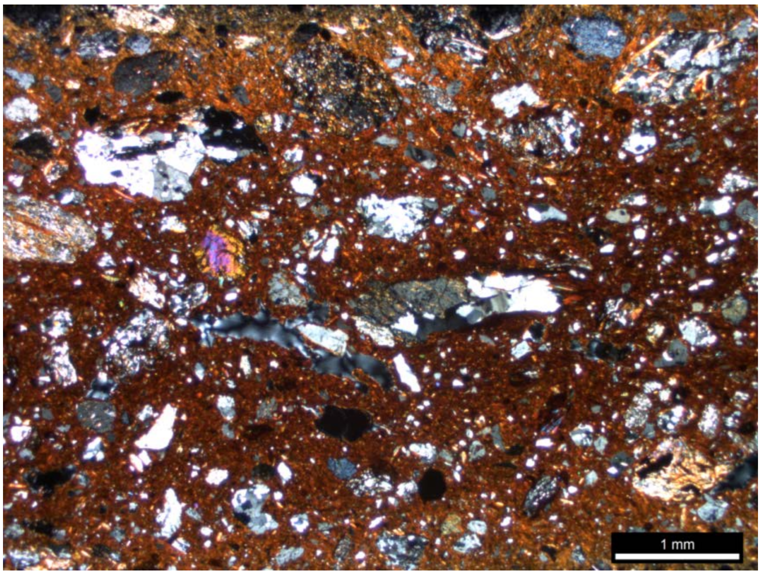

Figure 6.24: Fabric Group 17A in XP (Alimos 12/96).

6.2.4.1B Fabric Group 17B: Coarse blueschist

Group Members	Region of Deposition	Vessel Type

Alimos 12/79	Attica	Pithoid jar

Table 6.25: Member of the ‘Coarse blueschist’ fabric group.

Fabric Group 17B (Table 6.25; Figure 6.25) is constructed from a micaceous matrix that derivatives from decomposition of metamorphic parent rock and is the same as FG 17A. The texture of the groundmass is rather fine compared to the size of the inclusions. The colour is lighter near the edges and darker towards the core of the section and the groundmass is optically active. This indicates that the vessel was fired at relatively low temperatures. The dark core suggests that the vessel did not completely oxidise due to changes in the firing atmosphere (Rye 1981). A potential region of production is in the Attic-Cycladic Metamorphic belt (massif), potentially on the island of Kea, though, like FG 17A, comparative material of relevant material from southern Evvia and southeastern Attica are needed before these areas can be ruled out as potential places of production. This is the fourth storage jar fabric within the Kontopigado assemblage and the only one to have been imported into Attica.

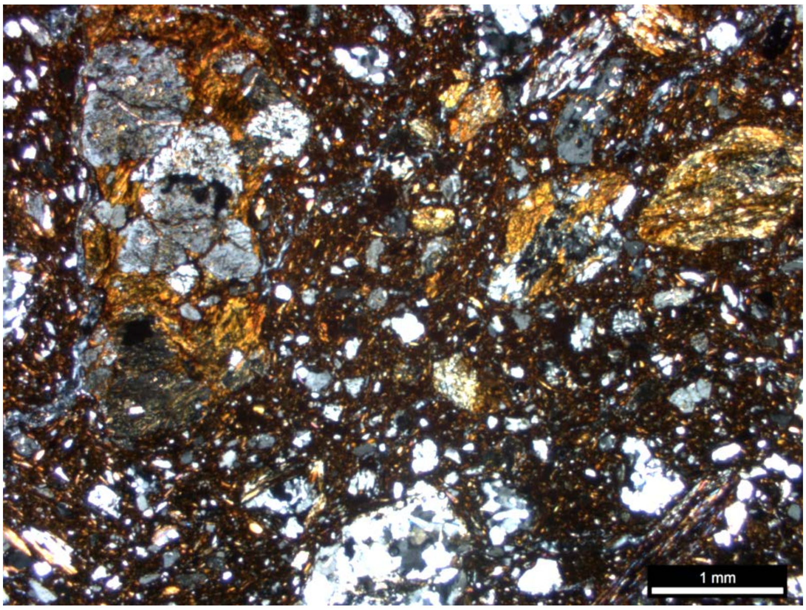

Figure 6.25: Fabric Group 17B in XP (Alimos 12/79).

6.2.5 Cretan fabrics

A number of jars have been found to have fabrics well known from the petrographic study of transport stirrup jars. Some are undiagnostic coarse vessels and two are wide-mouthed jars. Transport stirrup jars are used in trade and exchange as containers for value-added goods to transport liquid goods, such as unguents and oils, they are not exchanged for the vessels themselves rather for the goods they contain (Day et al. 2011: 513). As will be seen below, in most cases we can be confident in ascribing specific provenance for these in the Mesara, the Isthmus of Ierapetra and from the well-known Mycenaean centre of Chania.

6.2.5.1 Fabric Group 18: Biotite-Hornblende schist and phyllite

Group Members	Region of Deposition	Vessel Type
Kanakia 07/86	Salamis	Wide-mouth jar

Table 6.26: Member of the ‘Biotite-Hornblende schist and phyllite’ fabric group.

This fabric (Table 6.26; Figure 6.26) is composed of a micaceous, quartz-rich and calcareous matrix with rounded inclusions of metamorphic rock, probably added sand temper. The rounded inclusions are dominated by biotite schist and the sample belongs to the Main South-Central Crete Fabric A described by Day (Day et al. 2011, 522-523, Fig 3b, c; Shaw et al. 2001, Group 2a). The vessel originates in the Western Mesara Plain.

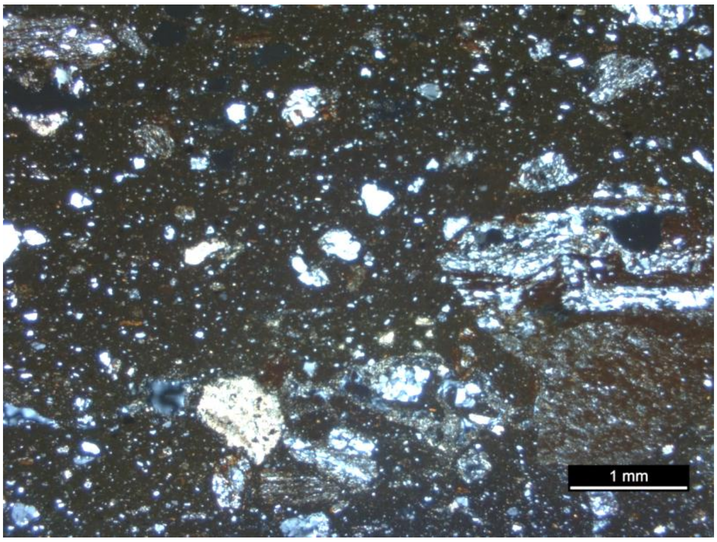

Figure 6.26: Fabric Group 18 in XP. (Kanakia 07/86).

6.2.5.2 Fabric Group 19: Granodiorite

Group Members	Region of Deposition	Vessel Type
Alimos 12/119	Attica	Transport stirrup jar

Table 6.27: Member of the ‘Granodiorite’ fabric group.

Fabric Group 19 (Table 6.27; Figure 6.27) is from a transport stirrup jar that is linked to production in East Crete. The fabric is composed of a fine calcareous matrix, tempered with intermediate igneous rock inclusions. The matrix is optically inactive and has a distinctive matte texture suggesting it is extensively vitrified from high firing temperatures. This fabric matches sample Kavousi 98/104, sampled to represent

Kavousi Type XIV macrofabric characterised by Haggis and Mook (1993: 276) in their coarseware fabric classification. It is similar to other fabrics observed in the LMIIIB-C period from the Vrokastro Survey which were studied by Martina Dalinghaus (Dalinghaus 1999, Vrokastro fabrics 10, 11 and 12; Plate VII B). Additionally, this fabric demonstrates similarities with other LMIIIC samples from Kavousi (Day et al. 2006, Group 2, 146-148, Fig. 5). This vessel was manufactured on the North coast of the Isthmus of Ierapetra in the Mirabello region of east Crete, more particularly from a production location between Gournia and Kalo Chorio.

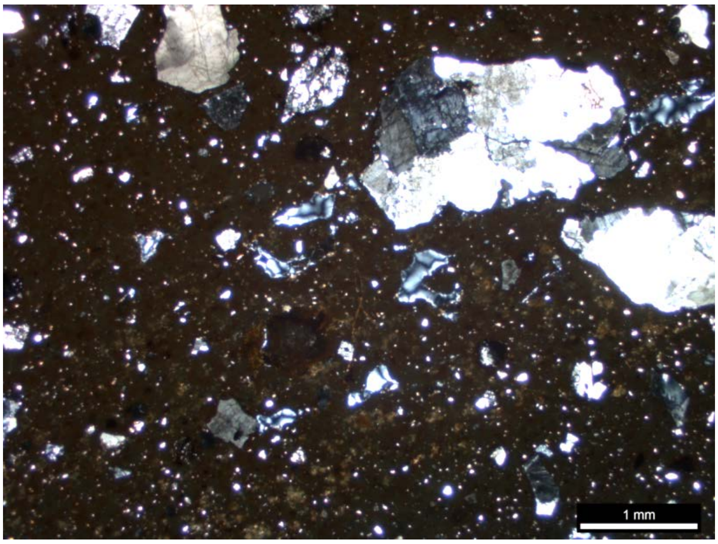

Figure 6.27: Fabric Group 19 in XP (Alimos 12/119).

6.2.5.3 Fabric Group 20: Quartzite, phyllite and schist

Group Members	Region of Deposition	Vessel Type
Dokos 12/5	Argo-Saronic	Closed vessel
Kanakia 07/87	Salamis	Closed vessel

Table 6.28: Members of the 'Quartzite, phyllite and schist' fabric group.

Fabric Group 20 (Table 6.28; Figure 6.28) is composed of a heterogeneous, quartz rich matrix containing low grade metamorphic rock fragments. The rock fragments consist of phyllite, mica schist and quartzite and derived from a phyllite quartzite series. It matches the main West Cretan fabric in Stirrup Jars which comes from Chania (Haskell et al. 2011, 42-44). This has wide distribution and has been found in a variety of sites, notably Chania, Tiryns, Mycenae, Thebes in the Mainland, Knossos, Kommos, Chania and Malia on Crete, as well as Enkomi on Cyprus and the Uluburun Shipwreck. The specific sample is an exact match for Inscribed Stirrup Jar KH 21, excavated at Chania.

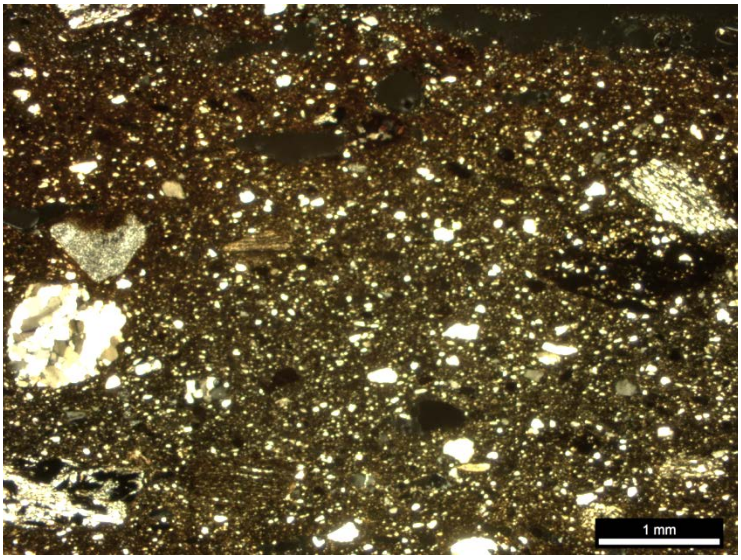

Figure 6.28: Fabric Group 20 in XP (Dokos 12/05).

6.2.5.4 Fabric Group 21: Phyllites and argillaceous rock

Group Members	Region of Deposition	Vessel Type
Kanakia 07/35	Salamis	Coarse stirrup jar

Table 6.29: Phyllites and argillaceous rock fabric samples.

Fabric Group 21 (Table 6.29; Figure 6.29) is another coarse stirrup jar fabric rich in phyllite. In addition to the phyllite inclusions are equant and generally rounded, dark red-brown ARF or mudstone fragments and quartzite fragments. The textural features indicate that this fabric was very poorly mixed and included at least two distinct clay materials. This fabric is very similar to FG 20, as the inclusions are derived from the Phyllite-Quartzite and is most probably a product of the Chania area. The clay pellets that characterise this particular sample are unfamiliar in Group 1 Stirrup Jars.

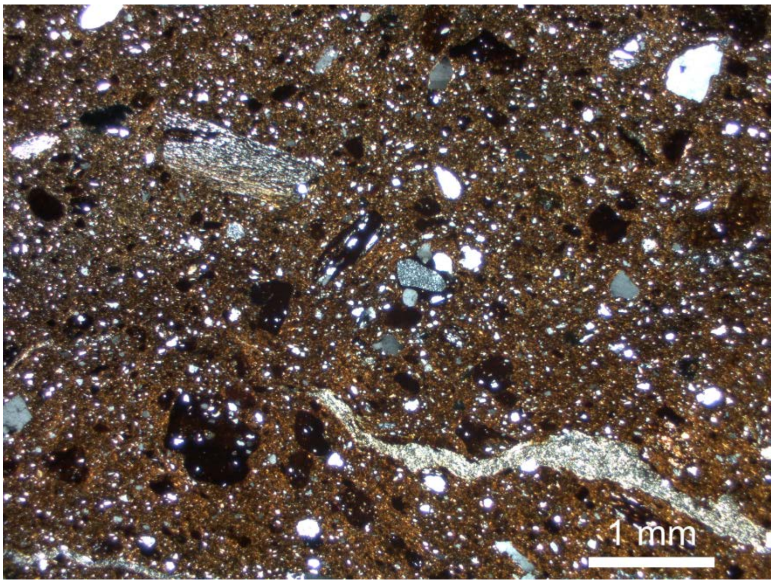

Figure 6.29: Fabric Group 21 in XP (Kanakia 07/35).

6.2.6 Fabrics of unidentified origin

There are several ceramic fabrics that have been recorded during this study where the origins of their production have yet to be determined. There are numerous reasons for this including a lack of comparative material, infrequent or non-discriminant inclusions or technological information to link these fabrics to any particular geographic location. In some cases, the mineralogy is too ambiguous to determine the location of production as several surrounding regions have similar geological formations. Many of these fabrics are single sherds that could not be assigned to any other fabric group while others have a significant number of group members. Where a tentative hypothesis about the potential place of production can be drawn it is mentioned in the text.

6.2.6.1 Fabric Group 22: Fine red with red TCFs

Group Members	Region of Deposition	Vessel Type
Ayios Konstantinos 12/41	Troezinia	Deep basin
Ayios Konstantinos 12/58	Troezinia	Closed vessel
Ayios Konstantinos 12/59	Troezinia	Closed vessel
Dokos 12/08	Argo-Saronic	Kylix
Kalamianos 12/56	Corinthia	Kylix
Kalamianos 12/60	Corinthia	Deep bowl
Lazarides 12/06	Aegina	Cup
Lazarides 12/09	Aegina	Deep bowl
Lazarides 12/12	Aegina	Deep bowl
Lazarides 12/13	Aegina	Deep bowl

Table 6.30: Members of the ‘Fine red with red TCFs’ fabric group.

Fabric Group 22 (Table 6.30; Figure 6.30) is a very fine fabric which is mica rich and red firing with very few inclusions. The main identifying features are the TCFs and the moderate optical activity, suggesting relatively high firing temperatures. The presence of foraminifera indicates that the raw material used in the matrix is from a Neogene deposit (Quinn and Day 2007), but there are several such deposits in the northeast Peloponnese. The TCFs and matrix are fairly distinctive however, perhaps chemical composition analysis will shed more light onto the origins of this fine fabric.

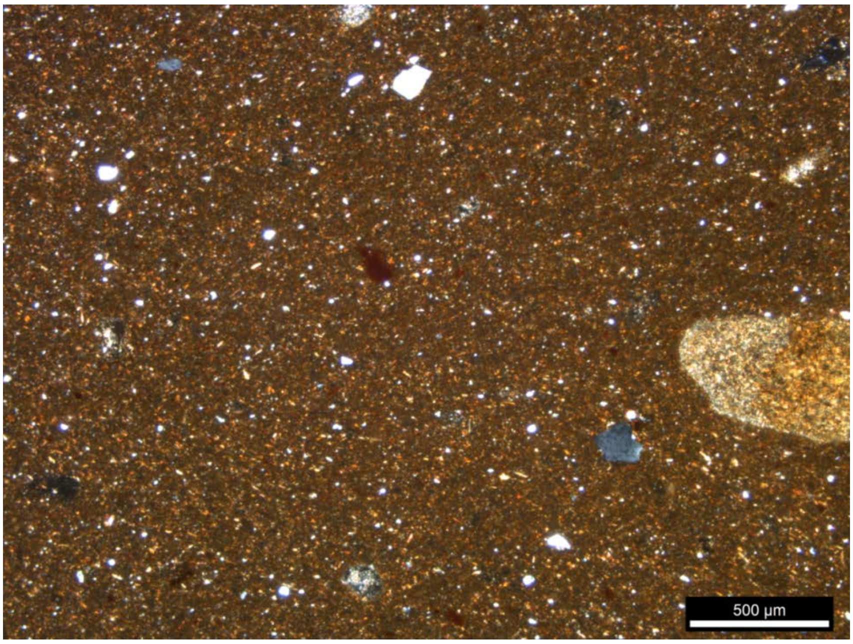

Figure 6.30: Fabric Group 22 in XP (Lazarides 12/09).

6.2.6.2 Fabric Group 23: Quartz mylonite

Group Members	Region of Deposition	Vessel Type
Acropolis 13/14	Attica	Coarse stirrup jar
Ayios Konstantinos 12/39	Troezinia	Closed vessel
Cave of Euripides 12/11	Salamis	Closed vessel
Kanakia 7/88	Salamis	Wide-mouth jar
Kanakia 10/04	Salamis	Piriform jar
Kanakia 10/07	Salamis	Medium stirrup jar

Table 6.31: Members of the 'Quartz mylonite' fabric group.

Fabric Group 23 (Table 6.31; Figure 6.31) is composed of a heterogeneous calcareous and micaceous matrix with cataclastic metamorphic rock fragments. The matrix is composed of at least two different clay materials one of which is represented in the TCFs present and the other by micrite. The strained texture of the TFCs and presence of "tails" trailing off the pellets parallel to the vessel margins is a clear sign of clay mixing. The fine texture of the micromass, in comparison to the size of the inclusions, suggests that the inclusions may have been added as temper. The inclusions are strongly bimodal in grain size, with the fine fraction very well sorted and the coarse fraction fairly poorly sorted. The fine fraction does not contain any of the cataclastic rock highlighting that the rock was added as a tempering material. The cataclastic rock is tentatively identified as Quartz Mylonite or Phyllomylonite according to the composition. Zones of rocks characterised by dynamic metamorphism are found in the Attic-Cycladic Metamorphic Belt (massif) (Andronopoulos et al. 1991; Gekas et al. 2003) and Quartz Mylonite and Phyllomylonite are both found in the Athens Schist outcrops. This fabric was not assigned an Attic provenance as there is no comparative material and this form of rock can be found in many areas surrounding Attica including Evvia and several islands in the Cyclades (Andronopoulos et al. 1991; Gekas et al. 2003; Papavassiliou et al. 1982b).

This fabric is variable in the abundance of coarse inclusions and could be split accordingly, however the raw materials are so strikingly similar as are the technological features of mixing micritic and iron-rich clays and using crushed metamorphic rocks as temper indicate that the vessels are probably from the same place of production. The members of the fabric group vary; Acropolis 13/14 is a coarse stirrup jar, and has approximately 40% temper while Kanakia 10/04 is a finer piriform jar with approximately 14% temper.

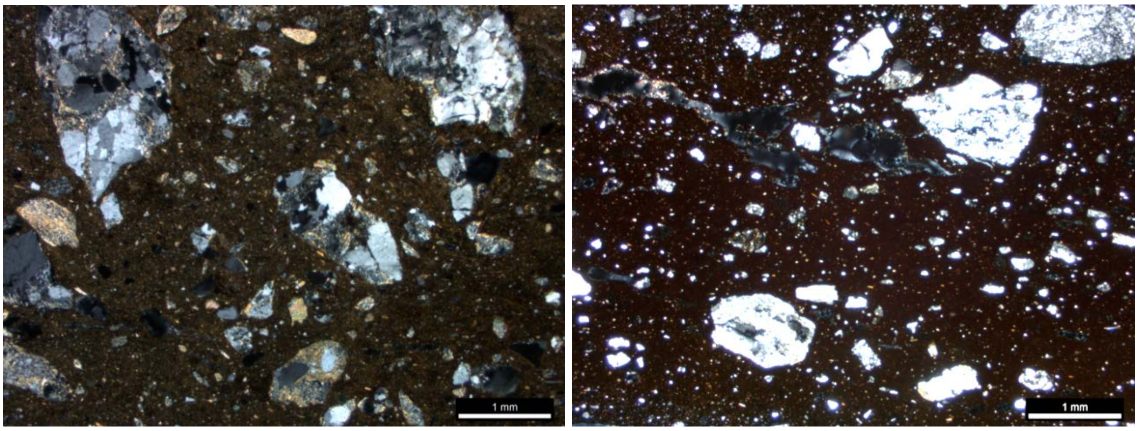

Figure 6.31: Variants of Fabric Group 23. Left: Acropolis 13/14; Right: Ayios Konstantinos 12/39.

6.2.6.3 Fabric Group 24: Volcanic with limestone and schist

Group Members	Region of Deposition	Vessel Type
Plaka 10/02	Attica	Chytra

Table 6.32: Member of the ‘Volcanics with limestone and schist fabric group.

Fabric Group 24 (Table 6.32; Figure 6.32) has a micaceous and amphibole-rich matrix with an abundance of glassy intermediate igneous, limestone, schist and phyllite inclusions. The matrix and glassy intermediate rock fragments are reminiscent of FG 9A and FG 9B however there is a considerable difference in this fabric, with the presence of metamorphic rock fragments. These types of low-grade metamorphic rocks are not present on Aegina and there are no comparative fabrics. However, the abundance of amphiboles, the clay texture and composition of the igneous components suggest that this fabric is related to FG 9 or at least it comes from a volcanic environment. The only other places with this kind of rock in the Saronic Gulf and wider Aegean Sea are Melos, Poros, Methana and west of Ayioi Theodoroi on the southwest coast of the Isthmus of Corinth (Dorais et al. 2004). The fact that this fabric is used to produce a coarse, red-firing cooking pot is even more reminiscent of Aeginetan production but the addition of a white calcareous slip is not a technological feature used in Aeginetan cooking vessels.

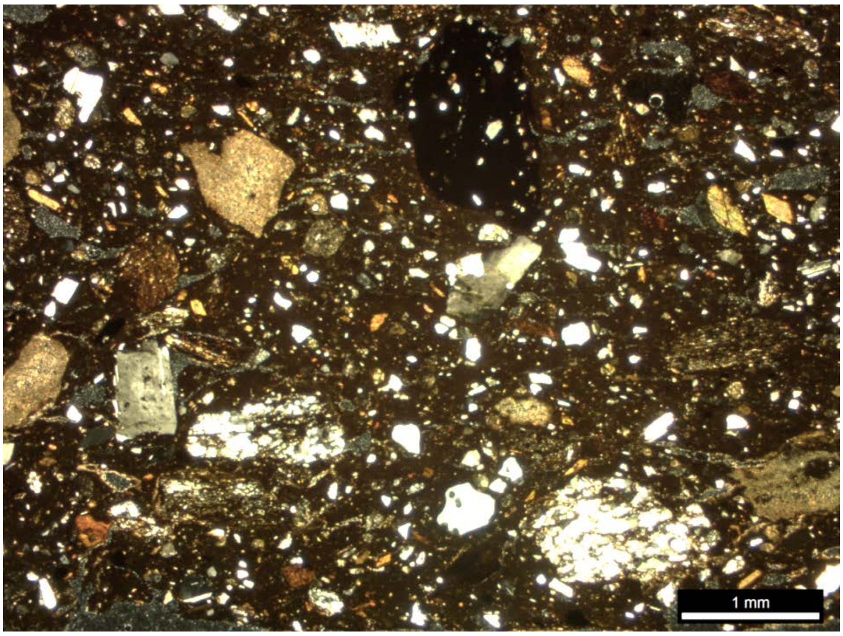

Figure 6.32: Fabric Group 24 in XP (Plaka 10/02).

6.2.6.4 Fabric Group 25: Calcareous with foraminifera microfossils.

Group Members	Region of Deposition	Vessel Type
Lazarides 12/16	Aegina	Deep bowl
Lazarides 12/24	Aegina	Deep bowl

Table 6.33: Members of the ‘Calcareous with foraminifera microfossils’ fabric group.

Fabric Group 25 (Table 6.33; Figure 6.33) is very fine fabric with few diagnostic features. The matrix is fossiliferous and calcareous with moderate optical activity indicating moderate firing temperatures. There are dark rings around the voids and less birefringence near the margins. The inclusions are comprised of quartz, feldspar and foraminifera microfossils. The most diagnostic feature of this fabric is the abundance of microfossils which include various diatom species, globigerinids and sponge spicules. All of the present species are found in the local Neogene clays on Aegina (Dietrich et al. 1991) and this could be a local product of Aeginetan production, however there are fossiliferous Neogene sediments in many areas surrounding the Saronic Gulf and thus cannot be used as a definitive provenance marker. The fact that these sediments exist locally to the place of consumption suggests local production but at present this group cannot be assigned a provenance without the aid of chemical composition analysis.

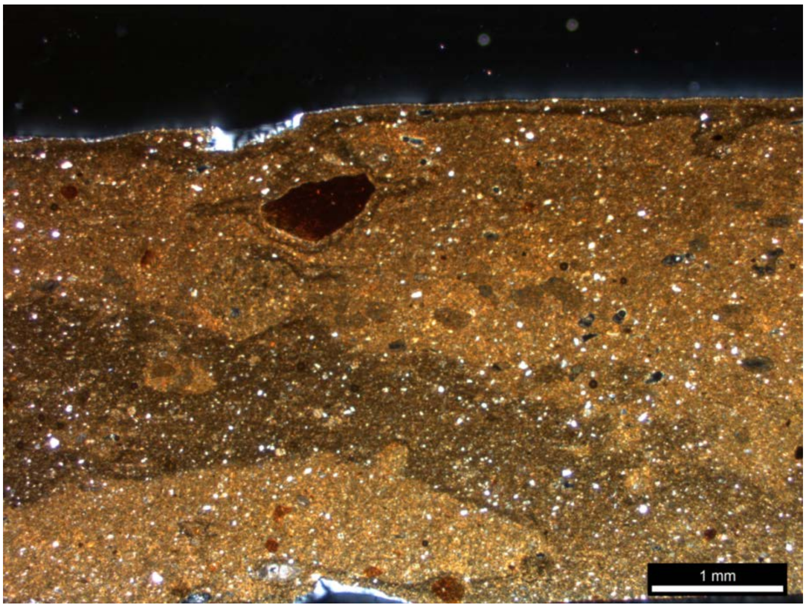

Figure 6.33: Fabric Group 25 in XP (Lazarides 12/16).

6.2.6.5 Fabric Group 26: Ultrafine grey-green with microvesicles

Group Members	Region of Deposition	Vessel Type
Ayios Konstantinos 12/30	Methana	Bovine figurine

Table 6.34: Member of the 'Ultrafine grey-green with microvesicles' fabric group.

Fabric Group 26 (Table 6.34; Figure 6.34) is ultrafine and micaceous. It is similar to FG 11 but is discriminated according to the overall lack of identifiable mineral inclusions and the colour differentiation in the micromass. This variation is perhaps due to the high temperature firing as this fabric is optically inactive. Thin section analysis presents problems when analysing ceramic fabrics that are as fine as this. Chemical composition analysis will provide more valuable information as to its relationship with FG 11.

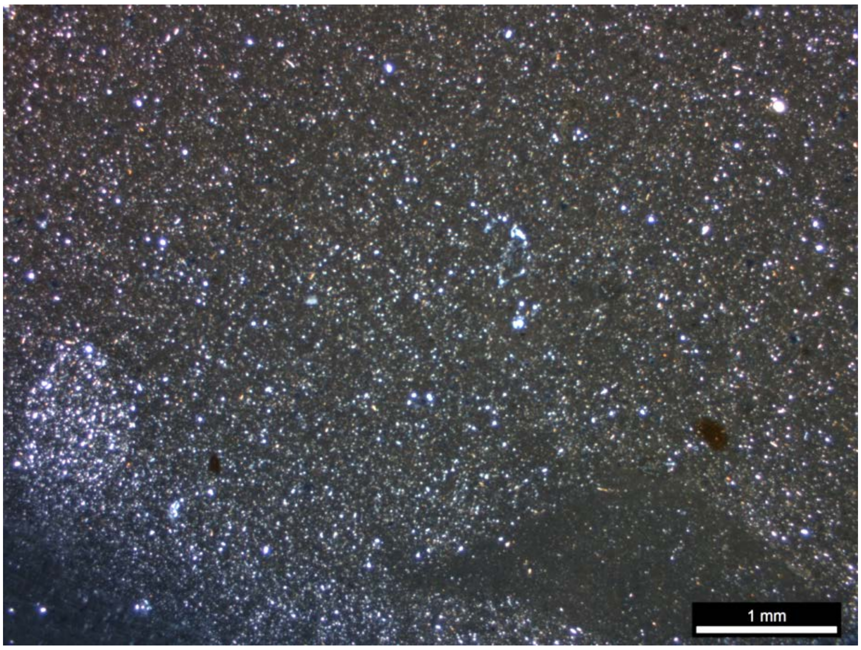

Figure 6.34: Fabric Group 26 in XP (Ayios Konstantinos 12/30).

6.2.6.6 Fabric Group 27: Ultrafine micaceous with round voids

Group Members	Region of Deposition	Vessel Type
Ayios Konstantinos 12/29	Methana	Bovine figurine

Table 6.35: Member of the 'Ultrafine micaceous with round voids' fabric group.

Like FG 26, Fabric Group 27 (Table 6.35; Figure 6.35) is very fine with rare discernible, diagnostic inclusions. There are very few medium to find sand sized inclusions of muscovite laths, undulose quartz, feldspar and a very small fragment of a low grade metamorphic rock fragment. There is an amorphous inclusion of what could be a calcareous TCF with igneous rock and zoned feldspar inclusions. There is a large crack that is filled in with the same calcareous matrix and zoned plagioclase as the amorphous TCF inclusion. Perhaps this is the calcareous slip used for the pale coloured decoration of the bovine figurine. The metamorphic rock fragment and calcareous slip material are not characteristic of any production identified thus far within the remit of this study. Chemical composition analysis may help determine the place of production more readily, however the petrographic evidence has indicated a metamorphic environment.

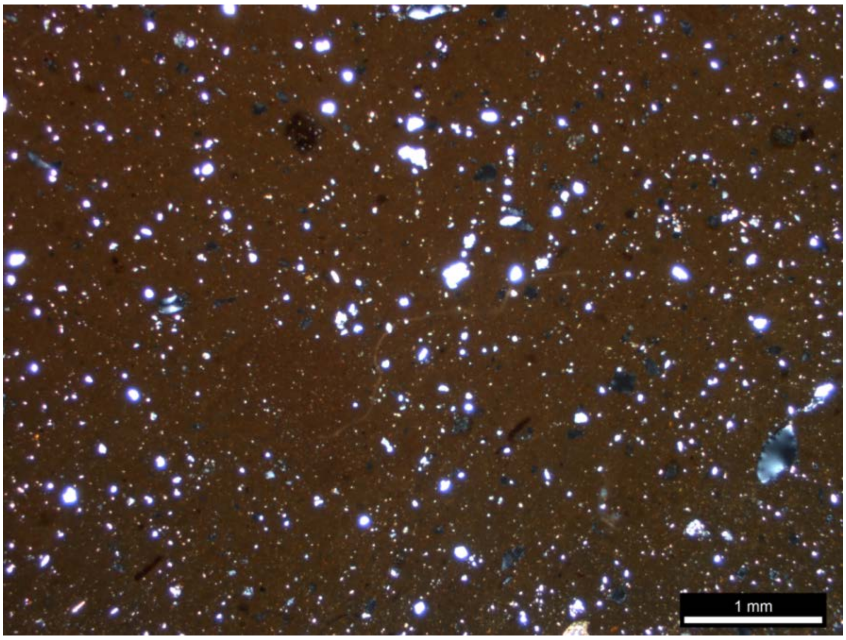

Figure 6.35: Fabric Group 27 in XP (Ayios Konstantinos 12/29).

6.2.6.7 Fabric Group 28: Very fine micaceous

Group Members	Region of Deposition	Vessel Type
Ayios Konstantinos 12/50	Methana	Kylix
Cave of Euripides 12/16	Salamis	Deep bowl

Table 6.36: Members of the 'Very fine micaceous' fabric group.

Fabric Group 28 (Table 6.36; Figure 6.36) is another very fine micaceous fabric with very few diagnostic inclusions. The mica-rich groundmass and the undulose extinction of the quartz do indicate that this fabric is derived from a metamorphic environment. The single micaceous siltstone is probably related to the raw clay materials used in its production, but gives no indication of where it was made. The matrix is reminiscent of the very fine examples from the Kontopigado production, but there is not enough detail to make a definitive assessment. Chemical composition analysis may play a more effective role in the determination of the production site.

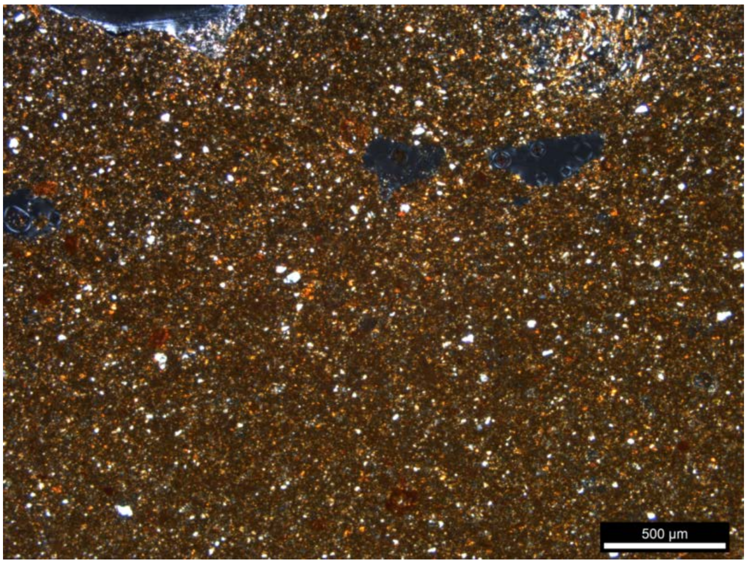

Figure 6.36: Fabric Group 28 in XP (Euripides' Cave 12/16).

6.2.6.8 Fabric Group 29: Angular quartz

Group Members	Region of Deposition	Vessel Type
Lazarides 12/29	Aegina	Slender necked jar

Table 6.37: Member of the 'Angular quartz' fabric group.

Fabric Group 29 (Table 6.37; Figure 6.37) is very fine with a micaceous matrix and angular, medium-fine sand sized, undulose quartz inclusions. The quartz indicates that this fabric derives from a metamorphic environment. The grey mudstone with the cracked microstructure could be related to similar features in FG 15 and FG 16 suggesting a Corinthian provenance. This type is rare within the studied assemblage and only appears at Lazarides on Aegina.

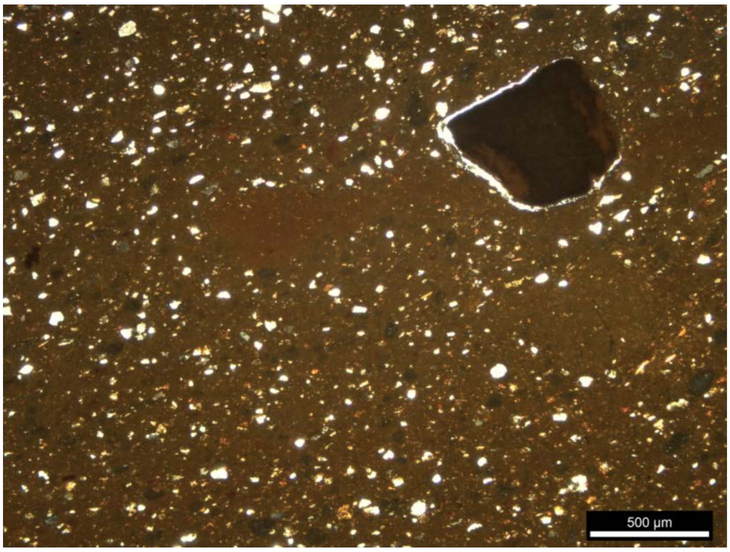

Figure 6.37: Fabric Group 29 in XP (Lazarides 12/29).

6.2.6.9 Fabric Group 30: Opaques and microfossils

Group Members	Region of Deposition	Vessel Type
Acropolis 13/16	Attica	Mug/tankard

Table 6.38: Member of the 'Opaques and microfossils' fabric group.

Fabric Group 30 (Table 6.38; Figure 6.38) has a fine micaceous and calcareous matrix with diagnostic well-rounded opaques and well sorted, fine sand-sized undulose quartz and zoned plagioclase feldspar inclusions. The groundmass is highly micaceous with distinctive muscovite and foraminifera. The raw materials appear to come from a metamorphic geological environment. The rounded opaque inclusions are the most definitive feature of this fabric and may help in future comparative work.

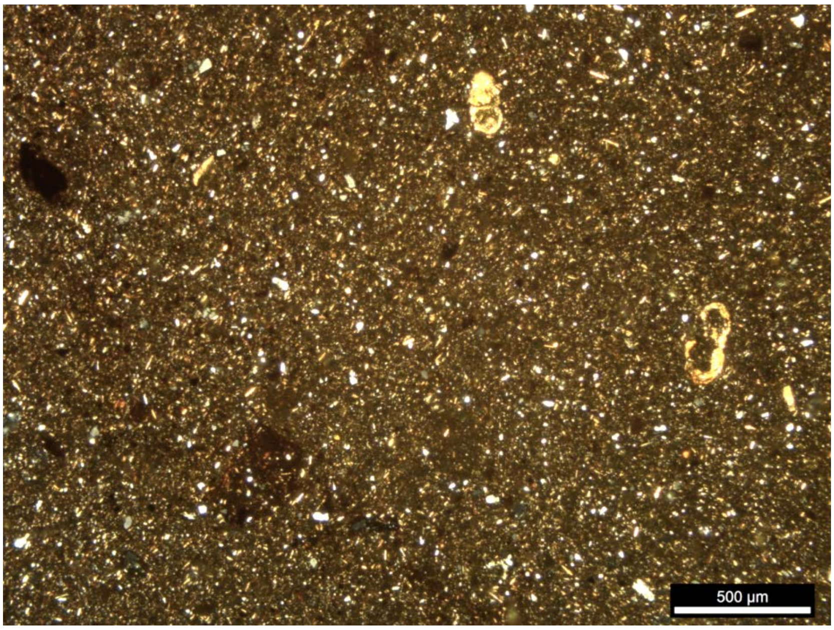

Figure 6.38: Fabric Group 30 in XP (Acropolis 13/16).

6.2.6.10 Fabric Group 31: Fine micaceous with quartzite and low grade metamorphic rock

Group Members	Region of Deposition	Vessel Type
Kanakia 07/89	Salamis	Shallow bowl

Table 6.39: Member of the 'Fine micaceous with quartzite and low grade metamorphic rock' fabric group.

Fabric Group 31 (Table 6.39; Figure 6.39) consists of an optically active, mixed micaceous and calcareous matrix with quartzite and other low grade metamorphic rock inclusions. The inclusions are poorly sorted and have a strong bimodal grain size distribution, indicating that the coarse inclusions were added as temper to the matrix. The rock fragments are similar to the greenschist described in many of the Attic fabrics above, but are too small to confirm a match. However, this fabric comes from a metamorphic environment and it may be safe to suggest that there is a moderate degree of probability that this fabric is from somewhere in Attica. Looking at other technological features, the matrix mixed and optically active, suggesting a low or incomplete firing.

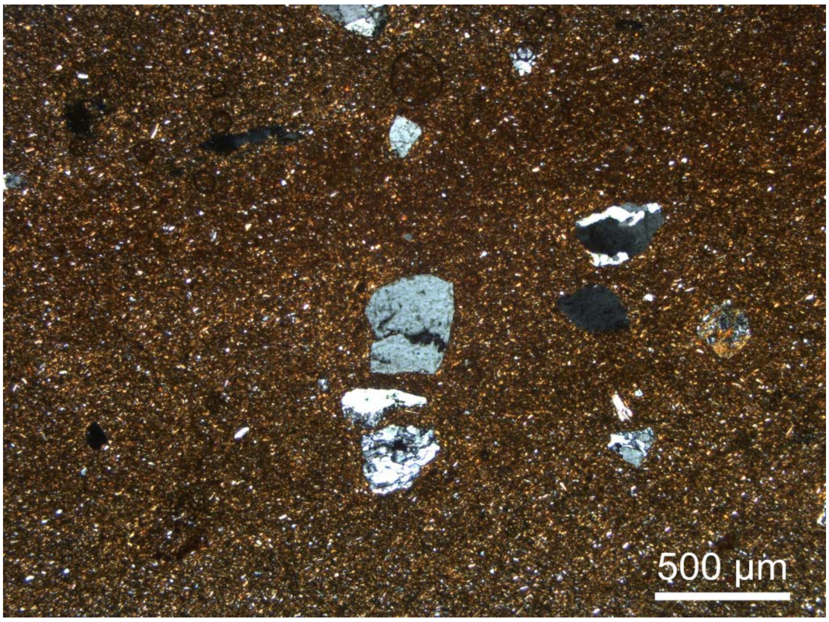

Figure 6.39: Fabric Group 31 in XP (Kanakia 07/89).

6.2.6.11 Fabric Group 32: Psammitic greenschist and greywacke

Group Members	Region of Deposition	Vessel Type
Eleusis 12/09	Attica	Krater
Eleusis 12/13	Attica	Hydria

Table 6.40: Members of the 'Psammitic greenschist and greywacke' fabric group.

Fabric Group 32 (Table 6.40; Figure 6.40) is made up of a homogeneous calcareous matrix tempered with metamorphic and sedimentary rock inclusions of siliceous schist fragments composed mainly of irregular polygonal quartz, plagioclase and (biotite?) mica and fine grained greywacke with plagioclase, quartz and amphibole. The inclusions in this fabric are derivative of psammitic greenschist facies rock material. The matrix is moderate-high fired, demonstrating slight optical activity. This fabric group is only found at Eleusis in a krater and a hydria. Psammite is found in Attica but there are no outcrops near Eleusis. There are no comparable samples of this fabric and at present, there is not enough information to infer a provenance location for this vessel.

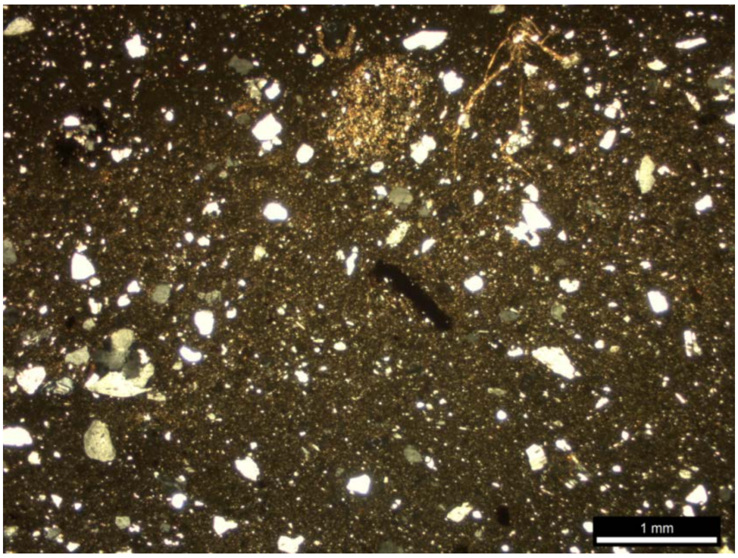

Figure 6.40: Fabric Group 32 in XP (Eleusis 12/13).

6.2.6.12 Fabric Group 33: Muscovite-chlorite schist

Group Members	Region of Deposition	Vessel Type
Ayios Konstantinos 12/19	Methana	Jar

Table 6.41: Members of the 'Muscovite-chlorite schist' fabric group.

Fabric Group 33 (Table 6.41; Figure 6.41) has a coarse matrix that is heavily laden with muscovite and crushed muscovite-chlorite schist used as temper. The matrix is optically active and yellow-brown in colour suggesting low firing temperatures in an oxidizing atmosphere. The origin of this fabric is metamorphic and probably comes from somewhere in the Attic-Cycladic Metamorphic belt (massif). Ayia Irini, Kea is one possible place of production as is the southern tip of Evvia. Further comparative analysis is needed.

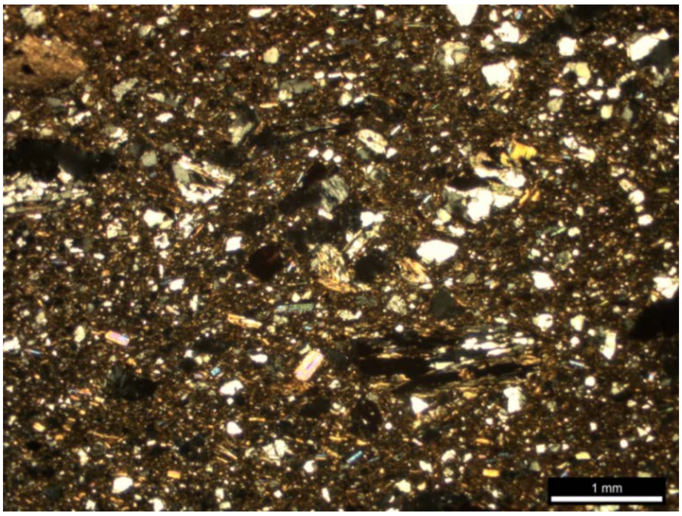

Figure 6.41: Fabric Group 33 in XP (Ayios Konstantinos 12/19).

6.2.6.13 Fabric Group 34: Mudstone and organic vegetal matter

Group Members	Region of Deposition	Vessel Type
Ayios Konstantinos 12/64	Methana	Tub

Table 6.42: Member of the 'Mudstone and organic vegetal matter' fabric group.

Fabric Group 33 (Table 6.42; Figure 6.42) is another large tub tempered with rock fragments and organic matter. The matrix is derived from a micaceous metamorphic environment. The mudstone appears to be added to the matrix as a tempering agent. One fragment near the exterior surface appears brecciated. Mudstones and brecciated mudstone are found throughout Corinthia (Whitbread 1995, 2003) and it may well have its origin the northeast Peloponnese or central Argolic peninsula where mudstones of this sort of prevalent (Papavassilou et al. 1984a).

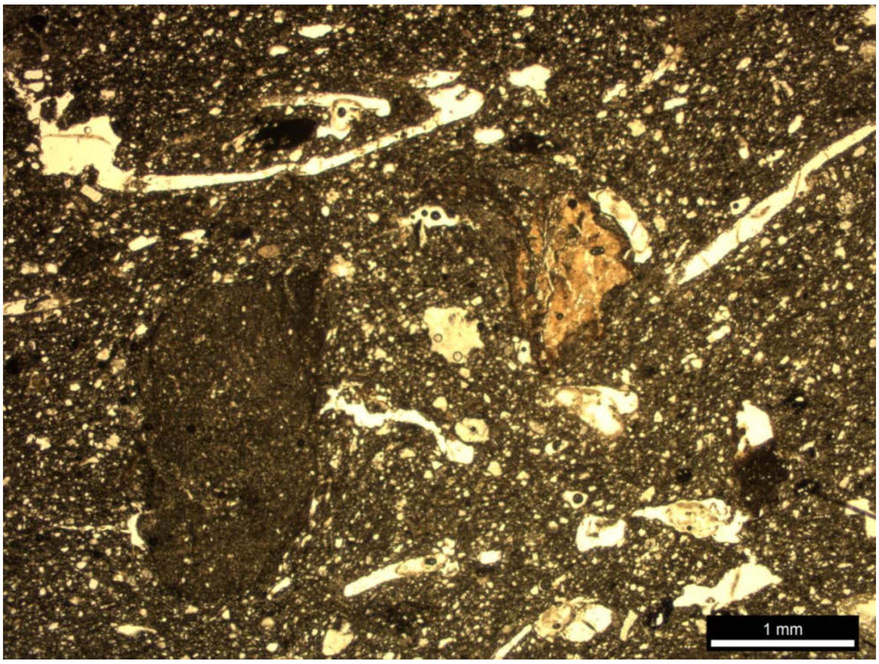

Figure 6.42: Fabric Group 34 in PPL (Ayios Konstantinos 12/64).

6.2.6.14 Fabric Group 35: Fine micaceous

Group Members	Region of Deposition	Vessel Type
Cave of Euripides 12/15	Salamis	Deep bowl

Table 6.43: Member of the 'Fine micaceous' fabric group.

Fabric Group 35 (Table 6.43; Figure 6.43) is distinct from the rest of the assemblage, but not diagnostic in terms of provenance. It is composed of an optically slightly active, fine calcareous matrix with well sorted, unimodally distributed micrite, mica, quartz and feldspar inclusions. The feldspars are zoned suggesting an igneous origin. There is one fragment of chert with inclusions of radiolarian microfossils and one fragment of serpentinite, both of which are commonly found in the northeast Peloponnese.

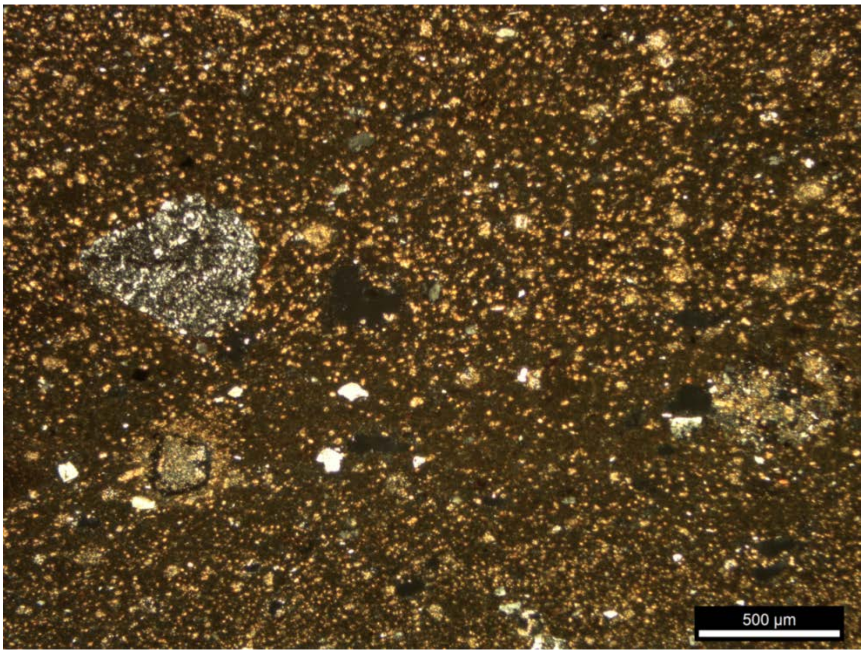

Figure 6.43: Fabric Group 35 in XP (Euripides' Cave 12/15).

6.2.6.15 Fabric Group 36: Sandy with chert-rich low grade metamorphic rock

Group Members	Region of Deposition	Vessel Type
Alimos 12/107	Attica	Wide-mouth jar

Table 6.44: Member of the 'Sandy with chert-rich low grade metamorphic rock' fabric group.

This sample (Table 6.44; Figure 6.44) has a matrix that is iron-rich and calcareous. The inclusions are comprised of quartz, alkali feldspar, arenaceous sandstone, and low grade metamorphic rock fragments and mica. The metamorphic rocks are foliated and rarely heavily crenulated. The inclusions appear to be water worn sand particles that include a mixture of metamorphic and sedimentary rock fragments and was probably added as temper. This sample bears a strong resemblance to some low-grade metamorphic jar fabrics from West Crete, though its inclusions are not enough to confirm this provenance ascription without further comparative material and there are a variety of low grade metamorphic inclusions in Attic pottery.

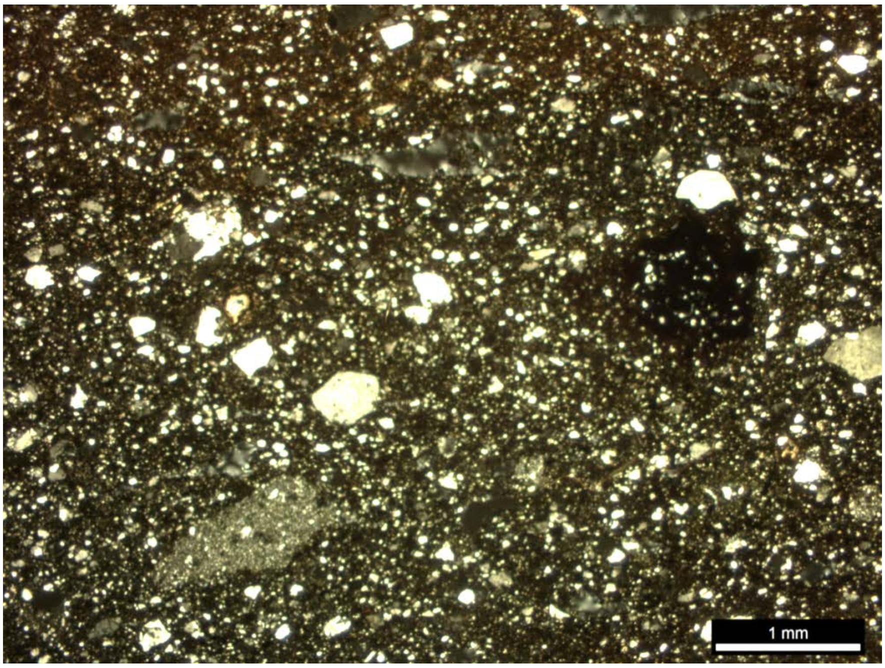

Figure 6.44: Fabric Group 36 in XP (Alimos 12/107).

6.2.6.16 Fabric Group 37: Calcareous ARFs and organics

Group Members	Region of Deposition	Vessel Type
Plaka 10/34	Attica	Tub

Table 6.45: Member of the 'Calcareous ARFs and organics' fabric group.

Fabric Group 37 (Table 6.45; Figure 6.45) comes from another large tub. The voids indicate that this vessel was tempered with organic vegetal matter. There is one TCF that is composed of micrite with silt sized felsic inclusions. This TCF is part of a marl that is incompletely mixed into the groundmass. The mixing can be observed by the merging to invisible margins on the TCF. It is composed of all the minerals that are found within the fabric. This groundmass of this fabric is reminiscent of samples Kontopigado 12/35, 49, Plaka 10/17, 37 and Kanakia 7/68. All of these samples have been assigned an Attic provenance. This fabric is different and does not have enough diagnostic inclusions to prescribe a provenance location, but it is yet another tub produced using organic temper.

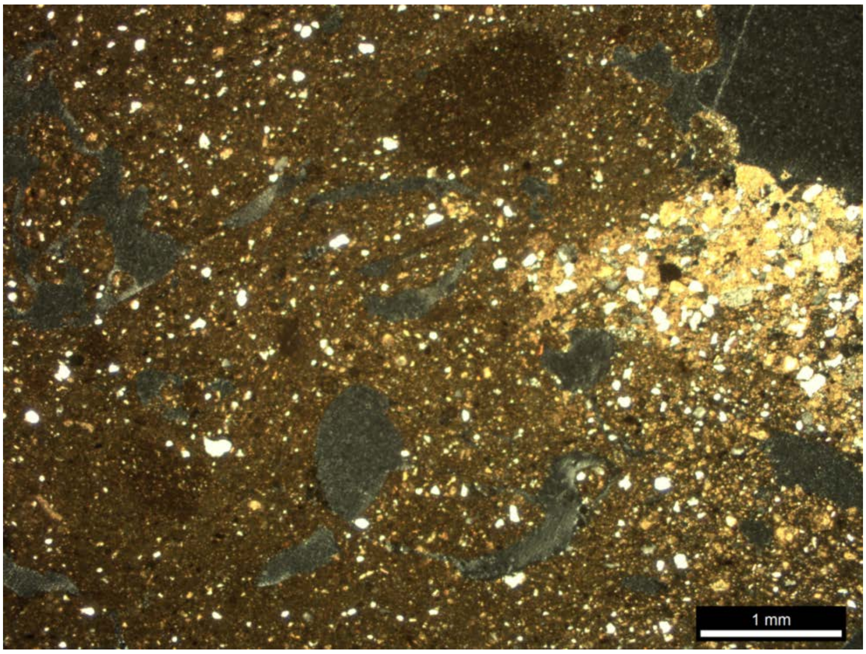

Figure 6.45: Fabric Group 37 in XP (Plaka 10/34).

6.2.7 Summary

The results of the systematic petrographic study of pottery assemblages from eleven major archaeological sites within the wider region of the Saronic Gulf have produced significant patterns of production, exchange and consumption during the transitional Late Helladic IIIB-IIIC early period. To begin, there are several pottery fabrics in a broad range of vessel types that were exchanged in the Saronic Gulf region during this late Mycenaean period, but only a restricted number of major production centres: Kontopigado in Attica, Corinth in the northeast Peloponnese and Aegina, perhaps Kolonna. Secondly, there are at least three jar fabrics imported into the area from Crete, including the Chania in the west, the Mesara in south-central region and the Mirabello region between Gournia and Kalo Chorio. Thirdly, there is a tripod cooking pot and large storage jar from the northern part of Kea in the western Cyclades, suggesting that trade networks of the period are quite extensive.

Returning to pottery production from within the Saronic Gulf, Kontopigado manufactures a large/extensive range of vessels including, kylikes, deep bowls, stemmed bowls, kraters, spouted bowls, spouted kraters, basins, spouted basins, jugs, jars, hydriae, amphorae, pithoi and other storage jars, a variety of tub sizes (asamanthoi) and a broad range of cooking implements (Kaza-Papageorgiou and Kardamaki 2012). Production in Corinthia comprises fine vessels, including kylikes, deep bowls, stemmed bowls askoi, fine stirrup jars and squat stirrup jars and coarse vessels such as two storage jars fabrics and three large tub fabrics. The variation in fabrics is such that there must be several producers in Corinthia, some perhaps beyond the environs of Ancient Corinth itself. It must be made clear that Corinthia is a geological domain, not a specific workshop.

On Aegina, production seems to continue from earlier periods unabated (*contra* Pullen 2013; Tartaron 2014). Cooking vessels, tubs and storage jars are made with non-calcareous and highly micaceous fabrics, while fineware is produced in a highly calcareous fabric. The production technology involved in fine and coarseware production on Aegina is so strikingly different that it is likely to come from two distinct manufacturing traditions (Gilstrap 2015; Gilstrap et al. in press).

Though regularly overlooked in the archaeological literature, both Attica and Corinthia are producing and exporting a variety of ceramics to several sites in the Saronic Gulf and likely beyond during the end of the Late Bronze Age. In fact the finest fabrics from both Kontopigado and Corinthia occur at every site within this study area. The only other fabric to do this is the Noncalcareous volcanic fabric used to produce cooking pots on the island of Aegina. Curiously, though there is fineware production on Aegina, they have a restricted range of distribution in comparison to the same vessel types produced at Kontopigado and Corinthia. Similarly, Kontopigado produces a variety of cooking vessels that are only found in local Attic contexts. At Kanakia there are finewares from Aegina (FG 10B), Corinthia (FG 11), Kontopigado (FG 1) and beyond, but the only cooking vessels present are those from Aegina (FG 9A) and the only sample in FG 22 whose provenance in unknown. Even at Kontopigado, a pottery production centre, there are finewares from Corinthia, cooking vessels from both Aegina and Kea (FG 17A) and a storage vessel also from Kea (FG 17B). Kontopigado manufactures all of the vessel types imported to Kanakia making it clear that there was a substantial level of exchange of ceramics which was not based on functional specialisation or a perceived lack of a specific type in one area.

It is very clear that Kontopigado, Corinthia and Aegina are exporting their wares in significant numbers, but pottery from local regional producers is much more likely to be found at other sites from within their region. For example, there are more vessels of Attic production at Kontopigado, Plaka and the Acropolis at Athens while Aeginetan vessels are dominant in the studied assemblages for Lazarides on Aegina and at Ayios Konstantinos on nearby Methana. Corinthian products are found everywhere; however they appear to dominate at Kalamianos and Stiri which lie on the Corinthian coast.

Lying in between all three production centres is Kanakia on Salamis where all the cooking vessels and few fine tablewares come from Aegina, and the majority of the tablewares and a some large tubs come from Kontopigado, while other tubs and many of the very fine vessels come from Corinthia. Plainly there is a network of exchange within this region that enables the movement of all ceramic vessels, and assuredly other goods as well. This exchange network provides the mechanisms in which people in the Saronic Gulf are afforded variability in the kinds of pottery that is available for consumption. This variability perhaps allowed for some personal choices to be made in obtaining a vessel for use and thus some degree of preference was acted on.

In fact it is the absence of some groups of pottery that indicate choice at work. Perhaps the clearest example of this is that, although there are substantial amounts of Kontopigado pottery, fineware, large storage jars and even tubs, consumed at Kanakia, none of the cooking vessels produced at the Attic site have been found there. The pottery clearly could have moved along the same channels as that for the tablewares and tubs, but apparently there was no demand or motivation. Whether this is because of reputation, culinary practice or other factors is unclear.

Looking at production technology, there are two significant features needing discussion. Firstly, there are several pottery production traditions co-existing in the Saronic Gulf during this period. The mixing of clays is a good example of this, as it is a prominent feature in the technical tradition at Kontopigado where there is a red micaceous clay mixed with a calcareous clay, likely a marl, in different proportions according to the type of vessel being made. In stark contrast, pottery from Aegina are not produced using mixed clays, rather the potters on this island prefer to use markedly different clays to produce either coarse or fine vessels. At Corinth, there is not enough evidence to identify any production tradition because there appears to be several places where pottery is produced in that area as represented in the variety of coarse and fine fabrics from that region. Thus we can only discuss production in the region of Corinthia, rather than at Corinth itself, at least for the time being. Secondly, the use of organic temper is a technological choice that is made at every workshop where large tubs were manufactured. This technical feature is present in every large tub fabric observed during the course of this study. It is likely that this information is shared along the same routes as the pottery itself travels during commercial voyages. At Kontopigado this technology moves into the cooking vessels as it is found in baking trays and punch-based griddles, while on Aegina, potters have applied organic temper technology to the production of storage vessels.

6.3. Chemical composition by neutron activation analysis

Samples from each site, with the exclusion of the Plaka, North Slope and Mycenaean Fountain deposits[9], were analysed at the University of Missouri Research Reactor (MURR) with measurements recorded for 33 elements (Al, As, Ba, Ca, Ce, Co, Cr, Cs, Dy, Eu, Fe, Hf, K, La, Lu, Mn, Na, Nd, Ni, Rb, Sb, Sc, Sm, Sr, Ta, Tb, Th, Ti, U, V, Yb, Zn, Zr) according to the method described in Chapter Four. Of these original thirty three, eleven elements were discarded before the commencement of statistical testing. As and Sb were excluded because they have high natural fluctuation which can improbable variability into the dataset. Twelve elements, Al, As, Dy, K, Mn, Na, Nd, Ni, Sb, Sr, Ti and V were also excluded because analysis generated such low counts that accurate measurement was not possible in approximately half of the samples. Finally, the remaining 21 elements, Ba, Ca, Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Rb, Sc, Sm, Ta, Tb, Th, U, Yb, Zn, Zr, were chosen for statistical analysis.

The breadth of sites in this study makes for a very large dataset. In order to develop a comprehensive picture of the variability in the NAA data the total variation was calculated using the 22 elements listed above. The resulting variation matrix (Table 6.46) illustrates the variation of each element (columns) expressed as logarithmic ratios to every other element (rows) when used as the divisor (Day et al. 2011: 534; see also Buxeda i Garrigós and Kilikoglou 2003). The total variation (*vt*) is calculated at the bottom of the table by dividing the sum of all variances by twice the number of elements in the dataset. This value is helpful for determining whether the dataset is monogenic or polygenic. A *vτ* value of 2.044 signifies that there are multiple chemically distinct groups within the dataset, but not high enough to indicate extreme variation between groups. This outcome is expected for a dataset comprised of material from an area such as the Saronic Gulf, which, as we have seen in Chapter Five, has a fairly diverse geology. However, the petrographic study demonstrates that there are a restricted number of sediments used as raw materials in pottery production.

[9] Samples from Plaka were not available for chemical analysis during the course of this thesis. Samples from the North Slope and Mycenaean Fountain deposits on the Athenian Acropolis were not made available in time to generate chemical data for this study. Thus, the results from these studies are forthcoming.

	Ca	Sc	Cr	Fe	Co	Zn	Rb	Zr	Cs	Ba	La
Ca	0	0.578	0.961	0.599	0.556	0.489	0.611	0.761	1.02	0.779	0.591
Sc	0.578	0	0.471	0.01	0.064	0.052	0.069	0.08	0.278	0.225	0.034
Cr	0.961	0.471	0	0.501	0.262	0.422	0.526	0.688	0.443	0.88	0.616
Fe	0.599	0.01	0.501	0	0.07	0.06	0.091	0.07	0.311	0.213	0.037
Co	0.556	0.064	0.262	0.07	0	0.073	0.131	0.194	0.291	0.359	0.127
Zn	0.489	0.052	0.422	0.06	0.073	0	0.109	0.145	0.308	0.3	0.084
Rb	0.611	0.069	0.526	0.091	0.131	0.109	0	0.168	0.18	0.355	0.085
Zr	0.761	0.08	0.688	0.07	0.194	0.145	0.168	0	0.433	0.195	0.062
Cs	1.02	0.278	0.443	0.311	0.291	0.308	0.18	0.433	0	0.686	0.366
Ba	0.779	0.225	0.88	0.213	0.359	0.3	0.355	0.195	0.686	0	0.21
La	0.591	0.034	0.616	0.037	0.127	0.084	0.085	0.062	0.366	0.21	0
Ce	0.638	0.033	0.633	0.033	0.131	0.089	0.094	0.048	0.371	0.186	0.006
Sm	0.601	0.023	0.533	0.026	0.1	0.063	0.083	0.059	0.323	0.213	0.008
Eu	0.606	0.024	0.598	0.024	0.122	0.073	0.096	0.05	0.353	0.195	0.01
Tb	0.66	0.047	0.591	0.048	0.14	0.094	0.125	0.077	0.371	0.21	0.028
Yb	0.638	0.029	0.606	0.025	0.127	0.078	0.106	0.049	0.362	0.189	0.015
Lu	0.634	0.027	0.597	0.025	0.123	0.072	0.099	0.052	0.344	0.21	0.019
Hf	0.798	0.067	0.673	0.06	0.187	0.14	0.166	0.029	0.415	0.158	0.05
Ta	0.666	0.042	0.633	0.039	0.144	0.103	0.111	0.046	0.389	0.175	0.018
Th	0.649	0.047	0.711	0.046	0.16	0.119	0.116	0.058	0.423	0.172	0.018
U	0.556	0.063	0.528	0.067	0.132	0.095	0.105	0.103	0.339	0.216	0.058
$\tau_{.i}$	13.39	2.263	11.875	2.355	3.492	2.968	3.426	3.365	8.004	6.125	2.44
$vt/\tau_{.i}$	0.153	0.903	0.172	0.868	0.585	0.689	0.597	0.607	0.255	0.334	0.838
$r.v\tau.$	-0.1	0.997	-0.054	0.998	0.839	0.964	0.932	0.975	0.524	0.855	0.99

	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
Ca	0.638	0.601	0.606	0.66	0.638	0.634	0.798	0.666	0.649	0.556
Sc	0.033	0.023	0.024	0.047	0.029	0.027	0.067	0.042	0.047	0.063
Cr	0.633	0.533	0.598	0.591	0.606	0.597	0.673	0.633	0.711	0.528
Fe	0.033	0.026	0.024	0.048	0.025	0.025	0.06	0.039	0.046	0.067
Co	0.131	0.1	0.122	0.14	0.127	0.123	0.187	0.144	0.16	0.132
Zn	0.089	0.063	0.073	0.094	0.078	0.072	0.14	0.103	0.119	0.095
Rb	0.094	0.083	0.096	0.125	0.106	0.099	0.166	0.111	0.116	0.105
Zr	0.048	0.059	0.05	0.077	0.049	0.052	0.029	0.046	0.058	0.103
Cs	0.371	0.323	0.353	0.371	0.362	0.344	0.415	0.389	0.423	0.339
Ba	0.186	0.213	0.195	0.21	0.189	0.21	0.158	0.175	0.172	0.216
La	0.006	0.008	0.01	0.028	0.015	0.019	0.05	0.018	0.018	0.058
Ce	0	0.012	0.011	0.031	0.015	0.019	0.032	0.009	0.008	0.063
Sm	0.012	0	0.006	0.021	0.01	0.012	0.047	0.022	0.031	0.053
Eu	0.011	0.006	0	0.02	0.007	0.01	0.039	0.021	0.027	0.062
Tb	0.031	0.021	0.02	0	0.023	0.029	0.055	0.039	0.051	0.081
Yb	0.015	0.01	0.007	0.023	0	0.007	0.034	0.023	0.029	0.065
Lu	0.019	0.012	0.01	0.029	0.007	0	0.04	0.027	0.034	0.062
Hf	0.032	0.047	0.039	0.055	0.034	0.04	0	0.027	0.037	0.096
Ta	0.009	0.022	0.021	0.039	0.023	0.027	0.027	0	0.013	0.066
Th	0.008	0.031	0.027	0.051	0.029	0.034	0.037	0.013	0	0.079
U	0.063	0.053	0.062	0.081	0.065	0.062	0.096	0.066	0.079	0
$\tau_{.i}$	2.462	2.244	2.353	2.74	2.438	2.442	3.148	2.612	2.826	2.888
$vt/\tau_{.i}$	0.83	0.911	0.869	0.746	0.839	0.837	0.649	0.783	0.723	0.708
$r.v\tau.$	0.989	0.998	0.992	0.992	0.992	0.995	0.973	0.986	0.976	0.99
$v\tau$	2.044									

Table 6.46: Total Variation Matrix of complete Saronic Gulf assemblage.

The variation matrix makes it evident that the elements Ca, Cr, Cs and Ba will introduce the most variability when log-transformed and used as a divisor. Elements Sc, Fe, Sm and Eu demonstrate the lowest variation and thus the lowest total variation in the matrix. Samarium (Sm) is an immobile, lithophilic element and has the lowest variation in the dataset. For these reasons, concentration data for each of the 21 elements is expressed as a logarithmic ratio over the concentration of Sm as it is the least likely element to introduce variability due to contamination and environmental alteration.

Variable	PC1	PC2	PC3	PC4	PC5	PC6
%	38.64	27.36	10.16	7.87	5.71	2.08
Cum. %	38.64	66.00	76.15	84.02	89.73	91.81
Eigenvalues	0.175	0.124	0.046	0.036	0.026	0.009
Cr	**0.735**	-0.051	**-0.536**	0.043	-0.046	0.182
Cs	**0.490**	**0.247**	**0.543**	0.078	**0.459**	0.035
Co	**0.290**	-0.023	-0.152	-0.056	-0.189	**-0.388**
Rb	0.194	0.078	**0.397**	-0.174	0.068	-0.101
Zn	0.168	-0.046	0.017	-0.063	-0.134	-0.250
Sc	0.113	0.069	0.032	-0.106	-0.071	-0.229
Ca	0.094	**-0.839**	0.197	**-0.385**	0.017	0.100
U	0.088	0.034	0.026	**-0.274**	0.051	**0.565**
Fe	0.080	0.076	-0.014	-0.057	-0.084	-0.245
Sm	0.063	0.098	0.037	-0.210	-0.175	0.023
Tb	0.028	0.126	-0.002	-0.210	-0.178	-0.022
Lu	0.020	0.114	0.054	-0.127	-0.153	-0.008
La	0.015	0.089	0.092	**-0.271**	-0.198	0.024
Eu	0.012	0.096	0.047	-0.159	-0.140	-0.026
Yb	0.006	0.118	0.020	-0.157	-0.137	-0.035
Ce	-0.002	0.126	0.053	**-0.256**	-0.148	-0.031
Ta	-0.007	0.142	-0.001	**-0.265**	-0.119	0.061
Hf	-0.044	**0.221**	-0.106	-0.119	-0.012	0.201
Th	-0.046	0.126	0.058	**-0.322**	-0.123	-0.112
Zr	-0.048	**0.182**	-0.069	-0.068	-0.061	**0.431**
Ba	**-0.148**	0.087	-0.398	**-0.481**	**0.704**	-0.231

Table 6.47: Principal Component Analysis of the complete Saronic Gulf dataset. The first six PCs account for greater than 90% of the total variance in the dataset. Strong elemental loading shown in bold.

Principal Component Analysis (PCA) was performed using all 21 elements in the complete Saronic Gulf dataset. The first six Principal Components (PCs) account for 91.1% of the cumulative variance in the entire dataset (Table 6.47). The first two PCs comprise 68.14% of total variance and have proven useful for separating out the main compositional groups (Figure 6.46). PC 1 is positively loaded on As, Cr, Cs and Sb and negatively loaded on Ca, a member of the Alkaline Earths. PC 2 has heavy positive loading on Ca and Cr while negatively loaded on As, Zr and Hf. Figure X illustrates that there are indeed multiple discrete compositional groups, as predicted by the calculated *vt*. By removing the elemental loading vectors it becomes apparent that there are three large core groups, a few smaller groups and several outliers (Figure 6.47).

Figure 6.47 illustrates that each of the three core groups are comprised of samples from several archaeological sites. Each of the three core groups has been split into subgroups through cluster analysis by PCA. Biplots comparing the first two PCs are used to discriminate subgroups, subsequent bivariate plots are used to determine if separation between groups can be easily identified in the non-transformed elemental data. After all groups are identified the membership probabilities are calculated as described in Chapter Four[10].

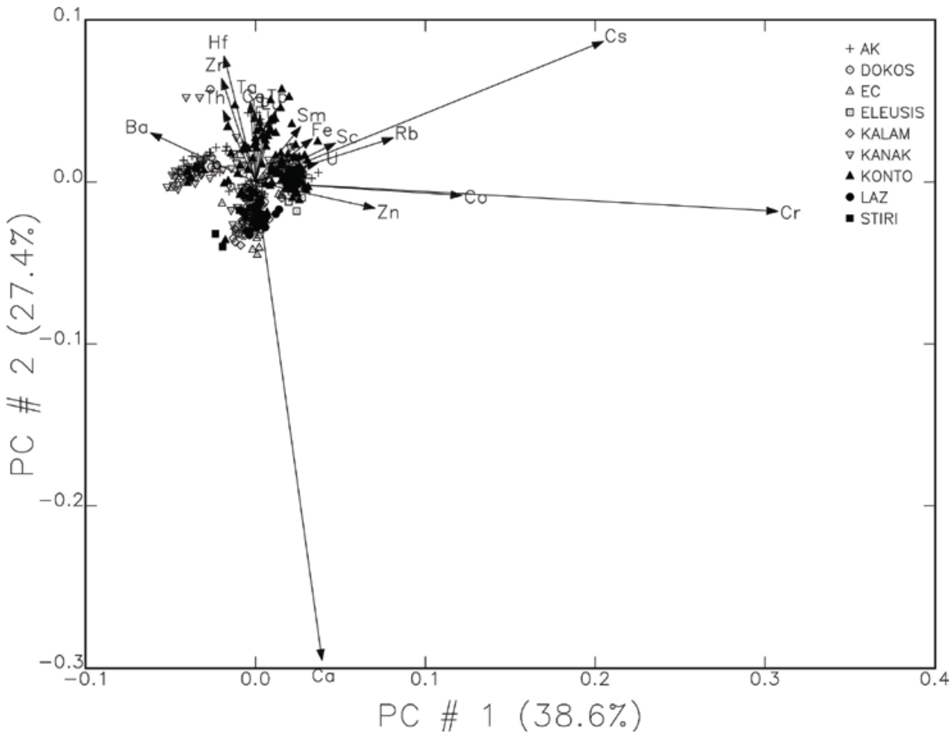

Figure 6.46: A biplot of the first two PCs (66.0% total variance) illustrating the broad grouping structure. Elemental loading vectors shown and labelled. Sites are labelled in the legend as: AK- Ayios Konstantinos; Dokos-Dokos; EC: Euripides' Cave; Eleusis-Eleusis; Kalam-Kalamianos; Kanak-Kanakia; Konto-Kontopigado; LAZ-Lazarides; Stiri-Stiri.

[10]Group membership probability tables are located in Appendix II.

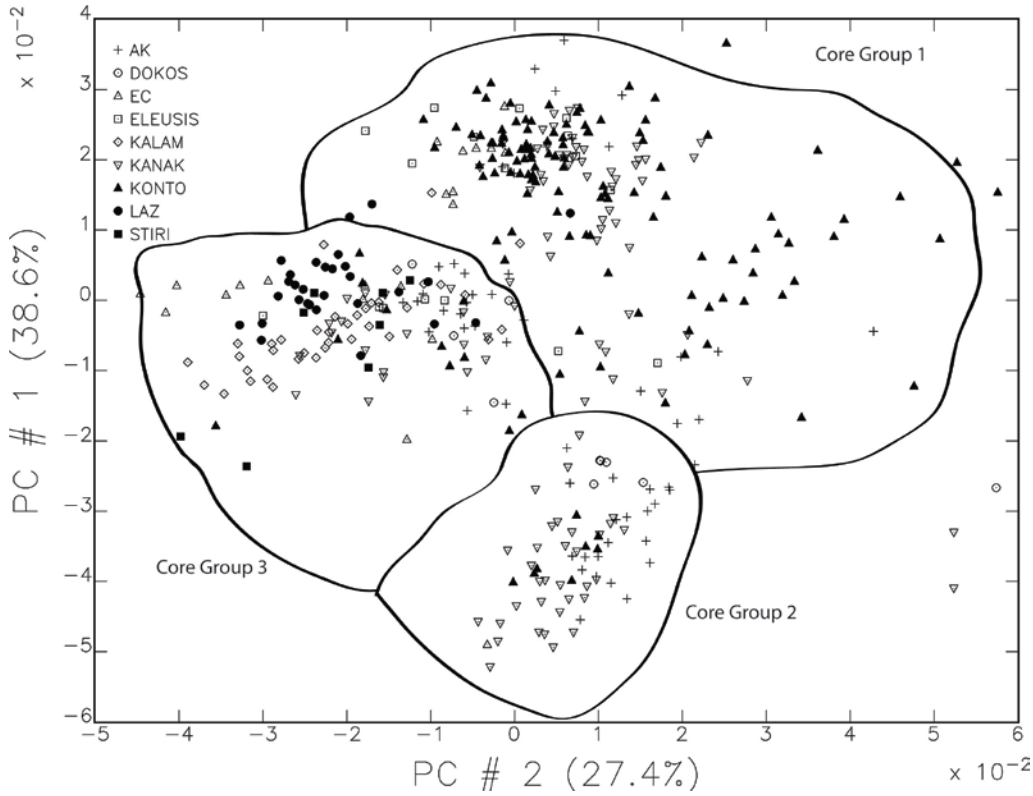

Figure 6.47: A biplot of the first two PCs (66.0% total variance) illustrating the broad grouping structure. Core Groups are roughly outlined and labelled. Sites are labelled in the legend as: AK- Ayios Konstantinos; Dokos-Dokos; EC: Euripides' Cave; Eleusis-Eleusis; Kalam-Kalamianos; Kanak-Kanakia; Konto-Kontopigado; LAZ-Lazarides; Stiri-Stiri.

	Group 1		Group 1A		Group 1B		Group 1C		Group 2		Group 2B		Group 3		Group 4		Group 5	
	Mean	SD (%)	Mean	SD (%)	Mean	SD (%)	Mean	SD (%)	Mean	SD (%)	Mean	SD (%)	Mean	SD (%)	Mean	SD (%)	Mean	SD (%)
Ca	5.1	28.0	1.5	36.2	0.6	18.8	6.2	9.7	3.4	20.0	2.7	28.2	11.0	26.6	11.6	16.0	11.7	25.8
Sc	21.0	6.2	19.5	9.1	20.1	5.8	19.1	13.8	16.0	12.0	17.6	16.1	18.9	12.1	15.5	9.5	13.5	16.0
Cr	645.7	17.6	321.1	8.9	346.1	12.4	175.4	28.5	88.7	30.4	234.0	11.7	218.0	12.6	449.3	9.9	455.5	5.1
Fe	5.4	10.0	5.4	9.7	5.5	5.2	5.1	9.6	4.5	8.7	4.7	12.2	4.9	12.2	4.2	8.8	4.2	11.3
Co	35.6	12.0	24.9	13.5	24.6	15.6	21.4	18.4	16.5	18.9	23.9	18.2	26.3	11.6	21.8	18.4	36.2	4.0
Zn	126.2	23.3	98.8	18.2	96.7	4.6	114.5	33.9	76.7	16.5	88.8	8.4	110.8	17.8	106.3	16.4	129.0	27.7
Rb	113.6	17.6	97.5	23.0	122.1	14.7	109.1	19.2	70.1	20.4	100.8	24.5	117.3	17.8	73.5	13.5	59.1	7.7
Zr	110.6	16.2	127.0	16.6	127.1	20.6	122.7	23.3	129.7	16.9	150.6	15.8	90.6	20.0	99.4	14.3	83.5	17.8
Cs	14.6	35.7	15.6	72.4	26.2	49.8	7.0	13.9	4.7	21.9	5.4	19.1	7.7	19.3	6.4	18.0	3.8	17.0
Ba	526.0	31.5	329.6	37.3	348.3	36.0	516.1	16.5	761.1	37.8	619.0	33.0	408.9	37.1	614.6	27.9	210.1	23.7
La	28.8	11.1	25.1	14.5	27.7	16.7	32.0	13.7	27.1	19.4	30.8	10.1	30.1	10.0	22.1	5.9	19.8	10.6
Ce	61.9	10.9	54.9	17.9	60.9	19.1	70.6	14.2	61.3	14.8	65.9	10.2	59.4	10.2	44.3	7.3	41.2	10.2
Sm	5.8	8.9	5.2	10.7	5.7	13.2	6.1	9.7	4.7	12.5	5.4	10.6	5.3	9.4	4.4	5.5	3.8	9.4
Eu	1.1	8.6	1.1	10.1	1.2	13.0	1.3	13.9	1.1	9.7	1.1	11.8	1.1	8.9	0.9	6.1	0.8	6.0
Tb	0.7	19.3	0.8	22.8	0.8	24.4	0.8	9.7	0.6	14.8	0.7	16.2	0.7	16.3	0.6	13.3	0.5	20.7
Yb	2.5	9.0	2.6	9.5	2.8	7.9	2.9	15.8	2.5	11.6	2.8	10.4	2.4	10.3	2.0	6.8	1.7	14.4
Lu	0.4	9.8	0.4	10.8	0.4	7.4	0.4	19.9	0.3	11.0	0.4	10.3	0.4	11.8	0.3	9.3	0.2	6.1
Hf	4.5	10.7	5.0	12.5	5.0	13.0	4.6	17.6	5.2	12.5	5.8	10.1	3.4	12.8	3.6	13.8	2.8	8.3
Ta	0.9	10.0	0.8	26.4	0.9	24.3	1.1	22.5	0.9	15.6	1.1	11.8	0.9	12.7	0.7	9.9	0.6	7.8
Th	9.9	10.9	8.0	25.0	8.9	22.6	11.7	13.6	11.3	17.3	11.0	9.1	10.0	12.2	6.8	9.0	6.2	9.4
U	2.3	17.7	1.9	25.8	2.0	19.0	2.0	31.4	1.8	22.8	2.3	11.6	2.2	16.9	2.3	14.6	1.5	18.2

Table 6.48: Mean and SD (%) of all reported chemical composition groups. All concentrations expressed in ppm except Ca and Fe which are expressed as percent.

The mean values of the resulting well-defined chemical groups are compared to known reference groups for Aegean ceramic material and Best Relative Fit factors are calculated using a modified Mahalanobis distance as described in Chapter Four (see also Beier and Mommsen 1996; Mommsen et al. 2001)to measure group member relationships. The mean and standard deviation (%) of the final chemical groups are presented in Table 6.48. All data for each site and larger ware groups are found in their entirety within Appendix II.

6.3.1 Core Group 1

Core Group 1 is heavily weighted by PC 1 while it has moderate weight attributed to PC 2 Figure 6.47. The loading vectors illustrated in Figure 6.46 indicates that Core Group 1 is separated from the other core groups due to enrichment in the elements Cr, Cs, Rb, Co, and Zn while there are significant depletions in Ca, Ba, Ta and Zr and trace elements such as Hf and Tb. Core Group 1 is dominated by ceramic samples from Kontopigado, including all of the overfired kiln wasters. Sherds sampled from Ayios Konstantinos, Eleusis, Euripides' Cave, Kanakia and Lazarides are also present.

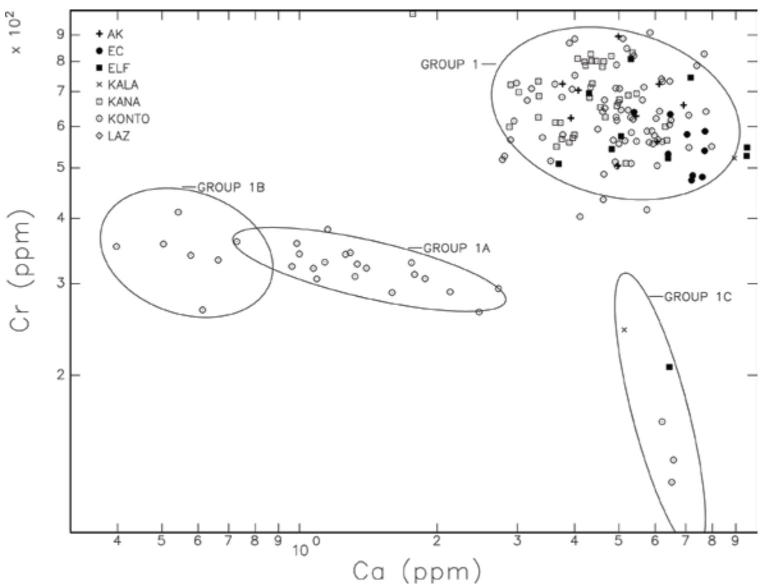

Figure 6.48: Bivariate plot of elemental values of Ca and Cr from samples in Core Group 1. All subgroups are labelled. Ellipses are drawn at the 90% confidence interval.

By removing samples from all other core groups it is possible to separate Core Group 1 into four subgroups: Group 1, Group 1A, Group 1B and Group 1C (Figure

6.48). For the most part, each subgroup is separated according to differences in Calcium concentrations. Figure 6.48 illustrates this separation with Ca compared against Cr, one of the enriched elements in Core Group 1. Group membership probabilities were calculated for all subgroups of Core Group 1 indicating that they are all individual groups. All of the subgroups in Core Group 1 are dominated by sherds originating from Kontopigado, though only Group 1 has kiln wasters as group members.

6.3.1.1 Group 1

Compositional Group 1 is by far the largest group both Core Group 1 and the entire dataset. It comprises of sample members from Ayios Konstantinos, Kontopigado, Euripides' Cave, Eleusis, Kanakia and Lazarides. Of the 133 group members, seven are over fired kiln wasters from Kontopigado (ALM 13/01-04, 13/06, 13/07 and 13/09) indicating this as the location of production for the entire group. The remaining 125 group members consist of a mixture of painted and unpainted finewares including deep bowls, cups, kylikes, and utilitarian vessels such as jugs, jars, amphora, lids for cook pots and several large tubs.

Chemical group 1 contains samples from several different petrographic fabrics from the above descriptions. The majority of samples derive from FG 1, though the large tubs of FG 2 and a pithoid jar from FG 5 (ALM 12/80) are also represented. Standard deviations for over half of the 22 elements are 12% or less. Ba, Ca, Cs, and Zn all have standard deviations of over 20% while Rb has a standard deviation of approximately 17. The fluctuation is indicative of possible post depositional alterations that occur in coastal marine environments where alkalis are selectively leached as has been shown in ceramic studies of the kiln material at Kommos, Crete (Buxeda i Garrigós et al. 2001; Day et al 2011). As and Sb are known transient elements and therefore their values are considered suspect, however, the pattern of these two elements within this group appears consistent. Enriched concentrations of Co (>30 ppm) and Cr (>600 ppm), especially when combined with high Ni concentrations, are usually indicative of ophiolites and ophiolitic soils, though this phenomenon also occurs in a variety of metamorphic rocks and metamorphic environments (Aubert and Pinta 1980: 115). Co, Cr and Zn concentrations can vary broadly in soils more so than rocks (Aubert and Pinta 1980: 117), perhaps explaining higher variation in Cr and Zn. Group 1 membership probabilities are shown in Table 6.49.

Group 1 was compared with “Early Mycenaean” chemical groups previously defined by Mommsen (2003) from the Athenian Acropolis (KRO-P), Kontopigado (ALIN) and Vourvatsi (VLIM; VOUV), but discernible differences need to be accounted for. Before the groups were compared, each dataset was recalibrated towards the Demokritos calibration standards using the methods supplied by Hein and Kilikoglou (2012; Appendix II).

ANID	*p*	ANID	p	ANID	p	ANID	p
AGK22	44.334	ALM15	97.852	ALM52	42.886	KAN704	56.222
AGK23	82.327	ALM16	17.941	ALM53	81.772	KAN705	81.657
AGK36	75.437	ALM18	80.314	ALM54	2.100	KAN706	79.593
AGK42	18.415	ALM19	70.081	ALM55	76.109	KAN707	77.860
AGK45	88.382	ALM20	81.509	ALM56	48.392	KAN708	9.949
AGK47	70.479	ALM21	76.313	ALM57	65.077	KAN709	49.278
AGK57	10.997	ALM22	64.162	ALM58	12.777	KAN710	15.833
AGK58	4.139	ALM23	61.964	ALM65	18.319	KAN711	95.647
AGK59	10.376	ALM24	44.444	ALM80	2.562	KAN712	96.222
ALM01	75.511	ALM25	61.386	ALM81	26.544	KAN713	80.892
ALM02	79.981	ALM27	61.975	ALM82	25.226	KAN714	86.839
ALM03	17.913	ALM28	4.428	COE02	49.389	KAN715	84.369
ALM04	26.356	ALM29	63.497	COE03	38.183	KAN716	34.678
ALM05	10.339	ALM30	33.948	COE04	52.196	KAN717	52.055
ALM06	87.759	ALM31	97.183	COE05	41.992	KAN718	50.463
ALM07	80.197	ALM32	68.061	COE06	91.688	KAN719	98.855
ALM08	98.036	ALM33	4.624	COE07	33.744	KAN720	26.402
ALM09	95.849	ALM34	99.917	COE08	12.247	KAN721	61.773
ALM110	72.130	ALM36	95.733	COE14	76.618	KAN722	37.275
ALM111	74.005	ALM37	99.624	COE18	82.540	KAN723	68.044
ALM112	2.572	ALM38	92.794	ELF02	36.634	KAN724	46.246
ALM116	22.321	ALM39	0.412	ELF06	64.206	KAN725	83.793
ALM117	49.043	ALM40	93.918	ELF07	0.002	KAN726	99.781
ALM118	7.332	ALM41	70.073	ELF09	0.138	KAN727	86.030
ALM120	1.978	ALM42	16.439	ELF10	55.138	KAN728	83.652
ALM121	93.389	ALM43	49.444	ELF11	59.569	KAN729	61.557
ALM122	31.319	ALM45	71.640	ELF13	13.190	KAN730	39.026
ALM123	56.724	ALM46	98.063	ELF15	59.755	KAN734	4.159
ALM125	33.441	ALM47	98.469	ELF17	89.934	KAN767	33.907
ALM126	24.487	ALM48	89.619	KAL45	13.231	KAN768	1.355
ALM128	0.062	ALM49	16.088	KAN701	13.831	KANA91	27.813
ALM13	92.392	ALM50	27.589	KAN702	76.394	KANA92	13.814
ALM14	81.116	ALM51	83.816	KAN703	83.789	KANA95	42.656
						LAZ12	61.315

Table 6.49: Group membership probabilities (*p*) for Group 1. Membership cut off has been limited to 1.00% probability.

Mommsen (2013: 17-18) demonstrates that these four "core" groups can be separated by statistical means and when compared to Group 1 only a weak relationship is revealed. Table 6.50 shows that the mean values of the three Bonn reference groups, ALIN, KRO-P and VOUV have group membership probabilities for Group 1 of 2% or less. However, using the Best Relative Fit method, dilution factors of 0.97 for Acropolis group KRO-P, 1.034 for Alimos (Kontopigado) group ALIN and 1.016 for Vourvatsi group VOUV were calculated thus suggesting that the chemical relationship between the three Bonn reference groups and Group 1 could be stronger than expected. Using these dilution factors Mommsen's group VLIM was removed due to significant variation in several elemental concentration values (e.g. Ce, Cr, La, Rb, Ta and Zn. The variation suggests that the fabric recipe differs for each group, though values are close enough to indicate similarities in the nature of raw material choice.

ANID	*p*	Fit
KRO-P	2.070	0.973
VOUV	1.038	1.016
ALIN	1.032	1.034

Table 6.50: Group membership probabilities (*p*) and fit factors calculated for Bonn Attica reference groups as compared to Group 1.

Mommsen only sampled very fine vessels for his 2003 study. Group 1 includes similar fine vessels as those samples by Mommsen, but coarsewares such as tubs and cooking vessels are also included. Thus the compositional differences in these groups may be due to the inclusion of coarseware vessels in the sampled assemblage or perhaps there is a difference in the fabric recipes used to produce similar pots earlier in the LH III period. What is clear is that all of the pottery from these groups is made with similar raw materials. Whether they all derive from the same production site at Kontopigado is inconclusive.

6.3.1.2 Group 1A

Group 1A is related to Group 1. These samples were separated from Group 1 due to significantly lower concentrations of Ca and Cr and higher average REE values. Group 1A contains samples exclusively from Kontopigado and represents several coarseware vessel types: large tubs, shallow pans, cooking pots (chytria), a griddle pan

(ALM 12/60), a spouted krater (ALM 12/108) and a basin (ALM 12/109). The samples in this group are linked to several petrographic fabrics: FG 2, FG 4, FG 6A and FG 6D. Group 1 A is part of the larger Core Group 1 and could be considered a subgroup of Group 1, however Group upon reviewing the calculated group membership probabilities it is clear that Group 1A is its own separate group (Table 6.51).

ANID	Group 1	Group 1A
ALM107	0.000	96.415
ALM108	0.000	92.311
ALM109	0.000	4.357
ALM59	0.000	12.883
ALM60	0.000	10.884
ALM62	0.000	11.727
ALM63	0.000	93.533
ALM66	0.000	64.736
ALM68	0.000	53.466
ALM69	0.000	89.826
ALM73	0.000	31.055
ALM86	0.000	22.495
ALM87	0.000	44.675
ALM89	0.000	25.942
ALM90	0.000	49.026
ALM92	0.000	81.090
ALM95	0.001	53.317

Table 6.51: Group membership probabilities (*p*) of Group 1A compared to Group 1.

Since this group is part of Core Group 1 and thus related to Group 1, it may be suggested that this group may be made of similar raw materials, such as a similar non-calcareous clay without the addition of a separate calcareous clay suggested for Group 1. The differences may also relate to the additional non-plastic inclusions present in the matrix as the majority of these vessels are much coarser than those found in Group 1.

6.3.1.3 Group 1B

Group 1B consists of cooking pottery (ALM 12/91, 12/93 and 12/97) and an askos (ALM 12/94) corresponding with FG 6A, a large pithos (ALM 13/10) that corresponds with FG 4, a tripod cooking pot (ALM 12/88) that corresponds to FG 6B and a second pithos (ALM12/84) that corresponds to FG 3. All of the samples in Group 1B exclusively originate from Kontopigado. Figure 6.48 above shows that Groups 1A and 1B are more closely related to each other than the other subgroups from Core Group 1. The close relationship between Group 1A and 1B is probably due to the very low Ca concentrations (Table 6.52). The separation of Groups 1A and 1B proved difficult; however a comparison of Ca to Cr concentrations provided clear discrimination as summarized by the group membership probabilities. Since there are too few samples in Group 1B to calculate the group membership, the samples were projected against Groups 1 and 1A (Table 6.53). Membership probabilities of greater that 10% indicate that these groups could be combined, however due to the extremely low Ca concentrations, they remain as discrete chemical groups.

Group ID	Mean Ca Concentration (%)	SD (%)
Group 1	5.113	27.9
Group 1A	1.476	36.2
Group 1B	0.576	18.8
Group 1C	6.176	9.73

Table 6.52: Comparison of average Ca concentrations (%) for subgroups in Core Group 1.

ANID	Group 1 (*p*)	Group 1A (*p*)
ALM129	0.000	0.247
ALM84	0.000	13.685
ALM88	0.000	43.769
ALM91	0.000	3.023
ALM93	0.000	32.958
ALM94	0.000	27.643
ALM97	0.000	54.778

Table 6.53: Group membership probabilities of Group 1B as compared to Group 1 and 1A.

6.3.1.4 Group 1C

Group 1C is the smallest subgroup of Core Group 1 with only five group members. Group members consist of two pithoid jars from FG 3(ALM 12/76, 12/77), a pithoid jar from FG 5 (ALM 12/71), an amphora from FG 2 (ELF 12/01) and fine war jar from FG 11 (KAL 12/20). Group 1C has the highest Ca concentration (mean: 6.176%) for all subgroups of Core Group 1. It has been separated from Group 1 due to much lower concentrations of Cr (Figure 6.47), but also lower concentrations of Co, and the Alkali elements Rb and Cs. Group membership probabilities are recorded in Table 6.54.

ANID	Group 1 (*p*)	Group 1A (*p*)
ALM71	0.000	3.143
ALM76	0.000	0.118
ALM77	0.000	0.482
ELF01	0.000	0.092
KAL20	0.000	0.019

Table 6.54: Group Membership probabilities (*p*) for Group 1C projected against Groups 1 and 1A.

6.3.1.5 Summary

Core Group 1 consists of four subgroups, Groups 1-1C, and is related to production in the region of Attica. Group 1 is tied to the production site at Kontopigado with seven out of ten kiln wasters from this site. This group contains a wide range of vessel types and corresponds well with petrographic groups attributed to production at Kontopigado. Groups 1A, 1B and 1C do not contain kiln wasters, but they are probably related to production at Kontopigado as they correspond well with petrographic groups compatible with a production in western Attica and contain cooking vessels that only appear in Attica, most commonly at Kontopigado. Using Bishop et al.'s (1992) *Criterion of Abundance*, all subgroups of Core Group 1 are formed of mainly, or exclusively, of pottery samples from Kontopigado or other sites in Attica indicating that they are products of local manufacture. Group 1, with several kiln wasters, is a definitive product of Kontopigado and contains all vessel types nearly all of the petrographic fabric groups represented in Groups 1A, 1B and 1C suggesting that they are all of products of the same manufacturer. The disparity in elements such as Calcium and Chromium is perhaps related to the mixing of the clay paste during the raw material processing stage. That most of the cooking pots are found in the Groups 1A and 1B, groups with very low Ca concentrations is significant and indicative of how potters at Kontopigado were processing materials for cooking pottery versus finewares and other utilitarian vessels like large tubs.

6.3.2 Core Group 2

Core Group 2 is represented in Figure 6.47 as being on the lower ends of bow PC 1 and PC 2. Looking back at the loading vectors in Figure 6.46, it becomes clear that Core Group 2 is depleted in elements such as Ca, Cr, Cs and Zn, however there is an enrichment in Ba and a slight enrichment in Zn, Hf and Th. Core Group 2 is split into 2 subgroups, Group 2 and Group 2B (Figure 6.49). Core Group two is dominated cooking vessels and storage jars that correlate with petrographic fabrics FG 9A and FG 9B. These two fabrics are constructed using noncalcareous and glassy volcanic raw materials.

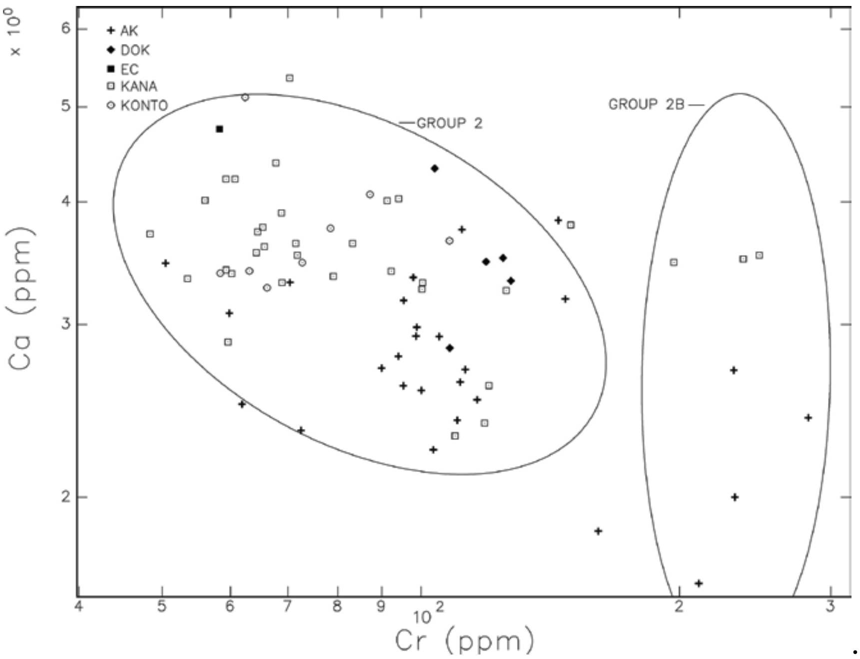

Figure 6.49: Bivariate plot comparing Cr and Ca concentrations (ppm) of samples in Core Group 2. Ellipses are drawn at 90% intervals.

6.3.2.1 Group 2

Chemical Group 2 is composed of 67ceramic specimen from Ayios Konstantinos, Euripides' Cave, Dokos, Kanakia, and Kontopigado. Group 2 is dominated by the presence of coarse cooking vessels, including tripod pots, cauldrons (*chytria*), cooking jars, an amphora (Dokos 12/01), basins, large storage jars and one large tub (Dokos 12/09). All of the samples in this group have also been classified as petrographic fabrics FG 9A and FG 9B which analysis demonstrates to be constructed of identical raw materials. The only difference in these groups is the practice of organic tempering in the tubs and jars assigned to FG 9B.

This is a very homogeneous group that is distinct from every other chemical group except Group 2B. The abundance of plagioclase phenocrysts present in the ceramic fabric varies from sample to sample as does the inclusion of plagioclase phenocryst bearing volcanic rock such as the andesite found in these samples. Ba and Ca are both Alkaline Earth elements and Alkalis are typically the most mobile elements (Golitko et al. 2012: 86), however the most variable elements are Ba and Cr not Ca and Ba (Figure 6.50). Buxeda i Garrigós et al. (2001) demonstrates that this factor is accentuated in low fired ceramics such is the case for all vessels in this group. Thus the difference in Ba may be explained by the location of deposition as illustrated by the high variance in Ba concentrations in vessels from Kanakia (approx. 650- 1200 ppm) and low concentrations. Moderate variation in U (22.8%), a highly immobile element, is significant; however group membership probabilities (Table 6.55) demonstrate that Group 2 is cohesive. Kanakia 10/11 and Kontopigado (ALM) 12/99 are kept as a group member because it consistently plots with the rest of the Group 2 in all forms of cluster analysis.

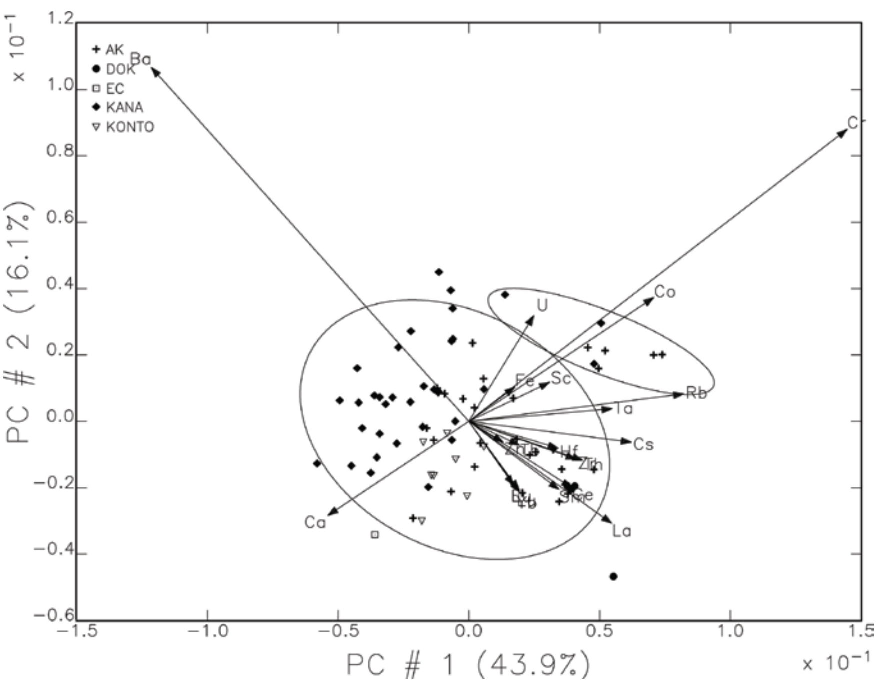

Figure 6.50: Biplot of PC 1 and PC2 from the PCA of Core group 2. Loading vectors are labelled and demonstrate that Ba and Cr show the most variance.

ANID	*p*	ANID	*p*	ANID	*P*
AGK01	95.035	ALM100	76.219	KAN755	4.619
AGK02	48.674	ALM101	89.033	KAN756	64.595
AGK03	60.663	ALM102	69.471	KAN757	83.582
AGK04	60.315	ALM103	42.396	KAN758	69.304
AGK05	10.075	ALM104	53.916	KAN759	10.299
AGK06	85.418	ALM105	52.423	KAN760	85.687
AGK07	59.241	ALM106	17.296	KAN761	70.590
AGK08	37.365	ALM99	0.656	KAN762	84.505
AGK09	79.248	COE13	5.895	KAN763	54.722
AGK10	57.168	DOK01	69.667	KAN764	98.121
AGK11	13.097	DOK02	2.040	KAN765	81.140
AGK12	80.591	DOK03	88.889	KAN773	61.565
AGK13	54.671	DOK04	7.384	KAN774	83.637
AGK14	90.617	DOK09	48.573	KAN775	17.055
AGK15	78.883	KAN746	53.302	KAN776	99.424
AGK16	53.879	KAN747	65.817	KAN778	84.364
AGK17	27.504	KAN748	14.704	KAN779	14.068
AGK18	12.039	KAN749	61.610	KAN1011	0.172
AGK21	10.125	KAN750	78.087	KAN1012	69.981
AGK24	24.084	KAN751	70.086	KAN1013	78.464
AGK25	78.968	KAN752	4.732	KAN1014	45.647
AGK26	51.136	KAN753	14.825		
AGK56	17.831	KAN754	64.703		

Table 6.55: Membership probabilities (*p*) for Group 2.

This group is related to the chemical reference group AEG-P as defined by the Bonn group (Mommsen et al. 2001) with a Fit factor of 0.924 and a group membership probability (*p*) of 6.765%. Mommsen et al (2001) link this group to production at the site of Kolonna on the island of Aegina known for its production of coarse cooking vessels. The majority of samples in this group are sampled from Ayios Konstantinos which is located on the volcanic peninsula of Methana and Kanakia on Salamis. The geology of Methana is very similar to that of the volcanic deposits on Aegina, but there is no viable evidence for a local pottery production. Efforts by Dorais and Shriner (2002) and Dorais et al. (2004) have indicated that they can differentiate the chemical composition of amphiboles occurring on Methana from those of Aeginetan geology, however they have not successfully demonstrated that local pottery production occurred on Methana. Group 3 is thusly considered to be from production on the island of Aegina though there is no current evidence to suggest that production continued past the LH

IIIA2 period at Kolonna. Therefore, Group 2 is attributed more generally to the northern part of the island of Aegina where the compatible Neogene sediments with similar chemical profiles are found (Hein et al. 2004c).

6.3.2.2 Group 2B

Group 2B is a subgroup of Group 2. It is comprised of seven samples including three fineware vessels from Ayios Konstantinos that have been attributed to FG 1 and three vessels from Kanakia: closed pot with an unprovenanced fabric (KAN 07/45) and two pithoid jars from FG 9A. Although these samples are statistically related, this group is tenuous at best. FG 1 has a metamorphic origin and FG 9A has a volcanic origin. These vessels plot together due to depleted Ca concentrations, low concentrations of Cr and enriched Ba concentrations. As discussed above, Ba is a transient element and thus should be viewed with suspicion. This group does not correlate well with the petrographic groups and needs further assessment to fully understand why these samples have grouped together.

6.3.2.3 Summary

Core Group 2 is comprised of two subgroups, Group 2 and Group 2B. Group 2 is composed of coarse cooking pottery from five different archaeological sites, Ayios Konstantinos, Euripides' Cave, Dokos, Kanakia and Kontopigado. It is linked to petrographic fabrics FG 9A and FG 9B which are composed of identical ceramic pastes, however FG 9B has the addition of organic temper, a feature which does not affect the chemistry in any way. FG 9A and FG 9B are constructed using raw materials that are compatible with a production on the island of Aegina. Thus Group 2 was compared to the reference group for aeginetan coarseware pottery utilised by the Bonn group, reference group AEG-P. When projected against Group 2, reference group AEG-P demonstrates a 6.765% group membership probability (*p*) indicating that the two groups are related. The low figure, 6.765%, is perhaps due to issues of comparing reference groups from different laboratories, even with the application of relevant calibrations. In any case, it is clear that Group 2 correlates well with petrographic fabrics FG 9A and FG 9B and chemical reference group AEG-P, all of which are attributed to a production on the island of Aegina. For these reasons, Group 2 is assigned a production provenance on Aegina.

Group 2B is not as straight forward as Group 2. Group 2B is comprised of three fineware vessels that are constructed in a fabric compatible with FG 1, the main ceramic fabric assigned to production at Kontopigado in Attica. Group 2B also contains three other vessels, two of which are coarse cooking pots compatible with FG 9A, which as it is discussed above, is compatible with aeginetan production. This group does not correlate well with the petrography or macroscopic groups. It is unclear why these six vessels have grouped together.

6.3.3 Core Group 3

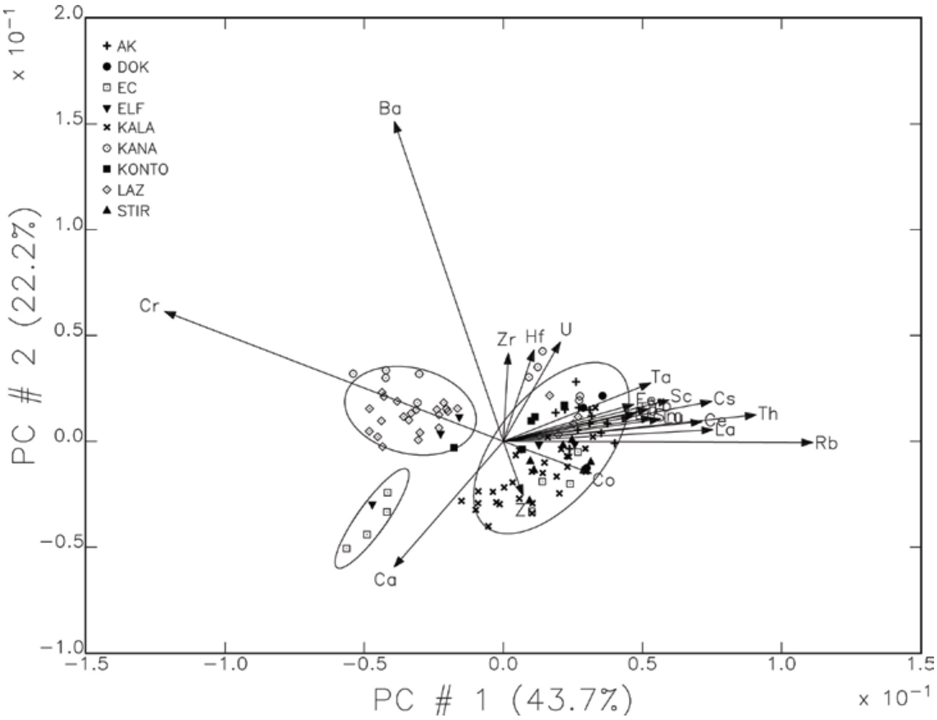

Figure 6.51: Biplot of PC 1 and PC 2 from the PCA performed on 21 elements for all samples in Core Group 3. Loading vectors are labelled. Ellipses are drawn at 90% confidence intervals.

Core Group 3 is made up of three discrete chemical groups, Group 3, Group 4 and Group 5. A new PCA was performed on all samples from Core Group 3 using all 21 elements (Figure 6.51). This core group is dominated by samples with enriched Calcium concentrations (>7% Ca) and depleted Cr, Ba and all REE concentrations as illustrated by the loading vectors. Comparing PC 1 against PC 2 shows that the three subgroups are easily separated with loading vectors illustrating that Group 3 is weighted on the Alkali elements Rb and Cs in addition to several trace elements. Group 4 has significant enrichment of Cr while Group 5 is enriched in Ca. Core Group 3 has heavy concentrations of ceramic samples from both Kalamianos and Lazarides, however the samples from these sites split fairly well into Groups 3 and 4 respectively, while Group 5 is almost exclusively formed of ceramics from Euripides' Cave (Figure 6.52).

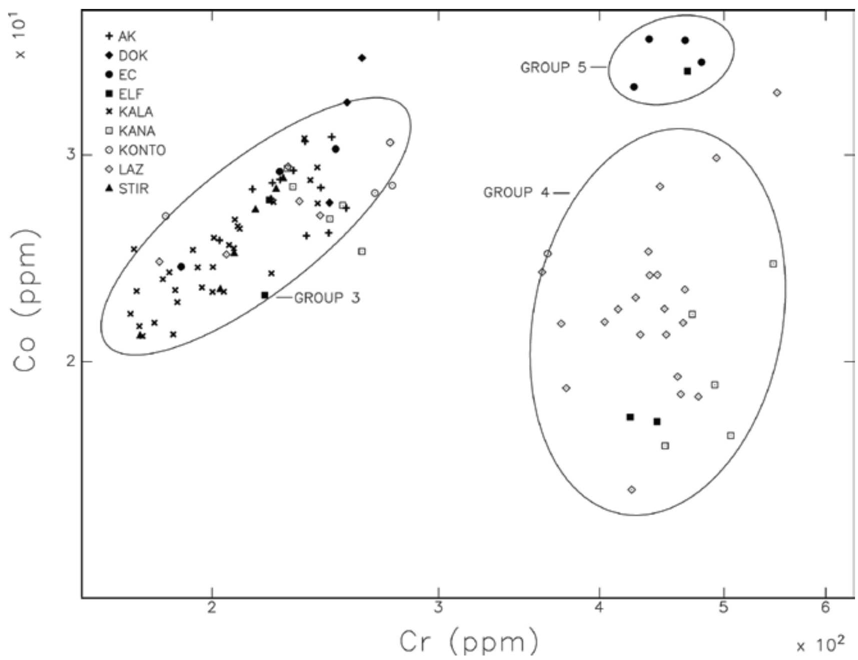

Figure 6.52: Bivariate plot of Cr and Co demonstrating how Core Group 3 splits into 3 discrete compositional groups. Groups are labelled and ellipses are drawn at 90% confidence intervals.

6.3.3.1 Group 3

This group comprises of samples from Ayios Konstantinos, Euripides' Cave, Eleusis, Kontopigado, Lazarides and Stiri, but the bulk of the group consists of samples from the harbour site at Kalamianos. The vessels represented are all fine painted deep bowls, stemmed bowls, cups, kylikes and fine stirrup jars. There are samples from both the petrographic fabric groups FG 1 and FG 11 which indicates that some of the fine vessels in FG 1 (Ayios Konstantinos 12/43, Kalamianos 12/25, 12/27, 12/42 and Stiri 12/100) may need to be re-assigned to FG 11 as this group has significantly lower average concentrations of Co (26.25 ppm) and Cr (217.96 ppm) and a much higher average concentration of Ca (11%) when compared to chemical the subgroups of Core Group 1 where the majority of samples from FG 1 are found. These vessels are extremely fine textured and have very few inclusions and make petrographic characterisation difficult.

This is a fairly tight clustered group with the majority of the group members showing over 30% probability of group membership (Figure 6.56) and the majority of elemental standard deviations are below 15%. Variation is found mainly in the transient element Ba (37%). The majority of the samples in this group come from the Corinthia and Methana; it is unlikely that these are local to Methana for it has a volcanic composition similar to that found on Aegina. Petrographic analysis suggests a Corinthian origin; however the group is closely tied to the well-defined Mycenae-Berbati reference group (Figure 6.53) originally constructed by Perlman and Asaro (1969) and recently restudied by Mommsen and colleagues (2002). However when the Bonn reference group MYBE (Mycenae-Berbati) is projected against Group 3 there are very few samples that show higher that 1% probability of group membership (Table 6.57). There is some degree of variance noted in elements Rb and Zr, however small.

ANID	*p*	ANID	*p*	ANID	*p*
AGK28	47.715	ELF14	5.144	KAL59	85.016
AGK30	22.432	KAL127	52.183	KAL61	77.729
AGK33	96.974	KAL137	56.697	KAL62	98.987
AGK34	10.540	KAL14	54.650	KAL64	21.026
AGK35	65.454	KAL16	81.342	KAL73	97.898
AGK37	82.032	KAL18	89.752	KAL74	97.416
AGK38	15.100	KAL21	81.149	KAL75	75.736
AGK41	43.521	KAL22	81.937	KAN737	14.215
AGK46	87.343	KAL24	0.094	KAN738	61.008
AGK54	45.219	KAL25	61.019	KAN739	7.083
AGK62	75.985	KAL27	98.427	KAN742	1.432
AGK63	42.110	KAL31	75.237	KAN743	44.538
ALM113	18.638	KAL32	73.016	LAZ06	57.437
ALM114	27.730	KAL33	70.505	LAZ09	73.402
ALM115	0.865	KAL35	65.711	LAZ11	60.071
ALM12	10.482	KAL36	32.872	LAZ28	62.354
COE09	39.504	KAL37	49.947	LAZ29	18.905
COE16	37.675	KAL39	95.985	STIR100	49.807
COE19	48.126	KAL42	17.172	STIR101	60.141
DOK06	6.708	KAL43	96.075	STIR102	36.346
DOK08	70.288	KAL44	80.869	STIR105	8.389
DOK10	9.627	KAL47	73.609	STIR108	6.990
ELF03	84.858	KAL52	39.262	STIR109	18.820

Table 6.56: Membership probabilities (*p*) calculated for Group 3.

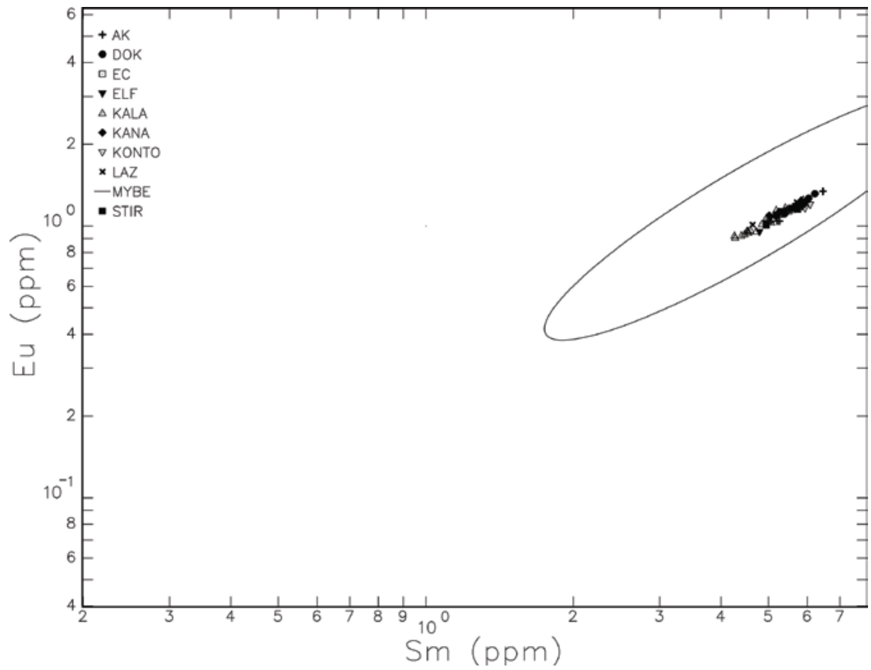

Figure 6.53: Bivariate plot of Sm and Eu showing Group 3 members plotted against the Bonn reference group MYBE. Ellipse drawn at 90% confidence interval.

Assigning Group 3 a provenance in the Argolid, specifically the Mycenae-Berbati region, is problematic as the Kalamianos material and Stiri are from a surface survey and are highly suspect due to chemical alterations from environmental contamination. Moreover, the reference group for Mycenae-Berbati has always created problems and it is more likely to represent the Neogene composition of NE Peloponnese than the Mycenae- Berbati area specifically (Kilikoglou pers. comm.). The study by Hein et al. (2002b) is a prime example of this problem by demonstrating that many of the clay deposits of the northern Peloponnese have chemically similar signatures and that separation of chemical groups requires consideration of marginal differences in elemental composition. Recent study of Early Bronze Age ceramic assemblages from ancient Corinth (cf. Burke et al. in press) may hold the key to discriminating Corinthian produced wares from those attributed to Mycenae and Berbati.

ANID	Group 3 (*p*)	MYBE (*p*)	ANID	Group 3 (*p*)	MYBE (*p*)	ANID	Group 3 (*p*)	MYBE (*p*)
AGK28	67.131	10.305	ELF14	0.465	0.028	KAL59	96.303	8.139
AGK30	0.681	0.043	KAL127	99.293	6.725	KAL61	92.982	2.162
AGK33	0.003	0.000	KAL137	69.743	5.777	KAL62	98.884	3.151
AGK34	21.331	26.123	KAL14	52.087	0.015	KAL64	63.057	0.135
AGK35	83.290	5.722	KAL16	98.680	1.196	KAL73	98.831	68.947
AGK37	79.077	4.984	KAL18	90.630	8.447	KAL74	98.530	2.807
AGK38	15.619	0.361	KAL21	94.292	8.564	KAL75	65.011	0.091
AGK41	38.807	13.956	KAL22	93.689	1.501	KAN737	24.663	0.056
AGK46	85.213	7.812	KAL24	0.714	0.000	KAN738	1.980	0.000
AGK54	40.177	0.693	KAL25	97.044	26.949	KAN739	44.397	2.178
AGK62	49.387	9.222	KAL27	92.779	15.539	KAN742	9.011	0.005
AGK63	31.732	0.039	KAL31	85.552	3.598	KAN743	37.045	0.020
ALM113	0.650	0.050	KAL32	86.086	1.657	LAZ06	91.551	5.396
ALM114	0.570	0.002	KAL33	98.755	1.542	LAZ09	69.217	0.749
ALM115	7.687	0.000	KAL35	86.990	2.073	LAZ11	98.648	17.276
ALM12	17.105	0.000	KAL36	55.189	0.099	LAZ28	0.012	0.000
COE09	0.526	0.011	KAL37	93.636	0.030	LAZ29	58.398	3.103
COE16	2.579	0.230	KAL39	99.545	73.739	STIR100	66.871	0.115
COE19	4.941	0.001	KAL42	49.863	0.491	STIR101	62.656	3.062
DOK06	8.887	0.000	KAL43	59.704	0.219	STIR102	81.752	0.449
DOK08	30.002	0.164	KAL44	30.045	0.694	STIR105	22.408	0.002
DOK10	21.326	0.021	KAL47	93.617	5.424	STIR108	16.456	0.139
ELF03	30.094	6.886	KAL52	69.212	0.300	STIR109	35.105	0.034

Table 6.57: Group membership probabilities (*p*) of Group 3 projected against Bonn reference group MYBE.

6.3.3.2 Group 4

Chemical Group 4 contains 28 samples with the majority coming from the Aeginetan settlement of Lazarides at 18 samples, with two from Eleusis, five from Kanakia and three from Ayios Konstantinos. The vessel types represented are mainly painted deep bowls with some jars, carinated kylikes, hydria and basins. All of the samples are assigned to the same petrographic group, FG 10B. This is a very tight group as illustrated by the high membership probabilities (Table 6.58). Standard deviations are generally 15% or less. This group is similar to the Bonn reference group AEG-A (Mommsen et al. 2001) and an unpublished reference group from Eleusis, ELF-AEG-A. The average elemental concentrations of this group are compatible with the soil profile for Ayios Thomas in north central Aegina which produces pale yellow fired ceramics (Hein et al. 2004c: 555). The vessels from this group are generally pale yellow in colour. According to Hein et al. (2004c) the variation in the two samples of the Ayios Thomas have a similar range of variation in measured values for elements Co, U and Zn.

ANID	(*p*)	ANID	(*p*)
ELF05	0.927	LAZ15	83.250
ELF12	3.931	LAZ16	14.144
KAN731	7.770	LAZ17	74.097
KAN733	49.297	LAZ18	86.075
KAN740	30.067	LAZ19	85.051
KAN744	28.521	LAZ20	83.316
KAN783	15.616	LAZ21	64.096
LAZ02	76.003	LAZ22	98.377
LAZ03	22.441	LAZ23	1.126
LAZ04	42.373	LAZ24	74.897
LAZ07	63.410	LAZ25	99.189
LAZ08	1.212	LAZ26	86.066
LAZ10	46.452	LAZ27	98.968
LAZ14	65.473	LAZ30	72.948

Table 6.58: Membership probabilities (*p*) for samples in Group 4.

Group membership probabilities show that the Ayios Thomas clays are compatible with Group 4 with *p* values greater than 1% on two out of five clay samples (Table 6.59). Hein et al. (2004c) mention clays from Cape Plakakia as another potential raw material source for Aeginetan finewares, but upon comparison it is very clear that this is not the source of Group 4. There is no evidence for pottery production at the site of Lazarides in the centre of the island where the topography is rocky with few soils suitable to pottery manufacture and the geology is mainly volcanic. This group is considered to be a local production on the island of Aegina. Production likely occurred in the northern part of the island, nearer to the calcareous clays such as those at Ayios Thomas.

ANID	(*p*)
AGTclayA	1.035
AGTclayA	0.000
AGTclayA	0.000
AgThoclay	0.634
AgThoclay	1.126

ANID	(*p*)
PLAKAKIA-cl	0.000
PLAKAKIA-cl	0.000
PLAKAKIA-cl	0.000
Plakakia1	0.000
Plakakia2	0.000
Plakakia3	0.000
Plakakia4	0.000
Plakakia5	0.000
Plakakia6	0.000
Plakakia7	0.000
Plakakia8	0.000
Plakakia9	0.000

Table 6.59: Membership probabilities (*p*) for clay samples from Ayios Thomas (AGTclay), Aegina (left) and Cape Plakakia, Aegina (right).

6.3.3.3 Group 5

Group 5 is the smallest compositional group in Core group 3 with only five group members. Much like Group 2B, Group 5 does not correlate well with any specific petrographic or typological group. Looking at each sample individually, Euripides Cave 12/01 is constructed with green firing calcareous clay that has volcanic inclusions. Petrographically it is described as FG 10Af, a very fine version of the fineware produced on the island of Aegina (compare to FG 2Af in Gauss and Kiriatzi 2011: 100-101; 134-135). Euripides' Cave 12/10 and 12/12 are two samples constructed using a calcareous clay with bioclastic limestone and microfossils (FG 12). Euripides' Cave sample 12/11 is constructed from calcareous clay and quartz mylonite inclusions. Finally, the only sample from a different context, Eleusis 12/16 is constructed in the main fabric from Kontopigado, FG 1. However different each sample is petrographically, both PCA and elemental bivariate plots keep this group together (Figures 6.51, 6.52). Perhaps the chemical correlation is due to some form of mineralogical alteration or chemical contamination caused by the deposition environment. The majority of samples come from Euripides' Cave, a site which is has a high probability for chemical contamination from the local cave environment. The elements Cs and Rb have depleted levels may be due to chemical leaching and salt replacement during deposition (Buxeda i Garrigós et al. 2001: 364).

6.3.3.4 Summary

Core Group 3 is comprised of three discrete chemical groups, Group 3, Group 4 and Group 5. Although the whole of Core Group 3 represents ceramic samples from all sites in the study, two groups, Group 3 and Group 4 are linked to specific geographic regions, while the third, Group 5, has a majority of samples from Euripides' Cave on Salamis. Group 3 is the largest and most regionally diverse compositional group in Core Group 3 with 69 group members originating from Ayios Konstantinos, Dokos, Euripides' Cave, Eleusis, Kalamianos, Kanakia, Kontopigado, Lazarides and Stiri. The shapes represented are the fine painted deep bowls, stemmed bowls, stirrup jars, squat stirrup jars, cups and kylikes, or the quintessential "Mycenaean" pottery shapes. The strong correlation with FG 11 and the Mycenae-Berbati (MYBE) reference group link Group 3 to the Northeast Peloponnese, however, it is unclear as to where the vessels are actually manufactured. FG 11 has petrographic ties to pottery production in EH Corinth, yet the chemical composition and strong relationship the MYBE reference group suggest a production origin in the Argolid in the Mycenae and Berbati valleys. Geologically, there are chemically similar calcareous Neogene clay deposits that span the entire northern region of the Peloponnesian peninsula (see Hein et al. 2002b). Perhaps it is time to revisit the composition reference group for Mycenae with current analytical methods and tools in addition to making a sincere attempt at generating a reference group production in the Corinthia, specifically at ancient Corinth.

Group 4 is also composed of painted finewares, specifically deep bowls, that form the petrographic fabric FG 10B. Samples in Group 4 originate from assemblages at Eleusis and Kanakia with the bulk deriving from the settlement at Lazarides. Group 4 has a weak chemical correlation with the clays and modern sherds sampled from Ayios Thomas (Ayios Nektarios), Aegina. This link to Aegina is compatible with the assigned production origin of FG 10B (Noncalcareous volcanic fabric). This is the second chemical group linked to an Aeginetan production. The production of Aeginetan finewares in the LH IIIB-LH IIIC Early period has not previously been identified.

Group 5 is composed of four vessels from the Euripides' Cave assemblage and a single vessel deriving from Eleusis (Eleusis 12/16). Of the five, only two (Euripides' Cave 12/10, 12/12) were assigned to the same petrographic fabric group, FG 12. The remaining three sherds were each assigned to a different petrographic group. The petrographic groups represented in Group 5, FG 10 Af, FG 12, FG 23 and FG 28, each have very distinct petrographic compositions and it is unclear as to why these samples as so similar chemically. One explanation could stem from the burial environment of the four samples from Euripides' Cave. Cave environments, like coastal marine environments, can result in the replacement of salts such as Rb and Cs with other salts, such as Ca (Buxeda i Garrigós et al. 2001).

6.4 Conclusions

Statistical analysis of chemical data has generated three core chemical groups with five distinct compositional groups and four subgroups. Looking back at the total variation matrix for the complete Saronic Gulf assemblage (Figure 6.46), it is the elements with the most variance that were commonly used to discriminate chemical groups. In fact, elements such as Ca and Cr are the most commonly used variables to split larger groups into subgroups. This is especially clear in the grouping and subgrouping of material from the production site at Kontopigado. Kontopigado produced wares are represented by Core Group 1 with related subgroups Groups 1, 1A, 1B and 1C. Group 1 contains a very broad range of vessel shapes, including tubs and cooking pots. In comparison Groups 1A and 1B are dominated by coarse utilitarian pottery, the main discriminating factor is the extremely low Ca concentrations. Petrographic analysis has demonstrated the raw materials are similar for samples in all three groups, however the moderate Ca concentrations in the vessels of Group 1 suggest that these vessels had a material high in Ca added to a noncalcareous material, i.e. clay mixing. There appears to be a pattern that connects the level of Ca concentration to the size and function of the vessel at Kontopigado. In other words, many of the large tubs show low Ca concentrations and cooking vessels and storage jars are noncalcareous while the majority of fineware vessels have Ca concentrations between 4-7%. This evidence is indicative of conscious choices being made concerning which and how much of raw materials are needed to produce specific vessel type. Clearly at Kontopigado there was a single workshop or group of potters creating several vessel types from different mixtures of the same raw materials. This pattern, however, apparently does not transmit to other identified places of production from the Saronic Gulf region.

Core Group 2 and specifically Group 2 relates to the noncalcareous volcanic fabrics FG 9A and 9B attributed to a production on Aegina. Group 4, from Core Group 3 is also linked to Aeginetan production, matching the chemical profile of Pliocene clays from the area of Ayios Thomas in the north central part of the island specifically. The difference in technological practice for these two groups is discussed in detail in Chapter 7. It must be stated that there is a clear separation in the types of raw materials selected for the manufacture of coarse, noncalcareous, red-firing utilitarian pottery such as tubs, storage jars and cooking pottery when compared to the highly calcareous, pale yellow firing painted fineware vessels which are produced on the same island. In fact, there are clear differences in the raw materials used to produce the different fineware fabrics as Group 4 is discriminated from Group 2 much the same as FG 10A and FG 10B are separated in terms of their petrographic composition. These observations suggest that there are more than one group of potters on Aegina during the Late Mycenaean period; each of which is very specialised in the kinds of wares they produce.

Group 3 from Core Group 3 is clearly compatible with the Mycenae-Berbati reference group, MYBE, which was first identified by Perlman and Asaro over 40 years ago (Perlman and Asaro 1969), though the current incarnation of this reference group derives from Mommsen and the Bonn group (Mommsen et al. 2001). This group has been used to identify ceramic exports coming from the pottery workshops controlled by the Late Bronze Age stronghold at Mycenae. With recent petrographic evidence form this study, and that of Burke et al. (in press), it appears that this chemical group may well reflect material produced near Ancient Corinth. Hein et al. (2002b) demonstrated the difficulties of discriminating compositional groups in the northern Peloponnese, specifically between Achaia and the Argolid, it appears that this problem also exists between the Argolid and northwest Corinthia. The shared geological landscape in this area is surely to blame creating similar chemical signatures for several viable raw material sources. In any case, the integration of chemical and petrographic information regarding this ceramic fabric is not yet reconciled. That this group dominates the sites of Kalamianos and Stiri, several kilometres to the south of Ancient Corinth, and is evident at Ayios Konstantinos on Methana further south coupled with the mineralogical petrological composition of this group presents a significant argument against a provenance at Mycenae. This is an on-going issue that needs more work like that of Burke et al. (in press) before a clear resolution can be achieved. Nevertheless, this group, like that of Groups 1 and 2, has a broad distribution throughout the Saronic Gulf region (Table 6.60).

Chemistry has identified three major areas of pottery production in Attica, Aegina and the northeast Peloponnese in Core Group 1, Groups 2 and 4 and Group 3, respectively. With the lack of chemical reference groups, petrographic analyses have further identified several other distinct places production in the Saronic Gulf and further afield to the Cyclades and Crete. FG 21 may derive from Attica, however it is produced from a different set of production practices than any other fabric attributed to Attica in this study. FG 12 probably originates from northwest Corinthia but it is not linked to Group 3 in anyway, rather it is part of compositional Group 5. FG 13, a serpentinite-based fabric, contains two samples that are probably from two different ophiolitic sources which suggest that there is two groups producing serpentinite based fabrics for the production of large tubs in Attica, southern Boeotia or Corinthia. FGs 17A and 17B are formed from blueschist-rich materials, likely from the south western Cycladic islands along the Attic-Cycladic metamorphic belt, perhaps near Ayia Irini, Kea. FGs 18 and 20 are linked to the Phyllite-Quartzite outcrops known from south central Crete, near the Mesara plain and the transport stirrup jar and wide mouth jar exports well known from this period. FG 19 derives from the granodiorite formations well-known from the Mirabello region in eastern Crete.

This integrated framework of analysis has demonstrated that there is a strong correlation between the resulting petrographic groups and the structure of the chemical compositional dataset. This is a very positive result because these two methodologies, thin section petrography and chemical composition analysis, determine characteristics of ceramic materials that are of different nature and therefore are not necessarily expected to demonstrate absolute correlation in groupings. Yet both datasets indicate that there are a restricted number of production sites with the majority of studied sites playing the role of pottery consumer. In fact, at least at Kontopigado, even the pottery producers acquired and utilised ceramic vessels from other production centres. There are still yet uncovered places of pottery manufacture in the Saronic Gulf region during the Late Mycenaean period, but the evidence for their existence is transparent. Of the three major areas where pottery production has been identified, Kontopigado in Attica, the northern half of Aegina and in northwest Corinthia, each has a broad distribution for their respective wares. It appears that, as we will see in greater detail in the following chapter, some aspects of technology is both localised while others are shared then shared, such as the use of organic vegetal matter as temper. In some areas, it seems that pottery production is specialised according to ware type, where at others it is not. Perhaps this is a reflection of regional social trajectories, another avenue to be explored in the following chapter.

Archaeological Site	Petrographic Fabric Group	Chemical Group
Athens Acropolis, Attica	1,4,5,6B,6C,7,8,9A,11,23,30	No Data
Ayios Konstantinos, Methana	1,9A,9B,10B,11,22,23,26,27, 28,33,34	1, 2, 2B, 3,
Myti Kommeni, Dokos	1,9A,9B,11,20,22	2, 3, 5
Eleusis, Attica	1,10B,11,32	1, 1C, 3,4, 5
Euripides' Cave, Salamis	1,9A,10Af,10Am,11,12,23,2 8, 35	1, 2, 3, 5
Kalamianos, Corinthia	1,(9A),10Af,11,22	1, 1C, 3
Kanakia, Salamis	1,2,3,9A,9B,10B,13,14,15,16 , 18,20,21,23,31	1, 2, 2B, 3, 4
Kontopigado, Attica	1,2,3,4,5,6A,6B,6D,9A,11,17 A, 17B,19,36	1, 1A, 1B, 1C, 2, 3
Lazarides, Aegina	1,10Af,10B,11,22,25,29	1, 3, 4
Plaka, Attica	1,1Ac,2,4,5,6A,9A,13,24,37	No Data
Stiri, Corinthia	1,(9A),11	3

Table 6.60: Overview of petrographic fabric and chemical composition groups and the sites where they are found. Numbers in parentheses signify that this group has been identified by Debra Trusty of University of Florida.

At present, there is not enough reference material available to locate the origins of all pottery studied in this thesis, but this is, in my opinion, a healthy start. Currently, more work is being completed by others form the research groups at Sheffield and Demokritos in Athens to reconcile many of the problems outlined in this chapter, most significantly the isolating a chemical signature of pottery produced near Ancient Corinth and that from the area controlled by the citadel at Mycenae. New excavations and surveys are identifying more contemporary and sites of other dates with comparable ceramic material. The information from this work will be invaluable for solving this problem.

Chapter Seven: Ceramic Production Technology

7.1 Introduction

Chapter Six presented the results of the multi-technique analytical study of Late Mycenaean pottery from the Saronic Gulf region and revealed that there are several producers of similar vessel types**.** These data work towards reconstructing aspects of the production technology for four broad vessel types: tablewares, cooking vessels, storage jars and large tubs. Reconstructing the technological practice is useful to identify and compare different production strategies that occurred simultaneously in the area of the Saronic Gulf which, during the Late Mycenaean period, was a place where both objects and ideas were regularly exchanged. Reconstructing technological sequences exposes the kinds of choices potters made and the specialist knowledge of material and process potters must have acquired to create such sophisticated ceramic vessels. Although the production origins of the majority of vessels were determined in the previous chapter, the only site from this study where clear evidence of pottery production occurs is Kontopigado in Attica. This presents a problem in trying to compare the strategies of the various production centres in the Saronic Gulf directly. Thus, instead of trying to explore further and characterise the different production strategies used at each place of production, this chapter details production at Kontopigado as a major Attic centre and explores the general patterns in the choice of raw materials and firing conditions in similar vessel types across the Saronic Gulf. Evidence suggests that similar vessel types were manufactured at different places across the study area, however, choice and manipulation of raw materials demonstrates stark contrasts. Still other details suggest the sharing of rather specific technological practices occurred (Gilstrap et al. in press). In other words, production of pottery in the Saronic Gulf during the Late Mycenaean period is approached in deeply different ways and yet belies some key points of contact and transmission of practice.

The four general pottery types have been chosen to explore these phenomena, interpreting them in light of the varied histories which might epitomise the experience of different settlements and regions. The analysis investigates the production technology of cooking pottery, large tubs, storage jars and both decorated and undecorated tablewares in order to identify the types of raw materials used, their processing, surface treatment of finished vessels and the conditions under which they were fired. This approach to technological reconstruction is motivated by an understanding of technology as a social phenomenon, where practice has far wider implications than the technical action itself (Lemonnier 1993). Working to reveal the way in which ceramic vessels were manufactured, reconstructing their operational sequences makes it possible to investigate each operative action independently, while simultaneously placing it within a technical system. As noted in Chapter Three, this method enables a dialogue of interaction between materials, object and technician delineating socially acquired knowledge and gesture.

Before we delve into the main discussion, a brief introduction to the four general categories of vessels is necessary. This will create a platform to explore the choices made in pottery production that are linked to vessel type and to further investigate the differences in technological practice and identify possible differences in production organisation within the Late Mycenaean Saronic Gulf. Subsequently, mineralogy, petrology, texture, microstructure and chemical composition are used to reconstruct the different stages of vessel production. Thin section petrography is used to reveal the raw materials, paste mixtures and assess the kinds of geological environments that provided the materials used in this production site. Microstructural analysis by SEM is combined with chemical compositional data in order to characterise level of vitrification and provide an estimation of equivalent firing temperatures. This combination of SEM and chemical composition is further applied toward identifying technological features involved in surface modification and decoration.

7.2 Ceramic types

What are referred to as ‘tableware’ throughout this chapter are the painted, monochrome and plain fine-grained and generally high quality vessels from the broad Saronic Gulf assemblage (Figure 7.1). This group includes conical and carinated kylikes, spouted and unspouted basins, shallow and deep bowls, straight-sided alabastra. Beyond tablewares, the fineware group includes more utilitarian vessels included jugs, jars, two-handled amphorae, ladles and hydria. The painted versions of these vessels are decorated in a variety of motifs including red or black straight or wavy bands or a combination of both.

Many handles are decorated with horizontal of vertical bands. Deep bowls have variants of concentric semi-circles and triglyph combinations and kylikes may are plain or painted with banded, spiral or shell motifs. Monochrome vessels appear in black, greyish black, dark brown, reddish orange and red, while hydria are commonly covered in a buff slip or undecorated.

Figure 7.1: Fine tableware vessels. Starting at top left: Kanakia 07/31 (deep bowl), Plaka 10/12 (closed vessel; possible stirrup jar), Kanakia 07/19 (spouted basin), Kanakia 07/39 (conical kylix), Kanakia 07/08 (hydria) and Kanakia 07/11 (jug). (Photos courtesy of Chr. Marabea, Y. Lolos and A. Papadimitriou).

The coarsewares from the Saronic Gulf appear in three main forms, large tubs (*asaminthoi*), storage jars and cooking vessels. The *asaminthos* is an ovoid tub, often referred to as a bath tub due to its shape (Figure 7.2). Most of these vessels are very large in size measuring approximately over a metre long by half of a meter in width and half a metre in height and very thick walls (>5 cm). At Kontopigado there are several sizes of this vessel shape; their exact dimensions are recorded by Kaza-Papageorgiou and Kardamaki (2012), but it is not the sole producer of this vessel type. As described in the previous chapter, there are five distinct large tub fabrics found in and around the Saronic Gulf, two of which are attributed to production in Corinthia (FGs 13 and 14), a third from Aegina (FG 9B), the Kontopigado tub fabric (FG 2) and finally a tub fabric of undetermined provenance (FG 34).

The majority of storage jars are referred to in this thesis as pithoid jars because the preservation of these vessels is too poor to reconstruct the exact shape. However, there are large vessels reconstructed as pithoi at Ayios Konstantinos, Dokos and Kontopigado. Storage jars tend to be coarse and thick walled, and in the Saronic Gulf, they exist in a broad range of petrographic fabrics.

Figure 7.2: Large tub (*asamanthos*; unsampled). Photo courtesy of Chr. Marabea and Y. Lolos.

Cooking vessels come in a range of shapes and sizes and from at least three production centres, however in this section the Aeginetan and Kontopigado types are discussed in the greatest detail as these are the most abundant. Cooking vessels come in one- and two-handled, ring-based cooking jars, tripod pots, round bottomed pots, semi-perforated flat griddles, flat pans, basins, spouted basins, lids and spit rests. The majority of these vessel types were produced at both Kontopigado and Aegina; however, the flat pans, semi-perforated griddles and spit rest are only known from the Kontopigado assemblage. These vessel shapes are described in detail elsewhere (for Aeginetan varieties see Marabea 2010; for Kontopigado varieties see Kaza-Papageorgiou and Kardamaki 2012).

7.3 Reconstruction of technology

This section examines in detail the different stages of manufacture for each of the four vessel types above. Technological practice, including raw material selection, paste mixture, decoration and firing conditions, are discussed according to shape category for each area individually followed by a discussion of regional technological practice and transmission of technical knowledge.

7.3.1 Tablewares

According to the provenance results discussed in Chapters Six, tableware production occurred at several centres across the Saronic Gulf. It is fairly clear that while each identified production centre were manufacturing similar vessel types, the strategies employed during the manufacturing process were varied. Near Athens, where pottery from Kontopigado dominates, potters were using more than one clay-rich raw material to produce their wares. Figure 7.3d illustrates the main paste mixture found in all tablewares. It is composed of a combination of reddish firing micaceous and calcareous clays. The main component is derived from secondary micaceous clay with both sedimentary and metamorphic rock inclusions. The groundmass is mainly composed of fine mica laths, quartz and feldspar. Small fragments of low grade metamorphic rock, identified as pelitic greenschist are found throughout the sampled fabric. This rock type is common in much of Attica. A secondary component is a greyish-yellow calcareous clay, marked by the yellowish, often mottled and optically active pellets. Figure 7.3a-c demonstrates the various raw material components and highlights evidence of clay mixing in the form of amorphous pellets and striations. This fabric forms the foundation for nearly all vessels manufactured at Kontopigado, including the large tubs, storage jars and cooking vessels which will become clear below.

The results of the microstructural analysis have revealed remarkable consistency in the firing conditions used in the production of the Kontopigado vessels. Though the calcium content is on the low end of the scale it is still considered calcareous since cellular microstructures were usually produced upon firing at the relevant temperatures. The continuous vitrification of the non-calcareous clay used on the exterior surface and the vitrified calcareous body of the painted and monochrome vessels indicates the vessels were fired to temperatures that reached the lower end of the 850-1050°C scale (Figure 7.4).

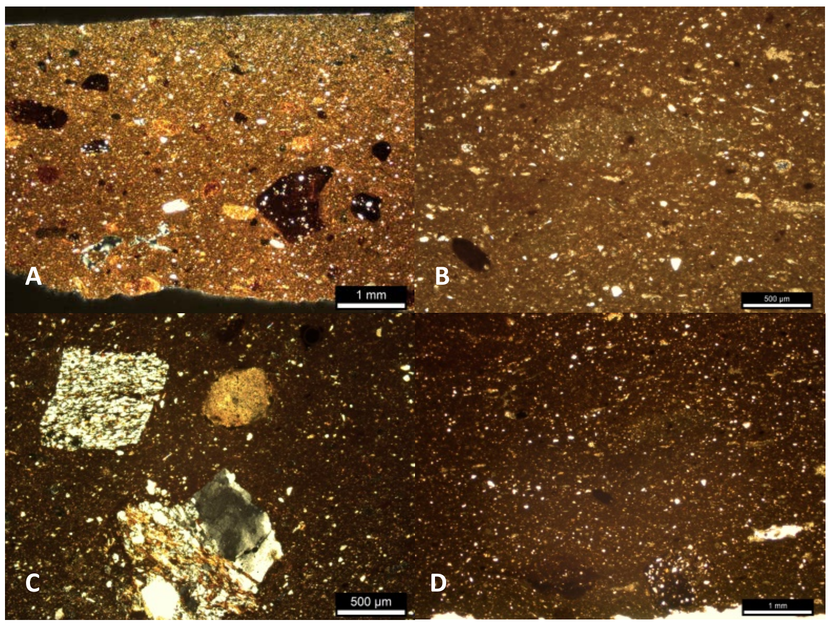

Figure 7.3: Tableware fabric (FG 1) raw materials in XP: a. red and yellow clay pellets (Alimos 12/112); b. elongated mixed pellet (centre; Plaka 10/13); c. low-grade metamorphic rock fragments (Plaka 10/08); d. greywacke and red striated pellet (bottom centre; Plaka 10/35).

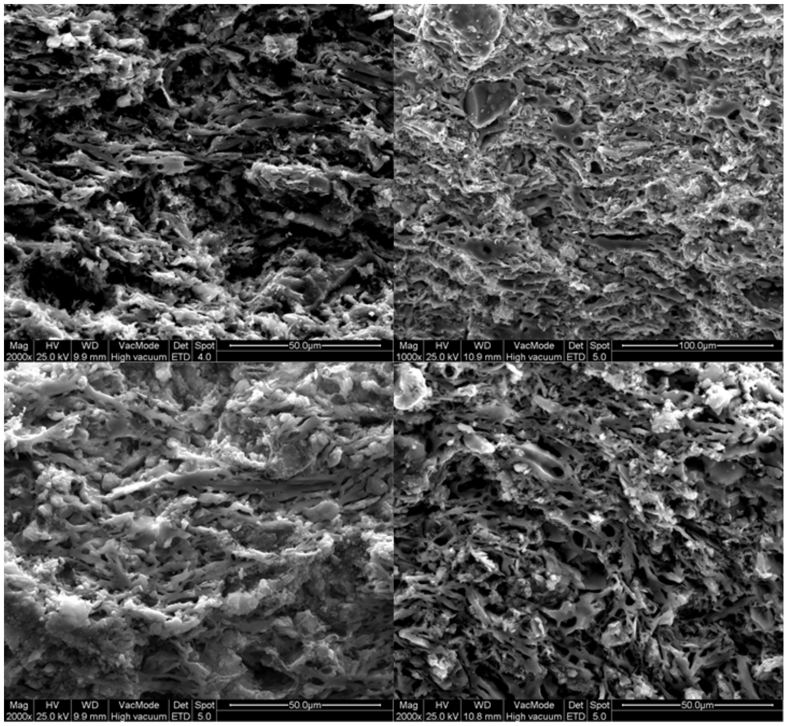

Figure 7.4: Secondary electron micrographs demonstrating the vitrification range in Kontopigado tablewares (FG 1); Top left- initial vitrification (Alimos 12/07); top right- extensive vitrification with small bloating pores (Alimos 12/21); bottom left-continuous vitrification (Alimos 12/22); bottom right- extensive vitrification with medium bloating pores (Alimos 12/30).

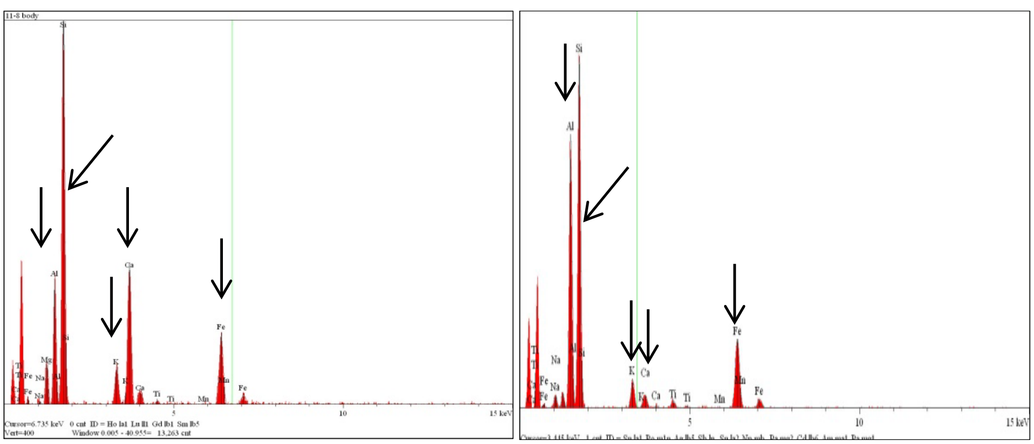

Figure 7.5: The EDX spectrum on the left hand side illustrates the bulk chemical composition of the body of the sherd and on the right, red paint on the surface.

Upon examination it is apparent that the clays used for the paints and the body are of a different composition. The paint on the surface is richer in Al, K and Fe but has significantly less Ca than the body (Figure 7.5). The presence of high amounts of K and the fine nature of the clay used for the production of the black/red paints lowered the necessary firing temperature to achieve complete vitrification as observed at the surface of the vessel on the top of Figure 7.6.

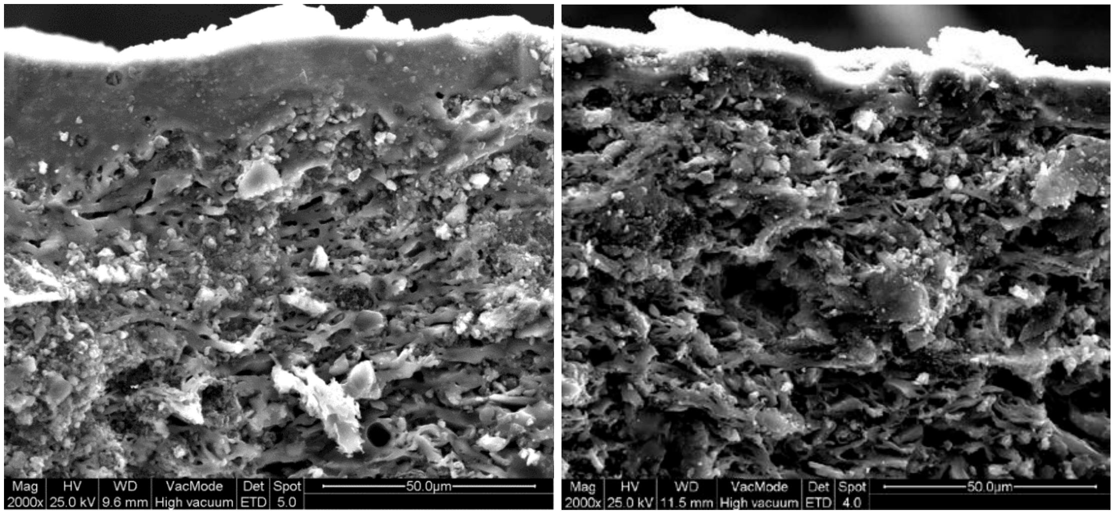

Figure 7.6: Secondary electron photomicrograph illustrating the complete vitrification of the fine grain layer of black paint on the surface and the continuous vitrification of the body on the left (Alimos 12/30). The image on the right is red paint that has been near completely vitrified (Alimos 12/07). The chemical composition is the same.

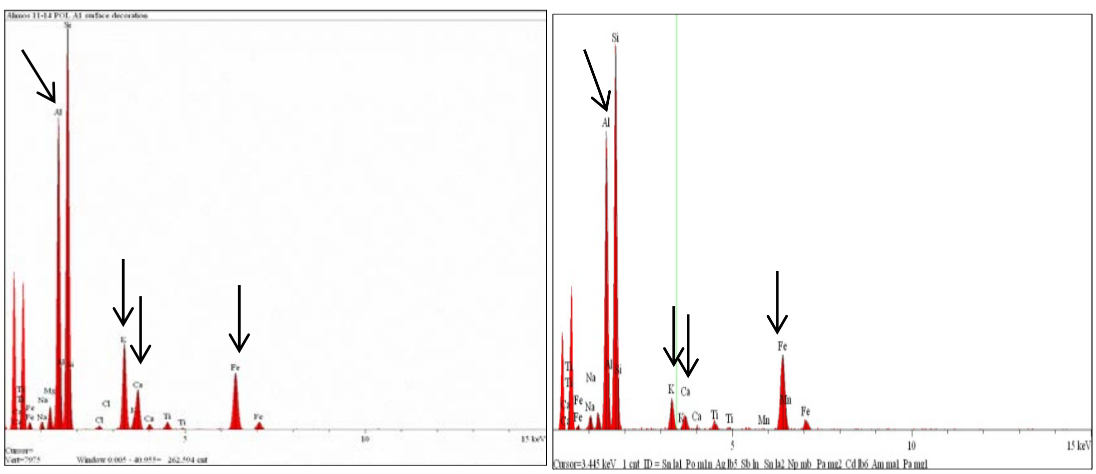

Figure 7.7: Left-EDX spectrum of Kontopigado black paint with peaks of Al and K and low levels of Ca. Right- EDX spectrum of Kontopigado red paint exhibiting a peak of Al, but both K and Ca levels are significantly lower than is observed in the black paint.

Both red and black paint are produced at Kontopigado using similar raw materials, both are rich in aluminium and low in calcium, however black consistently registers higher concentration of potassium, 9-16% and 2-5% for red and calcium, 2-4% for black and 0.5-2% for red (Figure 7.7). Aluminium and iron are consistent in both red and black. This observation means that the raw materials used to produce the black paint are different than for red paint and require different firing strategy, moreover, it indicates that the production of a black paint was deliberate. Iron-rich paint produces a black colour only if it has been fired in a low-oxygen, or reducing atmosphere (Noll 1978; Maniatis and Tite 1981; Maniatis et al. 1993) otherwise in an oxygen-rich environment the paint will turn red. Red and black paint are both applied as monochrome decoration or as bands or other motifs onto a light clay or pinkish-buff coloured body, usually with a pink or reddish core. Vessels painted with an iron-rich material were produced in a completely oxidising atmosphere. The high degree of vitrification in red paint is indicative of temperatures of 850^0C or higher. In the case of the iron black paint, monochrome vessels that have a light core and dark-on-light painted vessels are the products of a three stage oxidising-reducing-oxidising (ORO) process in which temperatures must have reached 850^0C in order for the paint to successfully vitrify so that it will retain its black colour during the final oxidation stage (Noll 1978; Maniatis et al 1993; Kilikoglou 1994). This type of firing technology is the same used to produce Attic black and red figure pottery from the Archaic and Classical periods. Both reduction and ORO firing procedure requires significant control over the firing environment. ORO firing is especially difficult as the ability to create and sustain a reduction atmosphere for approximately thirty minutes is necessary at temperatures of 850^0C and above in order for the physical transformation of the red haematite into black magnetite to take place thus keeping the black colour after the reintroduction of oxidising conditions (Maniatis et al. 1993; Kilikoglou 1994).

A second tableware fabric is identified as being compatible with an origin on the island Aegina. This fabric, FG 10, consists of a fine calcareous matrix with few to very rare inclusions of intermediate rock fragments, andesite and/or rhyodacite, plagioclase feldspar and hornblende amphibole. Carbonates are commonly found in the form of micrite and foraminifera microfossils. This fabric is identical to the Calcareous Volcanic Fabric described by Gauss and Kiriatzi (Fabric Group 2; 2011: 99-104) who split this group into two main subgroups, Fabric Group 2A and Fabric Group 2B, or in the case of this project FG 10A and 10B. FG 10B (Figure 7.10) is defined as having an overall greater abundance of inclusions and more green amphiboles in comparison to FG 10A. Gauss and Kiriatzi's

Fabric Group 2Af is comparable to FG 10Af in this study (Figure 7.8) where their more moderately coarse Fabric Group 2Am is comparable to FG 10Am (Figure 7.9).

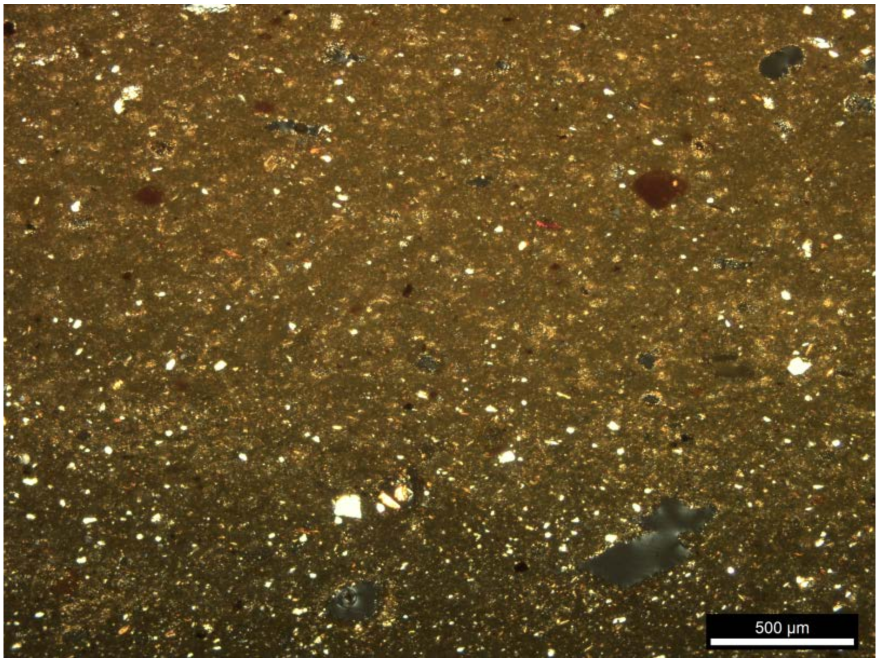

Figure 7.8: Finest subgroup of Calcareous Volcanic Fabric in XP (Lazarides 12/15, FG 10Af).

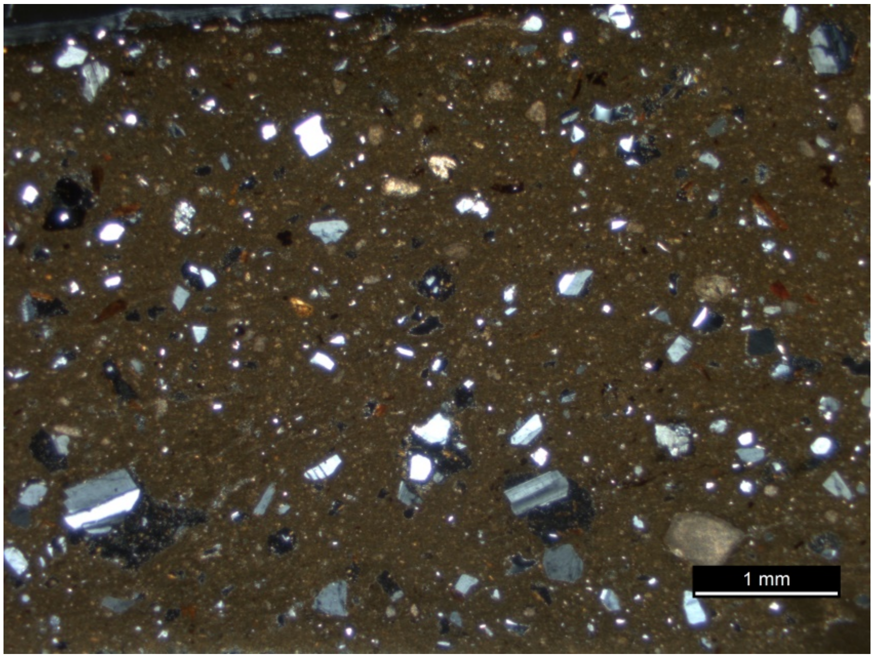

Figure 7.9: Moderately coarse variant of Calcareous Volcanic Fabric in XP (Euripides' Cave 12/01, FG 10Am).

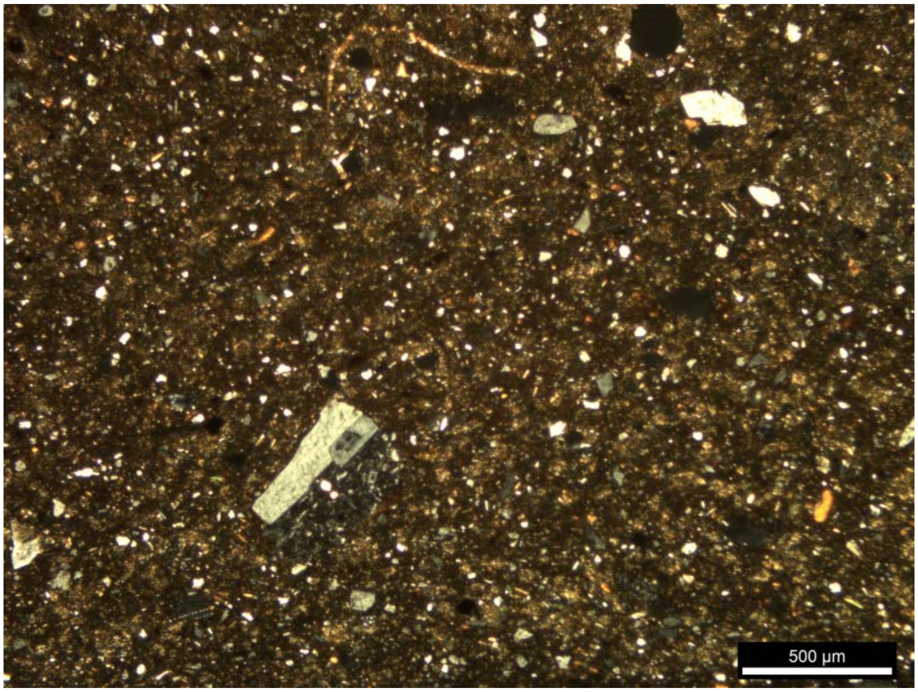

Figure 7.10: Calcareous Volcanic Fabric group B in XP (Eleusis 12/12, FG 10B) has more densely packed inclusions in the matrix.

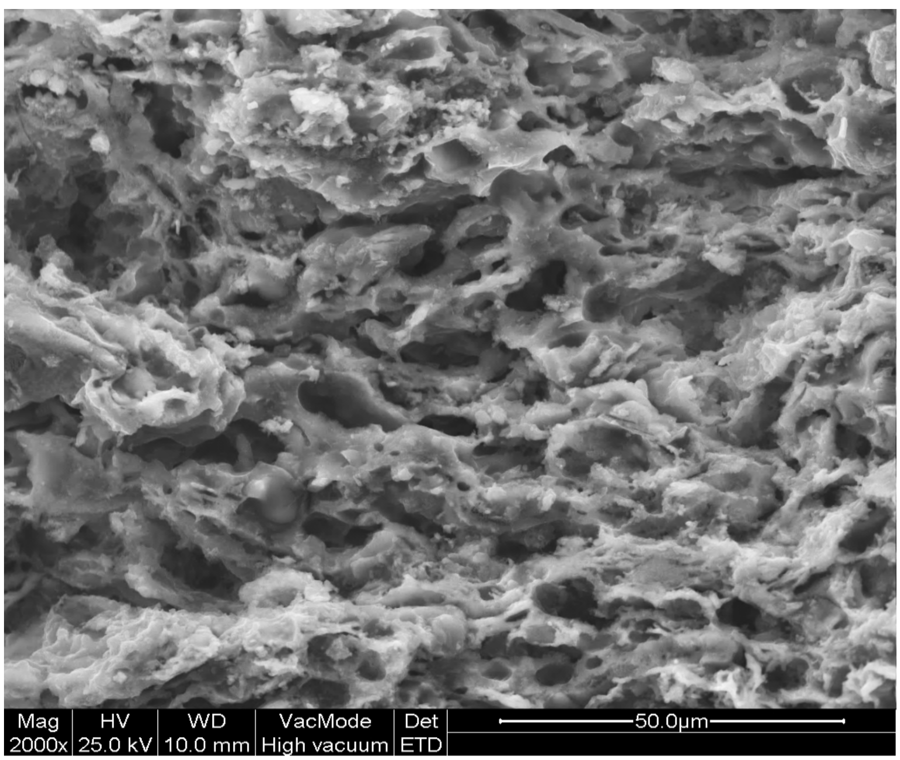

Figure 7.11: Microstructure from a drinking vessel from the Calcareous Volcanic Fabric (Kanakia 12/90). Extensive vitrification is visible in the form of glassy filaments and fine pores throughout the microstructure. Bloating pores are produced from the breakdown of CO_2 which occurs at 800-900^{0}C (Maniatis and Tite 1981).

The Calcareous Volcanic fabric (FG 10) presents an entirely different picture than the Noncalcareous Volcanic fabrics (FGs 9A and 9B). Here the CaO concentration is 13.5% and the microstructure of the ceramic body exhibits a very cellular morphology. As seen in Figure 7.11, the microstructure exhibits an extensive network of fine glass filaments interrupted by frequent, elongate pores with diameters up to 10μm. This type of microstructure is typical of fine calcareous ceramics fired at temperatures above the decomposition range of calcium carbonate (>800^{o}C). The difference between the two fabric microstructures is significant and indicates that distinctly different firing regimes were employed in their respective production events (Gilstrap et al. in press).

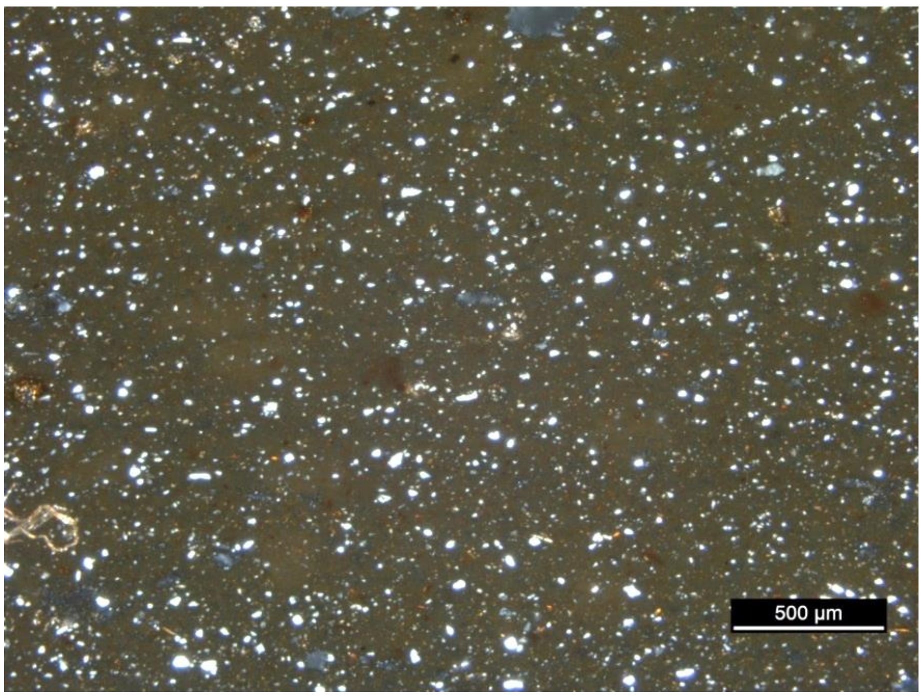

Figure 7.12: Corinthian Fine Green firing with biotite fabric used in the production of quality, decorated tablewares in XP (Kalamianos 12/18).

There are several fine tableware fabrics that are produced at or near Ancient Corinth. The most prominent is a very fine fabric with very rare coarse inclusions used in the production of high quality drinking and mixing vessels (Figure 7.12). The fine grain size of the inclusions makes it difficult to characterise through thin section petrography. The greenish colour and lack of optical activity indicate that the clay matrix is calcareous and the finished vessels were subjected to consistent high temperatures during firing. The only other fine fabric determined to be from this area is this yellow firing bioclastic limestone and marl fabric (Figure 7.13). The poor sorting and bimodal grain size distribution suggest that the bioclastic limestone inclusions were first disaggregated and subsequently added to the matrix as temper.

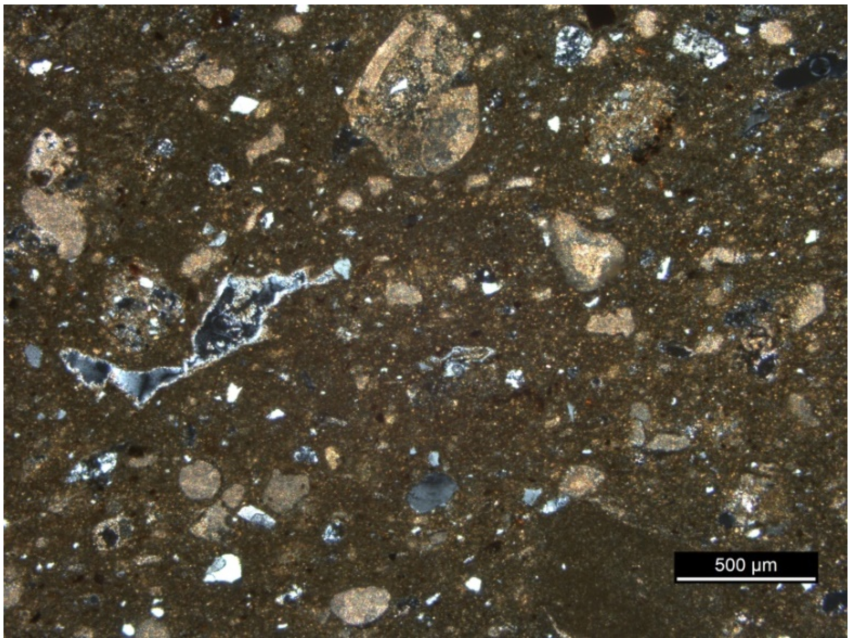

Figure 7.13: Bioclastic limestone fabric (Euripides' Cave 12/10, FG 12) in XP.

Similar to their counterparts at Kontopigado, Corinthian tablewares are decorated with red and black monochrome or dark-on-light motifs, however only black monochrome and dark-on-light variants of the Corinthian Green firing with biotite fabric and red dark-on-light in the Bioclastic Limestone fabric were sampled for analysis by SEM. The results corroborate petrographic evidence for high firing temperatures estimated according to the lack of optical activity. Figure 7.14 shows the cellular microstructure of a high fired calcareous ceramic. The Corinthian fine green tablewares analysed have CaO values of 12% and above indicating that they are considered calcareous (cf. Maniatis and Tite 1981). Figure 7.15 illustrates the total vitrification of the paint layer with fine bloating pores measuring approximately 5-8 μm in diameter. The cellular microstructure in the body and complete vitrification on the surface of the samples lead to an estimate of firing temperatures in the upper half of the 850-1050C range. Figure 7.16 shows extensive vitrification and the cellular microstructure of a high fired calcareous ceramic as well. This is the microstructure of the Bioclastic Limestone fineware fabric. The complete vitrification of the paint layer on the surface and the extensive network of glassy filaments in the microstructure of the body suggest high firing temperatures of 850-1000^{0}C.

Figure 7.17 illustrates the compositional spectra from the paint and body of a stemmed deep bowl in Corinthian green firing fabric found in the Cave of Euripides on the island of Salamis. These compositions are representative of black monochrome and black painted dark-on-light motifs of Corinthian fine tablewares. The black paint (Figure 7.17a) used in the decoration of both the monochrome and has a definitively different chemical composition compared to that of the body (Figure 7.17b). The paint layer shows a large peak in aluminium, a smaller peak in potassium and a much lower peak of calcium than the body.

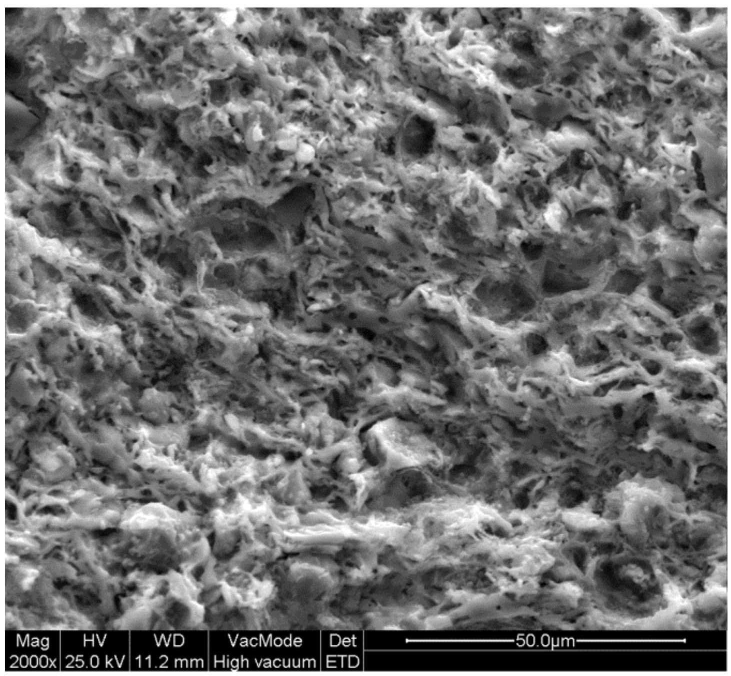

Figure 7.14: Microstructure of Corinthian green firing fine tablewares (Kanakia 07/39).

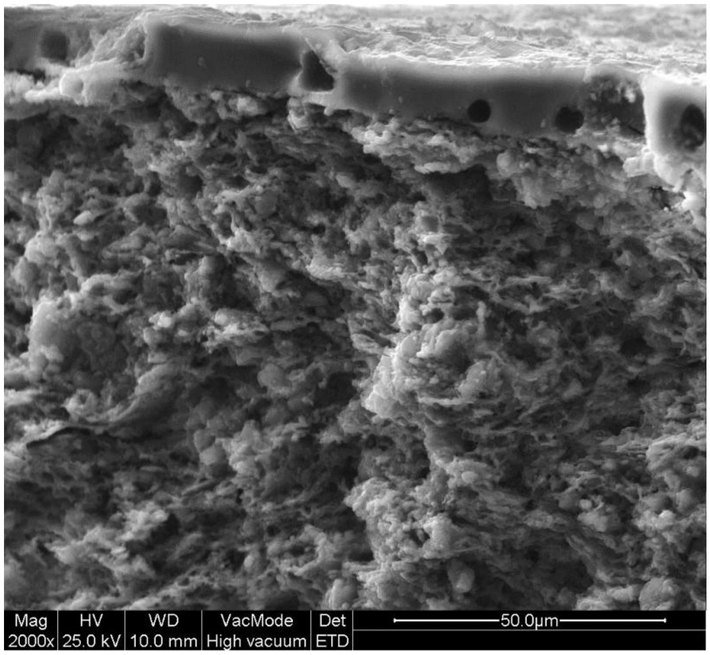

Figure 7.15: The paint layer at the top of this image is completely vitrified with small bloating pores approximately 7-10μm in diameter (Kanakia 07/36).

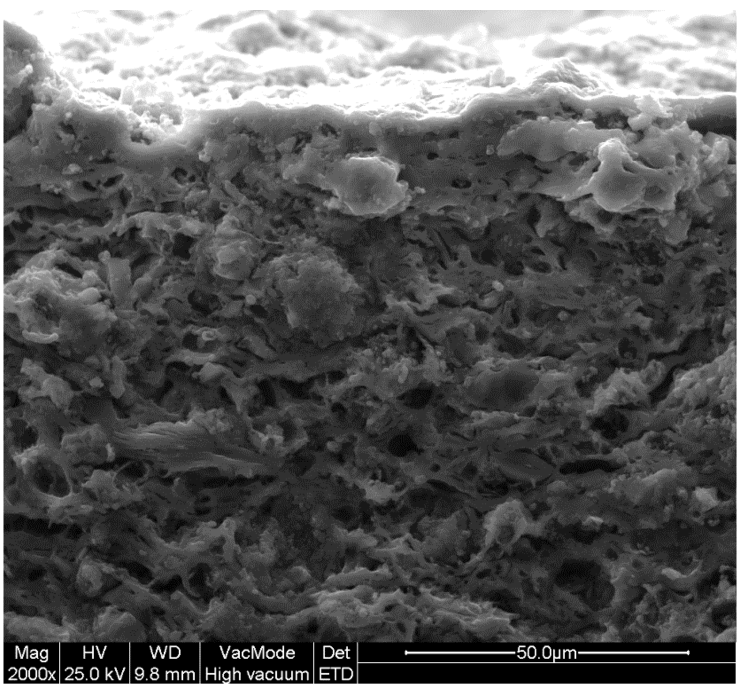

Figure 7.16: The red paint layer of a deep bowl in the Corinthian Bioclastic Limestone fabric is completely vitrified. The body demonstrates extensive vitrification (Euripides' Cave 12/12).

Figure 7.18 shows identical compositional patterning, however the ceramic body is not greenish-buff, but grey. Black paint on a grey body would normally indicate that a different firing process was used, but further analysis shows that this is not the case. This particular sample is from the settlement of Myti Kommeni on the island of Dokos and is a member of the same petrographic group as Cave of Euripides sample mentioned immediately above. These two samples are very different on a macroscopic level, but they are composed of the same raw materials and are produced in the same technical fashion, e.g. very fine calcareous paste with very rare inclusions of any kind and black painted dark-on-light decoration motifs. It seems that the Dokos vessel, a kylix, was produced in a failed attempt at an ORO firing where the body never completely re-oxidised. It is fairly clear that potters from Corinthia are intentionally decorating their pots using iron-rich black paints that require the specialist knowledge of ORO firing regimes.

Figure 7.19 illustrates the elemental composition of the body and red paint as used in the production of the Corinthian Bioclastic Limestone fabric. The pattern is similar to what is observed in the black paint of the Corinthian Fine Green Fired fabric. The body is calcareous at over 13% calcium and has low levels of iron, aluminium and almost no potassium. The red paint layer on the exterior surface is significantly different with low calcium and high aluminium and potassium peaks. Iron is roughly equivalent indicating that both body and paint contain significant levels of Iron. The red colour of the paint and buff colour of the body are indicative of an oxidising atmosphere during firing.

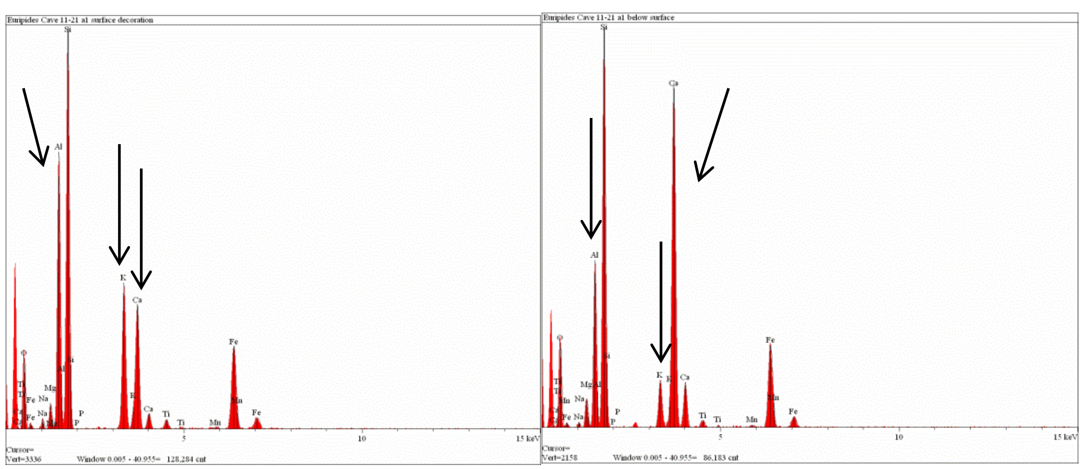

Figure 7.17: (Left) X-ray spectrum illustrating chemical composition of black paint layer; (right) composition of the greenish-buff coloured ceramic body.

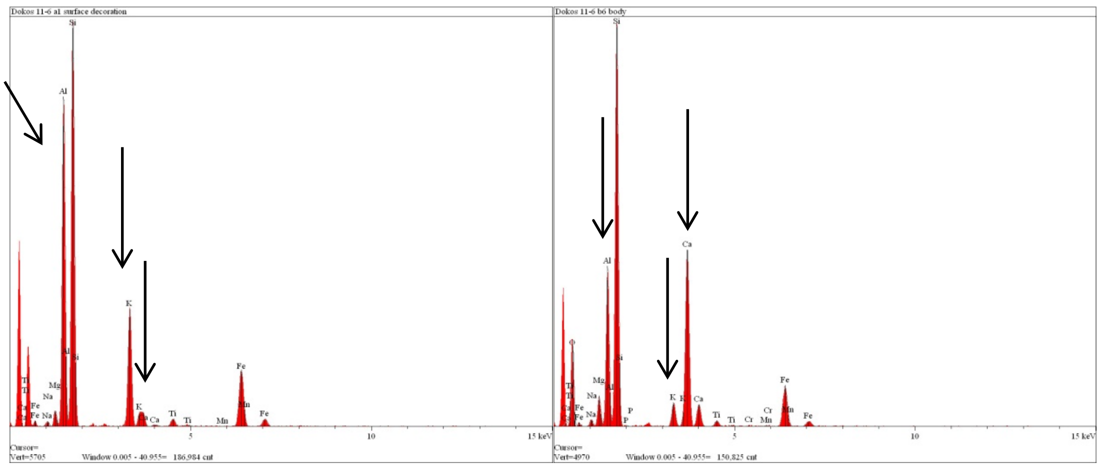

Figure 7.18: The composition of the black surface decoration (left) and the grey coloured body (right) are identical to that of the black paint on a greenish-buff coloured body (Figure 7.17). The paint is high in Al and K but lacks the Ca found in the body. Arrows point to peaks mention in the text.

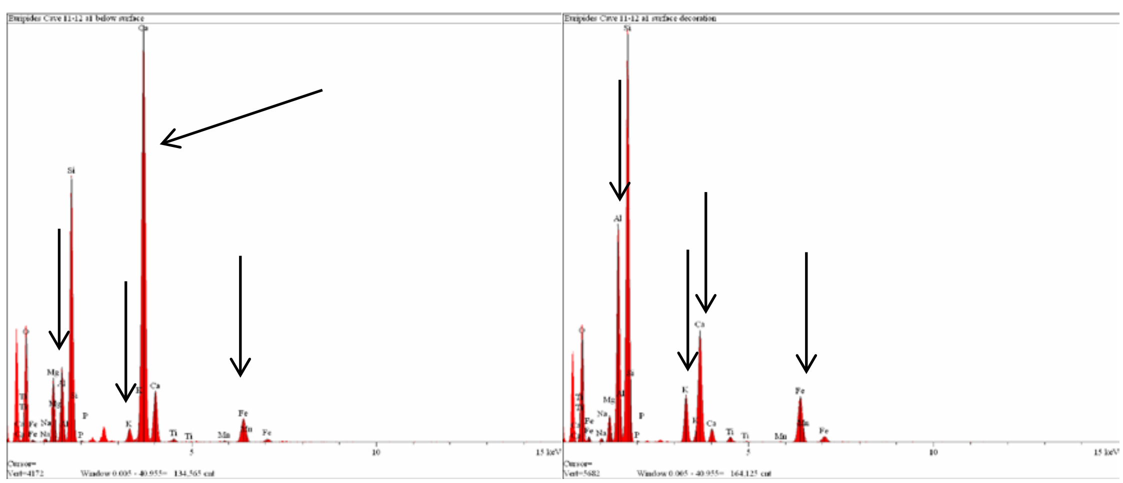

Figure 7.19: (Left) Extremely high peak of calcium indicates that the body is a high calcareous, also note the low iron peak; (Right) the calcium peak for the surface decoration is much lower, while aluminium, potassium and iron are considerably higher.

7.3.2 Tubs

The majority of the large tubs studied over the course of this project have been assigned to the production installation at Kontopigado. These were produced using slightly coarser micaceous, calcareous clay than FG 1 and have the addition of organic matter as temper. Figure 7.20 clearly demonstrates the use of the same recipe for the clay matrix in both tablewares and tubs. The elongated and curved voids are the remains of the organic matter that has been burnt out during the firing stage. Voids of this type mainly occur in tubs, both large and small, but are also found in griddle pans. The fragility of ceramic material makes it a poor choice for very large vessels, by adding organic matter into the matrix, potters were able to create large voids in their fabric which add to the overall toughness of a ceramic (Kilikoglou et al 1995). Mechanical properties tests have shown that large voids make for tougher ceramic vessels by dissipating the energy of cracks in the matrix (Kilikoglou et al 1995). Beyond mechanical properties, the porous structure left behind after firing out the organic matter would create a vessel with less mass than one without vegetal temper. The tubs are large and cumbersome objects that were moved long distances, perhaps the addition of organic temper was a pragmatic solution to the problem of burdensome weight.

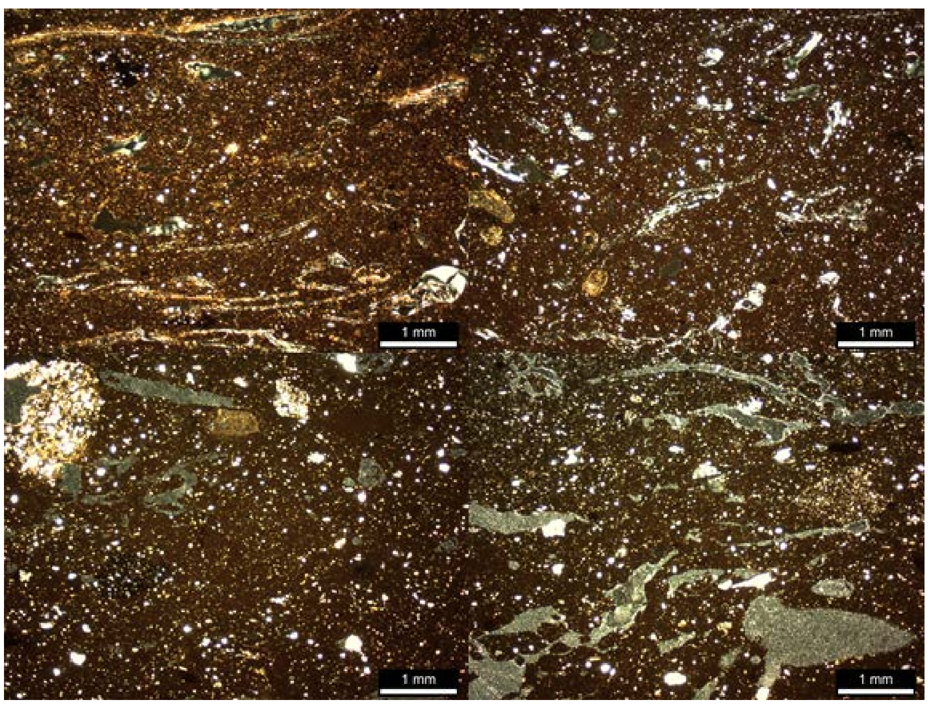

Figure 7.20: Variations of the Kontopigado tub fabric (FG 2) in XP. Organic matter is demonstrated by the irregularly shaped and elongated, curved voids. Top left- Alimos 12/55; Top right- Alimos 12/57; Bottom left- Plaka 10/38; Bottom right- Plaka 10/35.

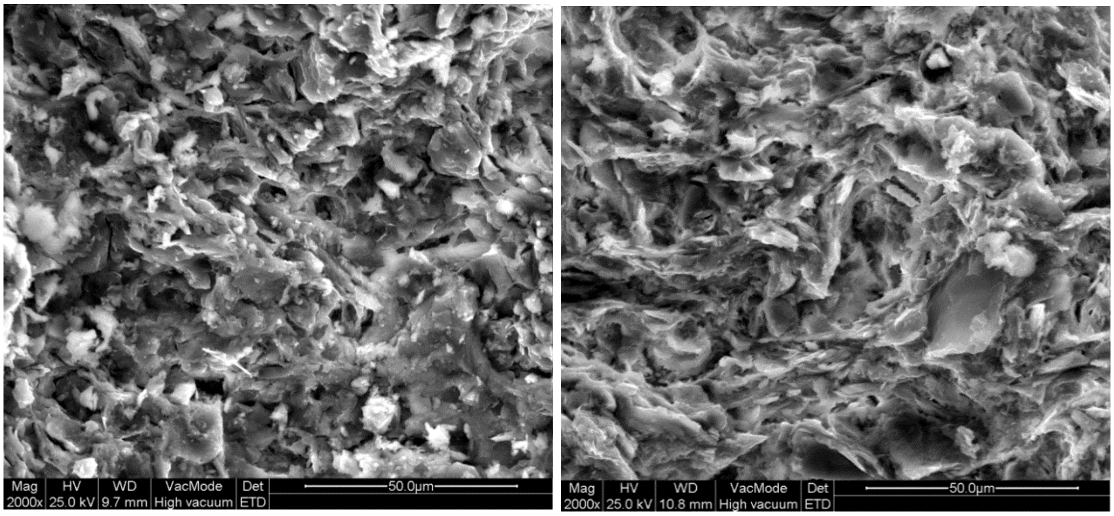

Figure 7.21: Left: Secondary electron photomicrograph of the large tub fabric (FG 2) with the initial stages of vitrification (Alimos 12/68); Right: Storage jar demonstrating no vitrification present in the microstructure (Alimos 12/72).

In reference to firing conditions, the levels of vitrification varies markedly from vessel to vessel from no vitrification (Figure 7.21, left) to initial levels of vitrified (Figure 7.21, right) suggesting that conditions varied during the firing process. With vessels this large, some degree of variation is to be expected and the range is not so drastic to suggest different firing practices at play. Rather this range shows that tubs are consistently fired to low temperatures ranging from 650-800^{o}C.

The following fabric (Figure 7.22) was used in to manufacture in large tubs (*asamanthoi*) and storage jars. The matrix is non-calcareous and micaceous with frequent hornblende amphiboles, plagioclase and intermediate volcanoclastic rock inclusions. Indeed, although the matrix is identical to the Noncalcareous Volcanic Fabric discussed below, it differs in that it was tempered using organic matter much like the tubs from Kontopigado. It appears the use of organic tempering is restricted to large coarse vessels, and is a new feature in Aeginetan pottery production as it does not appear until this period.

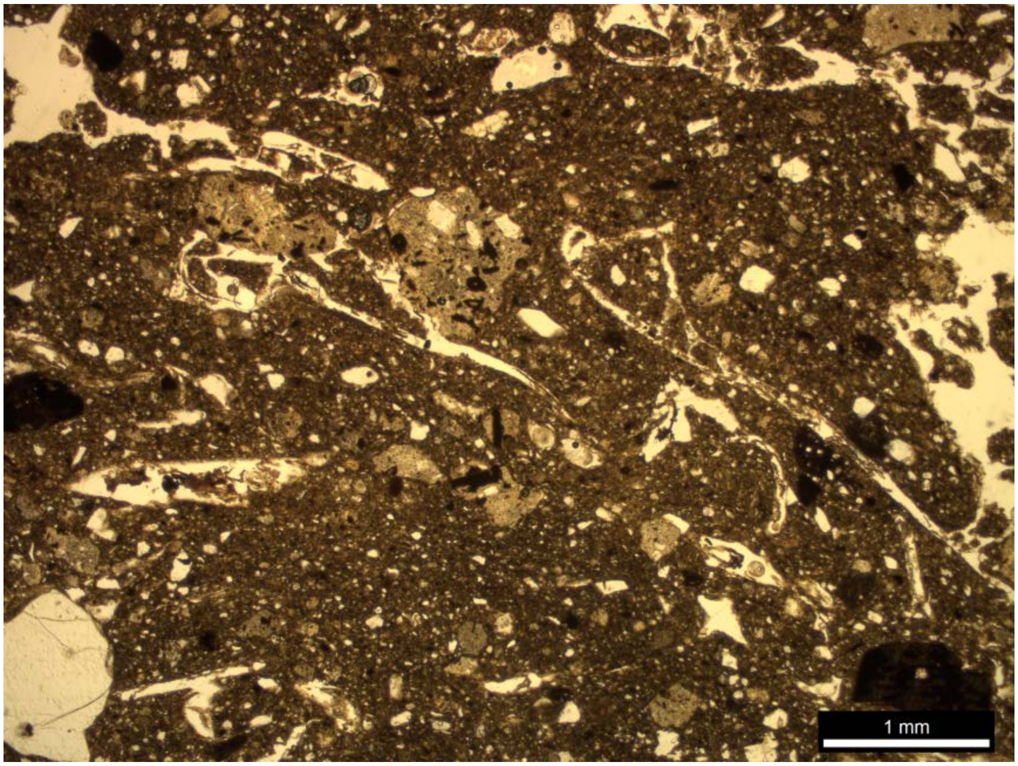

Figure 7.22: Large tub in the Noncalcareous Volcanic Fabric with organic temper in PPL (Ayios Konstantinos 12/21).

The next two large tub fabrics have been assigned a provenance in Corinthia. The first is characterised by a calcareous matrix with mudstone, tuffites and heavily altered, volcanic rock inclusions and elongated voids characteristic of burnt out organic matter (Figure 7.23). The second is comprised of a mixed calcareous matrix with serpentinite inclusions and burnt out organic matter (Figure 7.24). As with all tub fabrics from this study, organic vegetal matter is used as a tempering agent. Both Corinthian tub fabrics have an optically active groundmass suggesting low firing temperatures[11].

[11] Neither Corinthian tub fabric was subjected to microstructural analysis by SEM.

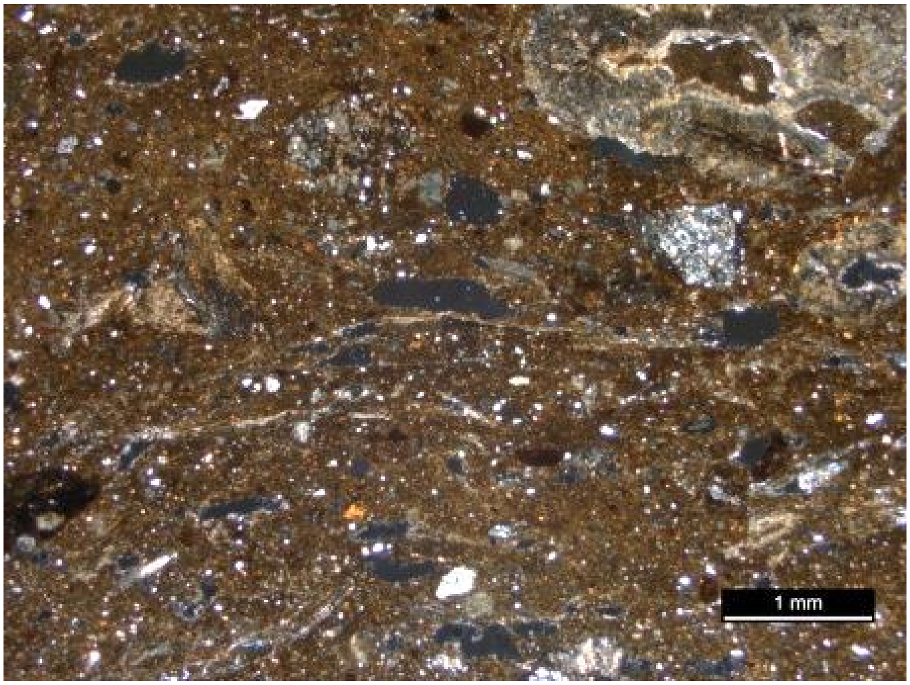

Figure 7.23: Large tub in the Volcaniclastic with vegetal temper fabric in XP (Kanakia 07/69).

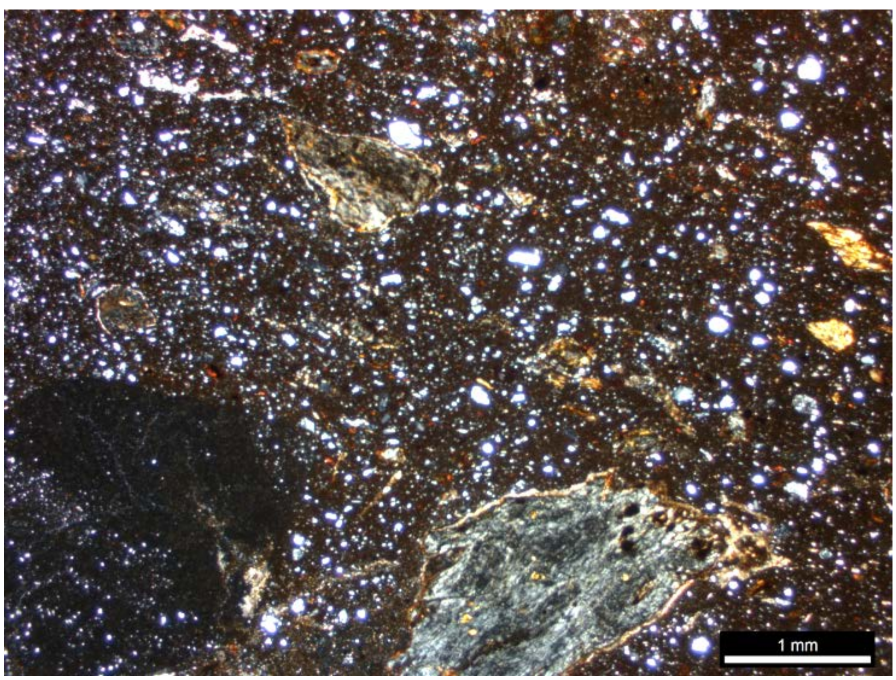

Figure 7.24: Serpentiniferous fabric in XP (Plaka 10/40; organic temper not shown).

7.3.3 Storage Jars

Storage jars from Kontopigado, like the tubs, are produced using the same mixture of raw materials as the finewares but the matrix is much more densely packed with inclusions. Unlike tubs, however, storage jars are not tempered with vegetal matter, rather the potters at Kontopigado tempered these vessels with local metamorphic rock, including metasandstone, greenschist and even marblised limestone (Figure 7.25). The clay paste is much coarser in storage jars than other Kontopigado wares, though there is a range of density in the coarse inclusions of this vessel class as reflected in the petrographic groups (FG 3-5) and the proportion of the clay mix and inclusion to matrix ratio are much different.

Storage jars from other production centres are consistently constructed in coarse fabrics, but they vary in practice. As it was mentioned above, storage jars produced in the Noncalcareous fabric attributed to an Aeginetan production are treated in the same manner as the large tubs. The characteristic raw materials are the same as those used in cooking pot production, but, as with the large tubs, vegetal matter was used to temper the clay paste (Figure 7. 26). Like the tubs, the storage jars have an optically active matrix and are low fired. The next two fabrics are assigned to a provenance near Corinth. The first is characterised by a calcareous matrix with inclusions of mudstone, tuffite and altered igneous rock (Figure 7.27). It is identical to the Corinthian mudstone and tuffite fabric above without the addition of vegetal matter as temper. It too has an optically active matrix and is low fired. The final tub fabric is again comprised of a calcareous matrix with mudstone, tuffite and altered igneous rock inclusions; however the tuffite has a different texture, colour and includes microfossils (Figure 7.28). It also has a matrix that is optically active indicating low firing temperatures.

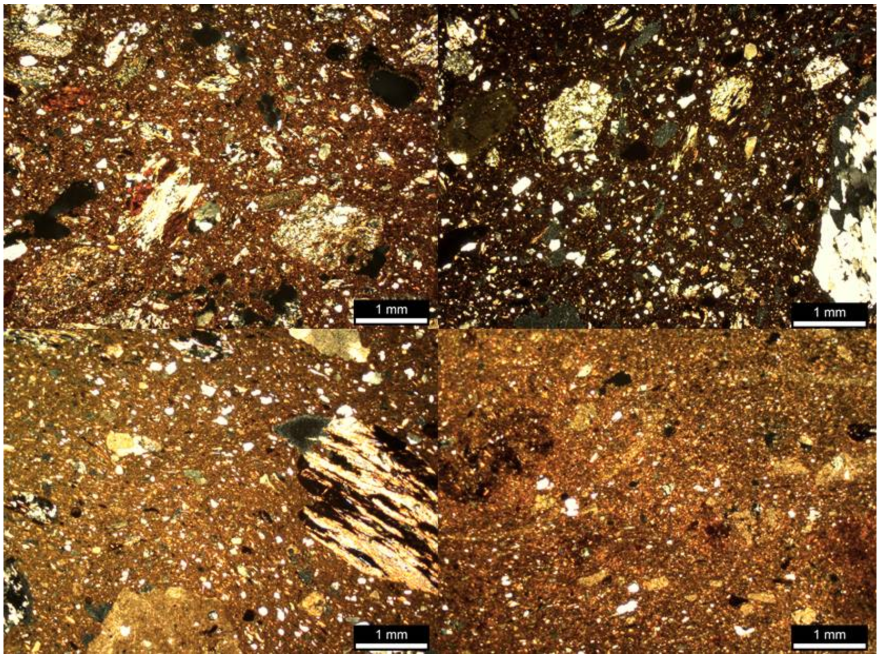

Figure 7.25: Kontopigado storage jar fabric variations in XP: a. FG 3 (Alimos 13/10); b. FG 3 (Plaka 10/19); c. FG 4 (Plaka 10/29); d. FG 5 (Alimos 12/71).

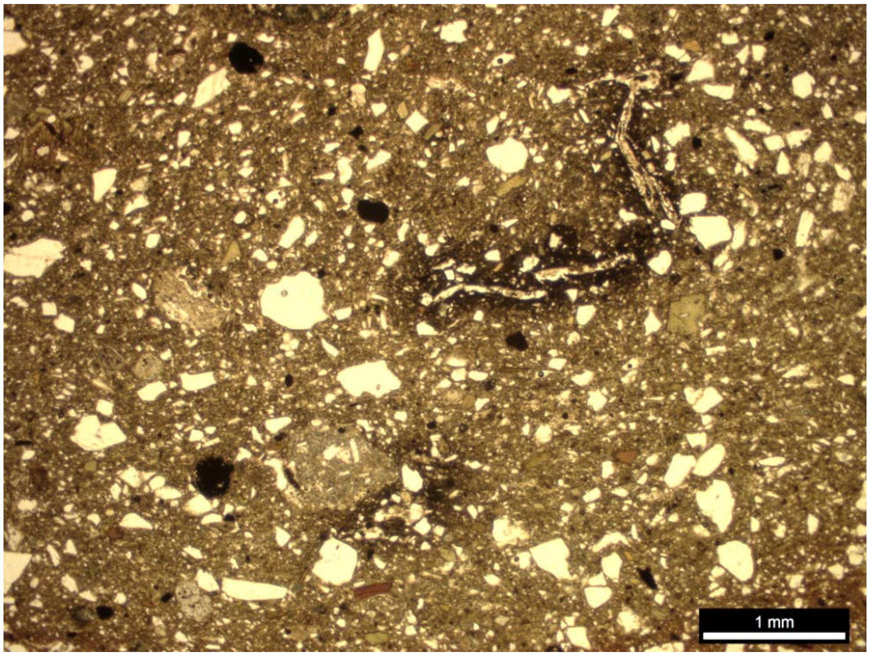

Figure 7.26: Storage jar in the Noncalcareous fabric with organics in PPL (Ayios Konstantinos 12/25).

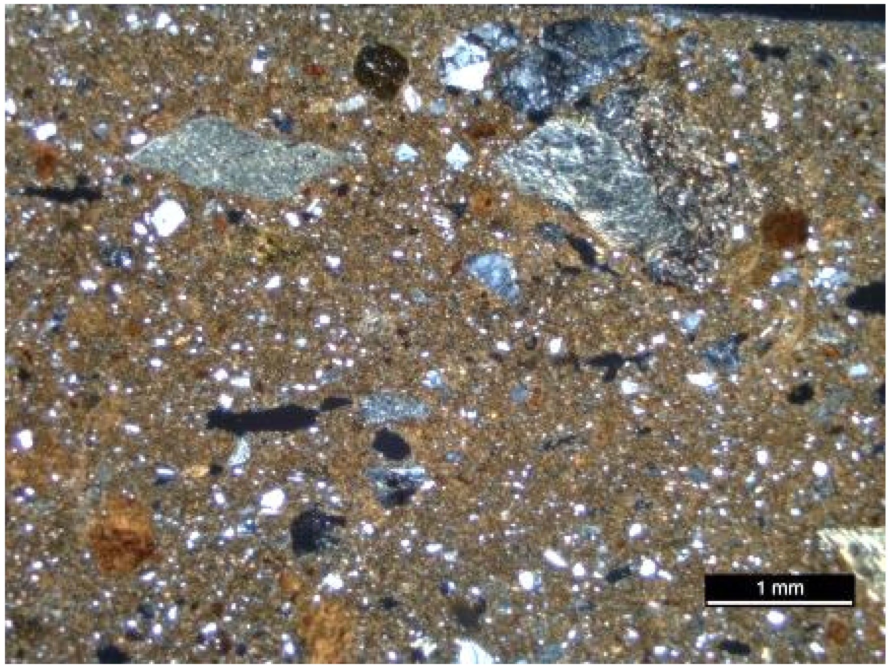

Figure 7.27: Storage jar in the Volcanoclastic fabric in XP (Kanakia 07/81).

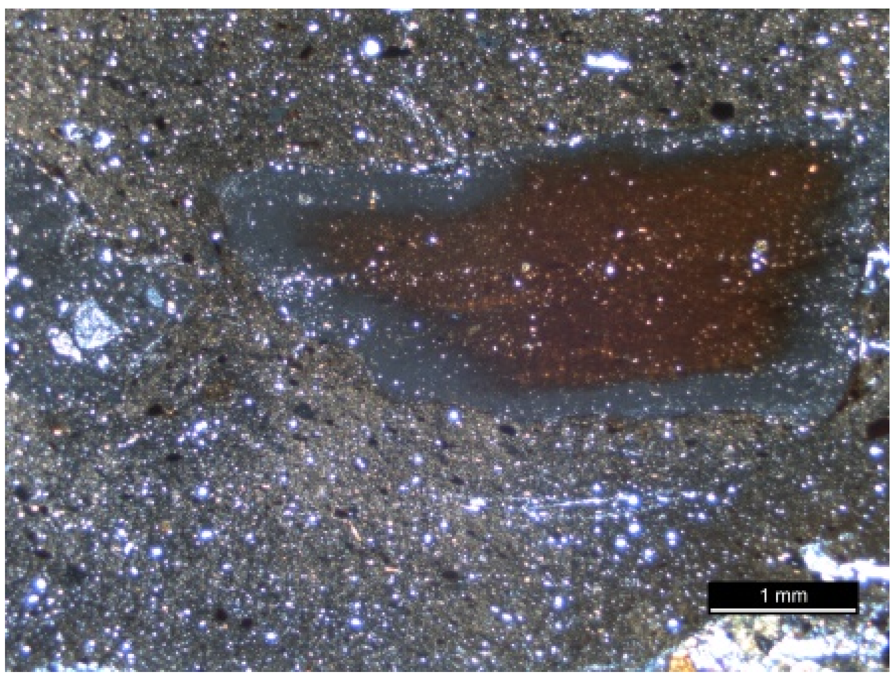

Figure 7.28: Storage jar in the Mudstone and tuffite fabric in XP (Kanakia 07/80).

7.3.4 Cooking vessels

Considering the cooking vessels made at Kontopigado, it becomes clear that the micaceous element of the previous two fabrics forms the major component of cooking vessel fabrics. The groundmass of the cooking vessels is formed from secondary micaceous clays, but unlike their tableware counterparts, the cooking vessels have subrounded sand inclusions that include coarse fragments of sandstone and metasandstone rock fragments (Figure 7.29). The sand and rock fragments give these vessels their gritty texture, while the reddish colour is due to a higher ratio of red micaceous clay to calcareous marl in the paste mixture. These vessels are occasionally found with calcareous greywacke and calcareous siltstone in addition to the sandstone and metasandstone rock fragments.

Regarding raw material selection and processing, it is clear that the potters of Kontopigado had a well-defined range of raw materials which were selected and mixed according to the types of vessels they wished to produce. Their basic ingredients are red clay rich in mica, calcareous marl, a variety of sedimentary and low-grade metamorphic rock and vegetal temper. This workshop produced their whole range of pottery from tablewares, to storage jars and tubs, and cooking vessels (Kaza-Papageorgiou 2011; Kaza-Papageorgiou and Kardamaki 2012) using the same palette of raw materials. In essence, analysis demonstrates that different vessel types are produced with differing quantities of the same range of raw materials; recipes vary according to vessels type, but only in terms of the proportions of the clays mixed and kinds of temper added. Interestingly, this relatively homogeneity of raw materials and their manipulation is matched by only minor differences in the firing regimes used to finish the ceramic products.

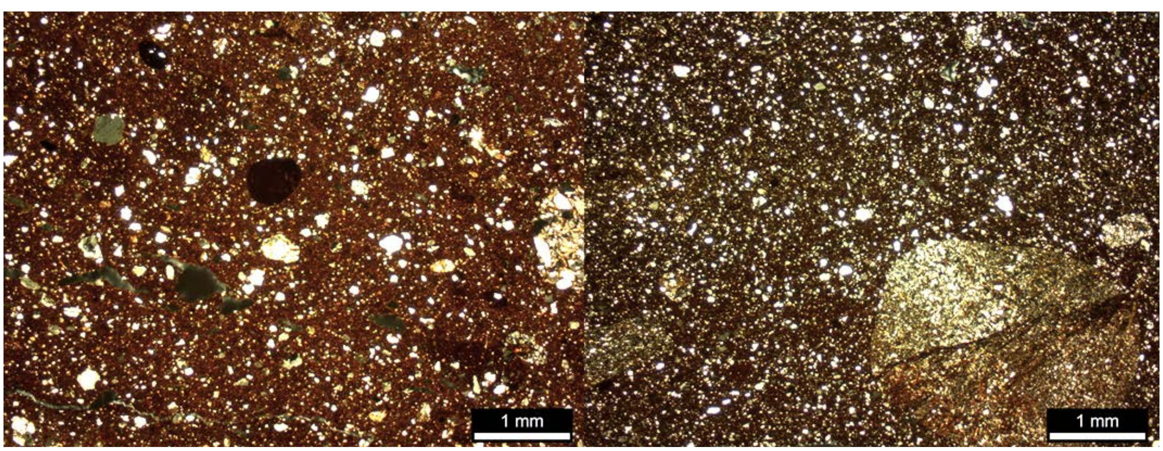

Figure 7.29: Kontopigado cooking pot fabric (FG 6) variants in XP. Left- Alimos 12/91; right- Alimos 12/88.

Though not a major feature in this thesis and further work is required, some observations on forming methods of cooking vessels need to be made. Firstly, it should be noted that the use of the wheel at Kontopigado is evidenced by the presence of an axle joint for the base of a potter's wheel, (Kaza-Papageorgiou and Kardamaki 2010). The rounded cooking vessels such as the tripod pots, jars and basins are surely wheel-made (Figure 7.30; Kaza-Papageorgiou and Kardamaki 2012), at least in part but other shapes are clearly handmade such as the spit rest and semi-perforated griddle pans (Figure 7.31). However, at the current stage of study, it is not possible to discriminate wheel throwing from wheel finishing techniques.

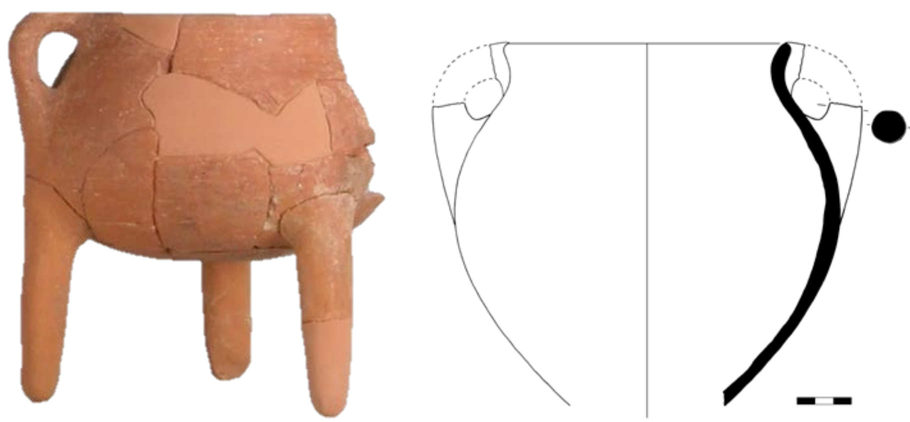

Figure 7.30: Wheel made cooking pottery from Kontopigado. Left- Alimos 12/88 (tripod cooking pot). Right- Alimos 12/93 (two-handled jar) (Photo by K. Kaza-Papageorgiou; Drawing by E. Kardamaki).

Figure 7.31: Hand formed cooking vessels from Kontopigado. Top- Alimos 12/60; Bottom- Alimos 12/90. (Drawings by E. Kardamaki).

Lastly, on average, microstructural evidence shows that these vessels are fired in conditions that consistently reached firing temperatures needed to initiate the process of vitrification and higher, perhaps indicative of firing temperatures of 750-850°C (Figure 7.32). Recent work shows that higher fired vessels, those with increased vitrification in their microstructure, have increased thermal conductivity (Müller et al 2012; Müller et al 2013). Increased thermal conductivity means that the material responds quickly to changes in temperature during the heating of food (Müller et al. 2013). This means that heat is diffused evenly across the material, a feature that is desirable for certain types of cooking such as boiling or frying (Müller et al 2012; Müller et al. 2013).

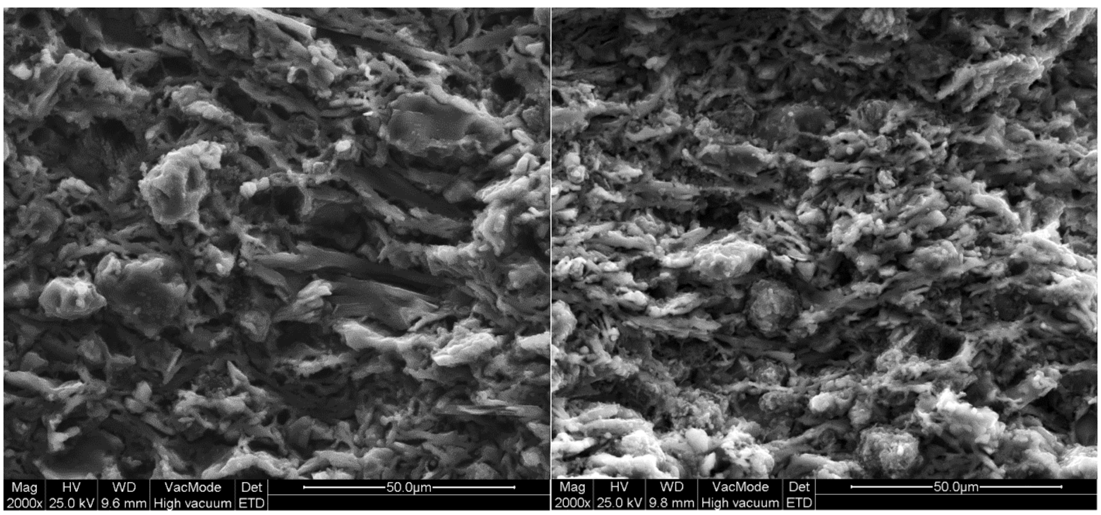

Figure 7.32: Secondary electron images of Kontopigado cooking vessels demonstrating different degrees of the initial vitrification stage. Left- Alimos 12/85; Right- Alimos 12/88.

Cooking vessels, it seems, make up the dominant group produced for export on Aegina. Aeginetan cooking vessels were first identified in the LH IIIB-transitional IIIC early period by Marabea at Kanakia in her macroscopic fabric study (Marabea 2010). Marabea's study identified several vessel types associated with cooking and general food preparation (tripod pots, 1- and 2- handled jars, spouted and unspouted basins) at Kanakia and these vessels have since been identified in a broad range of archaeological sites in the Saronic Gulf. The composition of this fabric has been characterised through thin section petrography as a highly micaceous clay matrix with frequent coarse plagioclase feldspar and volcanic rock inclusions (Figure 7.33). Analysis further shows that this fabric group is related to Gauss and Kiriatzi’s Noncalcareous Volcanic Fabric (FG 1; Gauss and Kiriatzi 2011: 93-95).

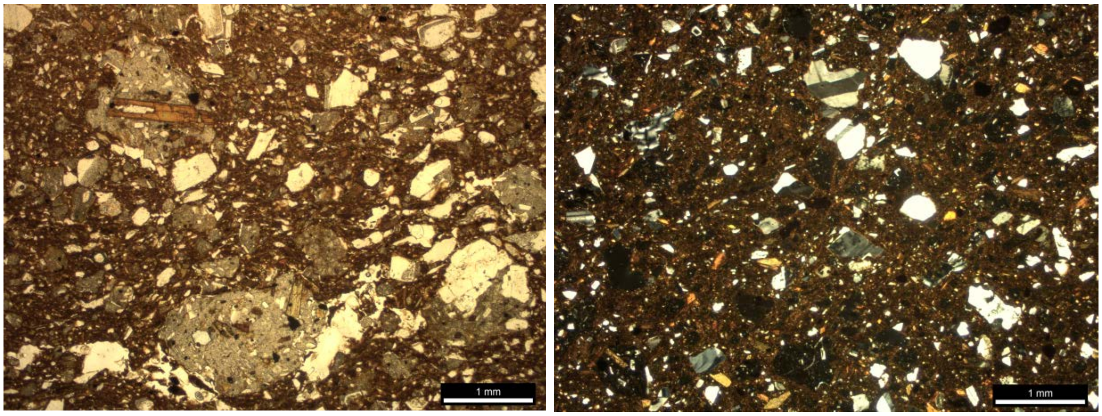

Figure 7.33: Noncalcareous Volcanic fabric (FG 9A) in PPL (left; Ayios Konstantinos 12/24) and XP (right; Alimos 12/104).

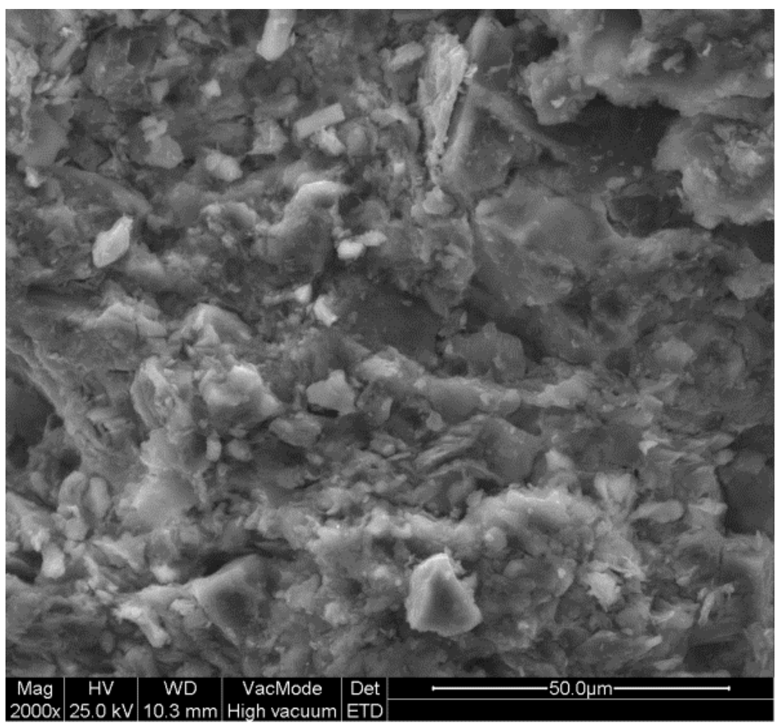

Figure 7.34**:** The microstructure of a cooking vessel from the Noncalcareous Volcanic Fabric (Kanakia 07/61). No vitrification is present.

In regards to firing conditions, cooking vessels from the Noncalcareous volcanic fabric exhibit no signs of sintering and clay particles are easily observed as nearly intact (Figure 7.34). This means that the temperatures did not exceed the range of 750-800^{o}C during firing. Furthermore, the CaO content is below 4% which indicates a non-calcareous clay paste. Noncalcareous low-fired cooking vessels were frequently used for cooking ware manufacture in the Bronze Age and Aegina is a typical example of this. While Tite and Kilikoglou (2002) suggest that low fired cooking vessels offer several advantages in both thermal and mechanical properties, Müller et al. (2013) are more specific in stating that low fired ceramic material, with little to no vitrification in their microstructure, have a high capacity for heat retention. This means that while higher fired vessels are more suitable for cooking activities such as boiling and frying, low fired cooking vessels are more suited for simmering or braising (Müller et al. 2013).

7.4 Pottery production at Kontopigado

The analysis of pottery manufactured at Kontopigado in Attica has revealed an organised system of craft production exhibiting sophisticated knowledge of the raw material resources available to the potters and the many ways of manipulating these materials to achieve their desired product be it fine painted tablewares, large tubs, storage jars or cookware. Paste recipes are plainly related to functional vessel types with the Kontopigado potters mixing the materials in different proportions and adding temper according to the functionality of the vessels being produced. The continuity of the raw materials and the practice of mixing clays in all vessels produced at Kontopigado is persuasive evidence indicating that all of the Kontopigado wares are produced by a single group of potters trained in the same craft tradition. Moreover, that the same raw materials are used in the manufacture of all vessel types at Kontopigado suggest the possibility that the potters practiced multiple forming techniques including wheel throwing for smaller vessels and hand forming by large coil or slabs for large tubs and storage jars.

Microstructural analysis reveals that a similar firing strategy was employed for all undecorated, red monochrome and red painted dark-on-light vessel types. These vessels were all fired in an oxidising atmosphere with the tablewares and cooking pots reaching moderately high temperatures and the tubs and storage jars being low fired. The black monochrome and black painted dark-on-light vessels were fired at higher temperatures in reducing and ORO atmospheric conditions. The high quality of the paints, as illustrated in the secondary electron photomicrographs above, and consistency of firing temperatures suggest that the reduction and ORO firing strategies were deliberate actions taken by the resident potters to create a desired outcome. The cooking vessels may show slightly less vitrification and were likely fired closer to c. 850^{0}C. The combination of raw materials and microstructural details indicate that these vessel types were subjected to a consistent firing regime regardless of the vessel or ware type. Although the larger vessel types were fired to lower temperatures, 750-850^{0}C, both tubs and storage jars are fired in a consistently oxidising atmosphere at consistent temperatures. In fact, the difference in firing temperatures are negligible in the broader context of the production considered as a whole, but they are systematic. It is understood that temperatures can vary much more drastically than the 100-150^{0}C witnessed here (cf. Gosselain 1992; Livingstone Smith 2001). Thus temperature difference may be result of systematic placement of pots at different, but particular parts of the kiln during firings. The implications of this are that both fine and coarse pottery may have been fired in single loads rather than according to their size and shape.

At Kontopigado different vessel types are produced with differing quantities of the same range of raw materials, recipes varying according to vessels type, but only in terms of the proportions of the clays mixed and temper added. The combination of more micaceous and calcareous components differs according to the vessel produced. It is remarkable is that this relatively homogeneous set of raw materials and the means in which they were processed is matched by only minor differences in the firing regimes used to finish the ceramic products. The nature of the archaeological deposits at Kontopigado and this restricted palette of raw materials and firing practices strongly suggest that we are dealing with a range of products of the same potters, of the same workshop.

7.5 Pottery production patterns in the Late Mycenaean Saronic Gulf

Provenance results detailed in Chapter Six demonstrate that pottery of all shapes and sizes were being exchanged throughout the Saronic Gulf. While the broad social implications of this are discussed in the subsequent chapter, at this point it is pertinent to discuss some of the patterns that reflect both the differences in raw material choice and firing regimes for vessels of similar shape and size and any evidence for shared technological practices that may illuminate potential transmission of practice.

7.5.1 Tableware

At Kontopigado the picture is pretty clear, while no kiln remains from the excavations, the large amount of wasters and remains of a potter's wheel are clear evidence to show that this site is indeed a pottery production installation. It is also clear that this one workshop was producing a whole range of pottery from table-ware through jug/jars, to large storage jars, tubs and cooking vessels (Kaza-Papageorgiou 2011; Kaza-Papageorgiou and Kardamaki 2012). Focusing on the tableware, both painted and unpainted vessels were produced using a mixed micaceous and calcareous matrix that is relatively free of aplastic inclusions. The vessels are wheel made (Kaza-Papageorgiou and Kardamaki 2012) and consistently fired to fairly high temperatures (i.e. above 850^{0}C). The decorated vessels were painted using materials that low in CaO and high in K, Al and Fe. Both red and black paint were created with the same raw material, the difference in colour is due to different firing practices, oxidation firing conditions for the red and ORO firing regime for black.

There are several fine tableware fabrics moving around the Saronic Gulf. Thus far we have looked at one linked to production on Aegina and two from Corinthia. Looking only at raw material choice it is clear that each is the product of a different set of practices. Where potters from Kontopigado practice clay mixing, this is not the case for fineware production on Aegina, nor is it observed in the Corinthian Bioclastic Limestone fabric. These fabrics are both comprised of high calcareous clays with aplastic inclusions. The Corinthian fine green firing tableware fabric is so fine textured that there are very few inclusions at all. The overall lack of inclusions implies that the raw material was heavily processed to remove all impurities, a feature that is not present at Kontopigado, the Aeginetan tableware or even Corinthian Bioclastic Limestone fabric. Looking only at raw material choice and manipulation, it would be easy to conclude that potters at different centres of production practice different methods of manufacture, but this is not the case when one moves to other stages of the production process.

The outlook changes when we look at both surface finishing and firing. At Kontopigado vessels are finished unpainted, with a wash of red or black paint, leaving the vessel monochromatic or painted with red or black wavy and straight bands, leaving the light colour of the body to come through creating a dark-on-light colour scheme. Both monochrome and banded dark-on-light decorative schemes exist in the Corinthian green firing fabric, whereas, thus far only dark-on-light banded vessels have been recorded on Aeginetan tablewares and vessels made in the Bioclastic Limestone fabric. This does not mean they do not exist, only that none were sampled for this study. Of the banded dark-on-light painted vessels only the green firing Corinthian fine green firing fabric is produced in black and red, while both Aeginetan and Corinthian Bioclastic Limestone fabrics are red or, in the case of the Aeginetan variety, brownish red painted. Like Kontopigado produced paints, all of the paint used to produce Corinthian dark-on-light motifs are rich in iron, aluminium and potassium while being low in calcium and are completely vitrified[12]. Reconstructed firing conditions also produce similar patterns. Consistent with Kontopigado, all tableware analysed were fired to 850^{0}C and above, as demonstrated by continuous to extensive vitrified networks of glassy strands in their microstructures. In contrast to what has been observed in the selection and manipulation of raw materials used to form the clay paste of the body, technologies employed for decoration and firing of fine tablewares are quite similar at all potteries in the Saronic Gulf.

7.5.2 Large tubs and storage jars

Making the transition to the coarse wares, shared practices become much more apparent. At Kontopigado the practice of vegetal tempering is reserved for large tubs and a small selection of cooking implements such as a spit rest and grill pans. Storage jars, while constructed of similar raw materials, are not tempered with vegetal matter and are much coarser as a rule. Both the tubs and storage jars from Kontopigado are low fired indicating a high level of toughness for the lack of a vitrified or glassy microstructure (Tite et al. 2001; Tite and Kilikoglou 2002). In the case of the tubs, vegetal tempering, because of the large voids in the post fired matrix, creates a porous or cellular-like microstructure adding to the overall toughness of the material (Müller et al 2010). The voids act to disseminate energy caused by trauma in open space thus not allowing cracks to propagate (Müller et al. 2010).

Vegetal tempering during the LH IIIB- transitional IIIC early phase has been observed in several coarse vessels within the study area in several fabrics of differing production origins (Gilstrap et al. In press). In fact all large tub fabrics studied in this thesis are tempered with organic vegetal matter. Moreover, all tub fabrics are low fired. This

[12] Aeginetan painted finewares were not available at the time SEM analysis took place.

technical feature is clearly a shared amongst the potters of the Saronic Gulf, however at the same time it is employed differently. While Kontopigado potters only use vegetal matter to temper tubs and some cooking vessels, it seems that the producers of cooking pots on Aegina applied this technology to both tubs and storage jars, but not cooking pots. Additionally, the potters who make tubs and storage jars from calcareous clays, mudstone, tuffite and altered igneous rocks appear to only use vegetal temper in the production of large tubs. As with tablewares, it is clear that certain technical knowledge is shared among potters around the Saronic Gulf. The distinction, then, lies not in the technical choice to implement a specific operation during production, but in how these operations are employed by their practitioners.

7.5.3 Cooking pottery

The cooking pottery examined in this study has presented some interesting patterns of production technology and practice. Kontopigado produced cookware is made in a broad range of shapes that afford the user a variety of cooking techniques. The vessels are constructed from similar raw materials as all other pottery from this production centre, however these vessels fire to a much darker red hue and demonstrate less calcareous inclusions, such as micrite and generally include rounded sedimentary and metamorphic rock and intentionally added quartz-rich sand as temper. These vessels are moderately high fired and wheel made. Conversely, cooking vessels produced in the Noncalcareous volcanic fabric from Aegina come in narrow range of handmade shapes and are made using unmixed noncalcareous clay with angular volcanic inclusions. These vessels are low fired and untempered. Clearly there are different sets of practices in use at Kontopigado than those used by the potters who made the Noncalcareous volcanic cookware.

Aeginetan potters produced cooking vessels of this period from an unmixed clay-rich material containing volcanic rock fragments that is fired to a low temperature. They manufacture large tubs and storage jars using the same clay-rich raw materials used for cooking pot construction with the deliberate addition of organic temper. Contemporary manufactures of finewares on the island demonstrates a different set of practices. These fine vessels are made using high-fired calcareous clays with a low abundance of inclusions. The raw materials originate from distinctly different geological deposits and possibly different locations within the northern part of the island (for more details and a discussion of Aeginetan geology, clay sampling and kiln remains of other periods, see Gauss and Kiriatzi 2011). In looking at these different classes of pottery, it can be suggested with confidence that the production of pottery on the island of Aegina is comprised of two deeply distinct set of production practices. The two main raw material types are substantially different from each other and their suitability for purpose, whether perceived by the producer or consumer, may be linked to specific properties or reputations (cf. Day et al. in press).

Pottery production on Aegina has a long history spanning from the Neolithic to modern day, however Kolonna, the main production centre in the periods prior to the LH IIIB-transitional IIIC early, has little structural evidence for production during this later period (Gauss and Kiriatzi 2011), the indirect evidence from the provenance study unmistakably identifies Aegina as the place of production. The study of Aeginetan pottery often concentrates on two clearly different types of pottery, both considered characteristic of its long ceramic tradition: low-fired, non-calcareous cooking vessels and finer, high-fired calcareous pottery for a range of jug/jars (Gilstrap et al. in press). The Aeginetan potters produced cooking vessels of this period from an unmixed clay-rich material containing volcanic rock fragments that is fired at a low temperature. The results from the provenance study in Chapter Six presented evidence for the manufacture of large tubs and large storage jars, vessels previously unidentified in earlier Aeginetan production, which are based on the same clay-rich raw materials, but differ significantly through the deliberate addition of organic temper observed as frequent elongated and curved voids throughout the ceramic body (see also Gilstrap et al. in press).

7.6 Conclusions

Through this detailed multi-technique study of pottery produced at a minimum of three different contemporary production centres, significantly different patterns of technological practice emerge. Kontopigado presents a picture of the production of the full range of ceramic types of the Late Mycenaean with subtle variation in the use of a range of related raw materials. Each of the different vessel types are produced in the same physical installation with very similar firing procedures. This phenomenon can be explained by the suggestion that the potters of Kontopigado were working in an area that historically did not witness the differentiated production of cooking and other vessels. The research group at Sheffield has elsewhere produced evidence for some similar fineware fabrics in EHII in the same area of Attica (Day, Hein and Douni, pers. comm.), yet technological reconstructions for the not-insubstantial intervening time period have not been carried out yet. Another possibility is that, regardless of the ceramic traditions in this area of Attica, the Kontopigado installation represents a politically attached workshop whose production was entrusted to a specific group of potters, whilst demanding a full range of vessel types (e.g. Costin 1991, 5). In this context, it should be recognised that the pottery workshop at Kontopigado is situated next to perhaps the largest craft production installation known from Mycenaean Greece, the rock-cut features that may represent large-scale flax processing (Kaza-Papageorgiou 2011; Kaza-Papageorgiou and Kardamaki 2012), within sight of what was surely a major Mycenaean centre around the Acropolis of Athens.

While the analytical results lead us to draw this strong contrast in production practices employed, there are several details that bring pottery manufacture together across the Saronic Gulf. All potters from the Saronic Gulf that produced large tubs tempered them with organic vegetal matter creating a distinctive void-ridden ceramic body. Kontopigado potters reserved this distinctive ceramic paste mainly for tubs, but also used it for their production of griddles and baking trays (though not for and other cooking vessels). Other potters of the Saronic employed vegetal tempering storage jars as demonstrated by the Noncalcareous volcanic with organic temper fabric from Aegina.

Evidence to support the sharing of technical knowledge and to show that potters chose the ways in which this knowledge was implanted into their production strategies is prevalent. Fine vessels are produced at consistently moderate to high temperatures, whereas the coarse vessels are low fired in general. At Kontopigado, the same palette of raw materials are used in the construction of coarse and finewares and the cooking vessels are fired in a similar manner as the finewares indicating a coherent strategy of production was in place to include all vessels. This is not the case for pottery with an assigned provenance on Aegina. Pottery produced on Aegina illustrate that there existed deeply contrasting practices in pottery manufacture for cooking vessels, tubs and table wares. These can be seen to be the successors of production practices which have a very long history, going back at least to the Early Bronze Age. The raw material choices and firing regimes for different types of pottery attributed here to Aeginetan production vary so fundamentally that they represent more than distinct choices according to some intended function of the completed vessels, but entirely different traditions and, it might be suggested, different groups of potters. The same may be said of Corinthian production where there is now evidence for traditions in pottery production lasting over three millennia (cf. Attas et al. 1987; Burke et al. in press).

Looking exclusively at firing practices, all storage jars and large tubs are low fired and all fineware is moderately high to high fired. Cooking pottery at Kontopigado is fired to moderate temperatures, while those made in the Noncalcareous volcanic fabric of Aegina are low fired. There is also evidence that at least two tableware producers, Kontopigado and Corinth, were adept at producing both monochrome and dark-on-light decoration in red *and* black using iron-rich paints. In the present study, the only dark-on-light painted pottery from Aegina is painted using a brownish red firing material. Iron rich black paint requires a reduction atmosphere during the firing procedure, and iron-rich black paint on a light coloured ceramic body requires a three stage oxidation-reduction-oxidation firing regime.

Whether emphasis is placed on different properties of the raw materials utilised in pottery production in the Saronic Gulf, or the dominance of strong long-lived ceramic traditions or even the relative control over craft activity in these different cases, this study shows the differences in practice, organisation and tradition that may exist in closely neighbouring production centres. It has been suggested that different regions within the Late Bronze Age mainland had varying trajectories in the emergence of the Mycenaean states, even in how those societies were organised (Parkinson and Galaty 2007). This study, based on a detailed reconstruction of everyday craft practice, demonstrates that an understanding of histories and traditions of craft practice is needed to evaluate the organisation of production. It is critical that ‘modes of production’, ‘specialization’ and indeed the perception of design and ‘intended function’, such fundamental concepts in the literature on archaeological pottery, are considered as historically contingent, set within locally understood and experienced rhythms of life. Only through understanding this are we likely to make sense of Mycenaean pottery and its myriad facets.

Chapter Eight: The Place of Pottery in the Late Mycenaean Saronic Gulf

8.1 Introduction

In his book *The Political Landscape,* Adam Smith develops a systematic critique of how politics are approached in the field of Archaeology. To start his second chapter he refers to a quote by the American philosopher John Dewey's book *The Public and Its Problems* which reads "The moment we utter the words 'the state' a score of ghosts arise to obscure our vision" (Smith 2003:78). Smith later refers to a lecture given by Vladimir Lenin in 1919 in which he intimates that the State has become "the focus of all political questions and of all political disputes of modern day" (Lenin 1965: 19 in Smith 2003:98). While Dewey was referring to a philosophical problem of how to understand the concept of *the state* and Lenin to Bolshevik politics in Russia at the beginning of the 20th century, the sentiment from both statements resonates well with the current discussions of Mycenaean political economy, especially when the topic of craft production and exchange is involved.

Chapter Two of this thesis presented an overview of the current state of affairs in the study of politics and economics of the Mycenaean world. From that discussion it was clear that the central focus of this topic has been the Mycenaean palaces, including all directly related people and activities. Such an approach leads to generalities constructed through observations about the top levels of this complex society, cascading down onto the vast majority of populace, many of who might be though to have little to do with palatial politics or regional economy at all. The information gathered about society at the level of the elite is invaluable for creating an understanding of Mycenaean society. However such a view of the elite needs to be tempered with insight into the lives of everyday people, rather than projected onto the rest of the society. That is not to deny, however, that the Linear B archives do offer perspectives in direct links of social and economic interaction between the palatial elite and popular society.

As suggested earlier, the palace and its constituency are merely part of a much larger whole that is Mycenaean society. This chapter aims to complement previous studies by moving away from a top-down perspective and considering regional political economies of Mycenaean society, in all their social manifestations. Taking into account Parkinson and

Galaty's (2007) reminder that Mycenaean polities are resultant from distinct formative trajectories leading to localised political structuration, the area of the Saronic Gulf is considered as a geographic unit consisting of multiple regional and political factions, before comparison to other areas of Mycenaean society are taken into account. Although the focus of this thesis on a single artefact type is a fundamental flaw according to Voutsaki (2010), examining whole, or near to whole as possible, ceramic assemblages from a broad range of archaeological contexts that incorporates several areas of social action in Late Mycenaean society provides a wealth of meaningful insights. Looking at the production, distribution and consumption of a wide variety of pottery types, in several places, has enabled the reconstruction of several elements of not only the more mundane activities of everyday life during the Late Mycenaean period, but how these activities interact to form part of the structure for a much larger political economic system.

There are at least three areas where major pottery production centres are detectable by petrographic and, to some extent, chemical means. Each is located within a separate geographical zone, Attica, Corinthia and Aegina, and produce broadly distributed pottery types of similar shape. In fact, some settlements used the *same* vessels types from *different* centres, yet others, which have certain access to products from a certain centre, consume only *some* of its products. Clearly choice is playing a role in pottery consumption.

Evidence suggests that there are several distinct potteries whose wares are distributed in this region. Chapter Six noted that there are two discrete potting traditions that occur simultaneously in Late Mycenaean Aegina, one generating low fired, coarse utilitarian pottery from noncalcareous Neogene clays while the other produced high fired, fine painted calcareous tablewares.

In Attica there is clear evidence to indicate that there is more than one production centre in the region, but the production centre at Kontopigado alone provides enough data to generate fruitful discussion. Kontopigado produced a large array of ceramic vessel types using the same or similar raw material in a cohesive production strategy for both coarse utilitarian vessels and finewares, both painted and undecorated. The stark contrast in production practice, at least between that of Aegina and Kontopigado, evidences further that each regional polity may have followed different formative trajectories.

The picture for pottery production in Corinthia is unclear. The only aspect that is understood from this project is that pottery is produced within this region, perhaps in the vicinity of Ancient Corinth and Acrocorinth. Chemical analysis, at present, cannot confidently separate wares that look identifiably Corinthian, green firing with very rare inclusion, from those that have ostensibly Argive origins.

Regardless of differences, there are clear indications that technological practices are shared between different production centres. This is best demonstrated by the use of organic temper in large tubs produced in the different production centres.

Identification of production centres and reconstruction of the technological practices they employed are only the first steps to develop a critical understanding of the place of pottery in antiquity. The knowledge earned through the identification of geographic areas where pottery is produced means that the movement of the pots across space to their point of deposition is more readily observed. In order to see the entire ecology of a pottery system one must move beyond observations of production and into mechanisms of exchange and patterns of consumption.

8.2 Pottery consumption: a view from the cooking pot.

During the Late Bronze Age, the Saronic Gulf facilitated the surrounding areas in regional commerce and served as an outlet into the Aegean and Mediterranean Seas. It has been said that, during the majority of the Bronze Age, the large settlement of Kolonna on the island of Aegina was the central settlement of the region and most likely controlled the ebb and flow of trade goods. The distribution of the characteristic – and easily recognizable - cooking vessels of Aegina has often been used as to interpret this influence. However, it has been suggested that at the end of the LH IIIA2 phase (1350 BCE), there is a decline at Kolonna; a phenomenon that has been argued to coincide with the rise and establishment of the palace at Mycenae in the nearby Argolid (Pullen et al. 2013; Tartaron 2010; Tartaron 2014). It has been contended that on the Saronic coast of Corinthia, drinking vessels and other utilitarian shapes previously exported by Aegina are replaced by imports from the Argolid. Using these changes in pottery distributions and the abandonment of the settlement to suggest the decline of Kolonna on Aegina, it has been argued that the Argolid state centred on the palace at Mycenae takes over as the dominant power in the Saronic

Gulf. In other words, pottery distributions are being interpreted in the reconstruction of political boundaries across large areas.

The past few years have seen increasing archaeological interest in the study of cooking pottery. This forms part of a shift of focus from the elite and exotic towards archaeologies of the mundane in the lives of ordinary people. Investigating the kinds of material culture used in these everyday activities is beneficial for understanding the types of choices people made during the production, procurement and use stages of objects' biographies. Cooking pottery, the normal everyday equipment used to process and prepare food, has been used to assess a wide variety of topics in archaeology. For these reasons, common cooking pottery is separated, for the time being, from the larger assemblage as a means to illustrate this argument.

Beginning with the cooking assemblage linked to Aeginetan production it becomes clear that, although primary production evidence is absent at Kolonna during this period, large numbers of Aeginetan cooking vessels have been recovered elsewhere from a wide variety of archaeological contexts dating securely to the Late Mycenaean period and beyond. Notably this period marks the construction of the acropolis at Kanakia - on the neighbouring island of Salamis to the northeast and what appears to be a large Mycenaean settlement at Athens (Lolos 2010).

One of the largest of these assemblages from this study was recovered from the East Building Complex atop the acropolis at Kanakia (cf. Marabea 2010). In the case of all its cooking vessels, the determination of a production origin for Aegina was originally recognised by the macroscopic study which was confirm by both petrographic and chemical analysis in Chapter Six.

Apart from the well-known tripod pots, with globular or carinated body, and jars with one or two handles, other shapes may now be added to the Aeginetan cooking vessel repertoire, such as the shallow angular tripod pot with a differentiated handle attachment, the jug, the spouted and other types of basins and possibly the stand for holding skewers to roast meat. These vessels are thick walled and very coarse. They are very porous with a distinctive microstructure composed mainly of planar and interlocking channel voids. The pore structure created a tough final product, a characteristic that would be preferred for a vessel that is under repeated stress from temperature changes that occur during cooking.

Although their comparatively low thermal conductivity due to a lack in vitrification in the microstructure results in a product which makes food ‘sluggish’ to heat up, they would retain heat enough to contents at a constant temperature once they are heated up, and can be argued to be well-suited for slow, long-term simmering (Müller et al. 2012; Müller et al 2013).

With such a characteristic fabric and wide distribution, Aeginetan cooking vessels are found in most sites around the Saronic Gulf, with more in the Argolid and Nemea valley to the west and as far north as Mitrou in east Lokris during the LH IIIB to LH IIIC early period (for distribution in the Saronic Gulf see Table 6.48; for broader resolution, see Rutter 2001: 127, Figure 12; Tartaron 2014: 227, Figure 7.7). Such a wide distribution of pots produced on Aegina and their significant presence at Kanakia suggests that the picture of collapse at Kolonna, based as it is on the phasing of one – albeit major – site, is over-simplified. There are other settlement sites of this later period on the island, such as Lazarides, and it is clear that the production and distribution of its characteristic product continued unabated. To consider this further, it is necessary to look eastward turn to the pottery production centre at Kontopigado in Attica.

A large proportion of the Kanakia pottery assemblage – notably the table wares and storage jars – were produced in Attica. Further investigations demonstrated that the same fabrics are found in the North Slope and Mycenaean Fountain deposits on the Athenian Acropolis and the Mycenaean town that surrounds it such as the remains found at Plaka, at Lazarides on Aegina, in Euripides’ Cave near Peristeria on Salamis, at Kalamianos in Corinthia, Ayios Konstantinos on Methana and Myti Kommeni on Dokos. Recent excavations for the extension of Athens Metro in Alimos uncovered a large area with primary evidence for craft production with what appears to be an attached settlement. This craft production installation is located approximately 5km south of the Acropolis of Athens and has been identified as a place for processing flax into fibres that can be used to make linen textiles. Beyond linen processing, pottery was also being manufactured, as shown by the large numbers of pottery wasters. The fabrics produced at Kontopigado match the table wares and jars from Kanakia and were distributed widely around the Saronic Gulf at this time.

Within the wide range of vessels being produced at Kontopigado are several vessel types associated with cooking. These shapes include the globular tripod pot, 1- and 2-handled wide mouth jars with lids, shallow basins, deep basins, spouted basins, punch base griddles, pans, and roasting spit rests (Kaza-Papageorgiou and Kardamaki 2012). Generally speaking, these vessels are much finer than their Aeginetan counterparts, they are constructed from noncalcareous micaceous clay with medium-fine quartz and metamorphic rock sand temper. They are thin-walled, relatively high fired and are smoothed on their exterior surface. In terms of microstructure, the Kontopigado vessels have relatively few voids. The fact that these vessels are not as coarse and tend to have slimmer walls combined with the addition of the punch base griddles and pans into the cooking repertoire suggest that this assemblage may have been geared towards a different type of cuisine than those produced on Aegina, which tend to suggest boiling and simmering.

The cooking vessels are only part of the large-scale production at Kontopigado, which, as demonstrated in Chapter Six, spanned from cups to bathtubs. However, it is interesting that despite the wide distribution of most of its products, regardless of size, the cooking vessels are only found in Attica, at Kontopigado itself, the Athenian Acropolis and Plaka. In other words, in light of present evidence it appears that the movement of these cooking vessels is restricted to local consumers.

The situation at Kanakia is indicative. While around 22% of its pottery comes from Kontopigado, not one of the cooking vessels has its origin in the Attic production centre. Instead, the cooking assemblage at Kanakia is dominated by Aeginetan cooking vessels. This pattern is replicated in the assemblage of the nearby Euripides' Cave, at Kalamianos and Stiri, Dokos and Ayios Konstantinos, while at Kontopigado, there is evidence to indicate that the occupants there used *both* Aeginetan and local cooking vessels. In fact, all locations analysed so far contain fineware pottery from Kontopigado and cooking vessels from Aegina (Figure 8.1).

The implication of this is that there was clearly a choice of cooking vessels from at least two sources in the Saronic Gulf at this time. The inhabitants of Kanakia used only Aeginetan cooking pots not because they were the only such pots available, but because – despite the fact that they procured everything from table wares to bath tubs from the Attic centre of production - they chose not to use the cooking pots from that site. This begs the question of what kind of choices were actually being made.

To start, cooking vessels from Kontopigado are much finer, more thin walled and higher fired thus linked to grilling and frying than they are to boiling and simmering (Müller et al. 2012; Müller et al 2013), though there is some overlap in the repertoires of the two production centres. If vessel shapes are linked then to speciality cuisine and cooking practices, it would appear that cooking vessels were obtained to perform specific tasks. Higher fired cooking vessels have different affordances in terms of heat transfer retention and require a different set of cooking techniques. Thus inhabitants of the Saronic sites may have been choosing cooking vessels according to the types of cooking activity taking place at specific locations. For example, the cooking vessels from Ayios Konstantinos, a sanctuary with clear evidence for large group feasting (Hamilakis 2003; Hamilakis and Konsolaki 2004), are much larger than any other cooking vessels in this entire study. Contextually, this makes a great deal of sense. The site was a place of gathering to perform religious rites that were connected with the consumption of a meal. To produce such meals would require a large number of small vessels or less numbers of vessels with greater capacity.

Figure 8.1: Cookware distributions in LH IIIB-LH IIIC Early Saronic Gulf.

At Ayios Konstantinos there are over twenty of these large cauldrons and tripod cooking pots. Cooking pottery of this size does not occur at any other site in this study potentially indicating that the cooking pottery was procured these suit a specific need, i.e. ritual feasting. This is a far cry from hypothetical redistributive efforts of a ruling political faction or through some form of politico-economic transaction between different regional elites. The assemblages from Kanakia, Ayios Konstantinos and even the production centre at Kontopigado shows that certain types were selected from particular producers, even if they manufactured pots themselves.

8.3 Pottery consumption: a view from the assemblage

Cooking pottery presents a picture (Figure 8.2) where Mycenaean pottery consumption in the Saronic Gulf is, at least in part, driven choice. At Kanakia, people had a variety of pottery from several production centres available to them but certain selective choices resulted in the consumption of cooking pottery only from Aegina, while the rest of the assemblage originates from several places. At Ayios Konstantinos the picture is much the same, cooking pottery comes only from Aegina, while the rest of assemblage has mixed origins. What of these other pottery types? Is this scenario the same for all sites and all pottery types of the Late Mycenaean Saronic Gulf? To answer these questions, we must first return the cooking pots to their respective assemblages and consider each site individually.

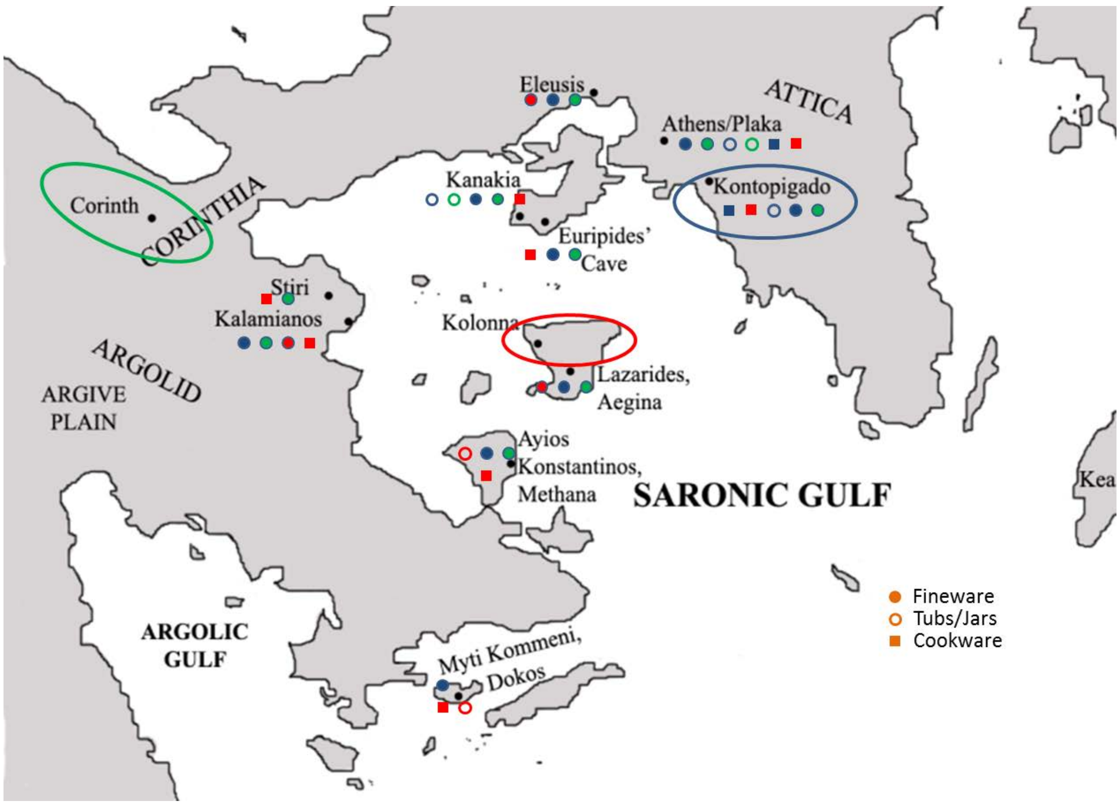

Figure 8.2: A distribution map illustrating the movement of all forms of pottery in this study in the Saronic Gulf during LH IIIB- LH IIIC Early.

Looking first at Attica, all three sites in this study reveal patterns similar to that observed above. The pattern of consumption from the Acropolis at Athens is one of diversity. As is to be expected for a site which may have been the seat of the regional polity, there is an abundance of products from local production, especially from Kontopigado. Pottery is present in nearly all forms available from Kontopigado: fine painted vessels, undecorated jars, kylikes, deep bowls and various forms of cooking vessels. The only vessels not represented are storage jars and large tubs. This does not mean either of these vessel types were not present atop the acropolis, rather it is function of preservation and the nature of this deposit. In terms of imported pottery, kylikes, kraters and assorted "open" and "closed" vessels from Corinthia are present, as are Aeginetan kitchen implements, such as spouted kraters and cauldrons. Although all of the pottery shapes probably required was available locally the deposits on the Acropolis still indicate that pottery was imported from both Aegina and Corinthia.

This pattern is reflected at the foot of the Acropolis at the urban settlement represented at Plaka. Plaka also demonstrates the degree to which pottery is moving around the Saronic Gulf, yet taking into consideration its location, it may be in a good position to illustrate the interaction between differing sectors of Mycenaean society. If a state centred on the Acropolis existed as has been suggested by Iakovides (1962), Plaka would be in the central part of the settlement. Recently the identification of a palace on top of the Athenian Acropolis has come been the subject of investigation as Privitera (2013) has re-dated at least two, if not all five of the Mycenaean terraces, in which Iakovides places a 14th and 13th c. palatial building by approximately a century 1200/1185 BC. If Privitera's assessment of the acropolis proves corrects, then a very different picture emerges for Attica during the last phases of the Late Bronze Age than has previously been suggested (Rutter 2013). Even if the terraces are from a later date, there is a clear Mycenaean presence on the acropolis during LH IIIB (cf. Hurwit 2000; Mountjoy 1995). Moreover, it may be the events and material that characterise this period in the Argolid and Messenia, for which most of the palatial chronology is based, occur at later in Attica.

The variation in the pottery assemblage, containing fineware, storage jars, cooking pots and large tubs from Kontopigado, cooking pots from Aegina and large tubs in the Serpentinite fabric (FG 13), indicates that even in such close proximity to the political centre of the region, the people at Plaka procured pottery from a variety of regional pottery manufacturers. Coincidently, all of the pottery analysed from Plaka come from regions where political affiliations are currently under debate (Pullen and Tartaron 2007; Tartaron 2010, 2014; Privitera 2013).

The production site and settlement at Kontopigado, though a producer of a full range of pottery, appears no different than its urban Attic counterparts. It should be clear by now that Kontopigado produces all of the vessels that it could need, however there are a number of cooking vessels of Aeginetan origin with evidence for use (Kaza-Papageorgiou and Kardamaki 2012). Additionally there is a tripod cooking pot and storage jar that are compatible with a production origin on the Cycladic island of Kea. Corinthian production is represented by a single sampled alabastron. The presence of vessels from other production sites was not expected at a site that manufactures pottery itself, however, it shows that even production centres acquired pottery from other places.

Moving west, the pottery assemblage for the sanctuary at Eleusis is quite small, but no less reflects the wide array of pottery fabrics acquired by the inhabitants there. All vessels from this site were imported from no less than three production centres, namely Kontopigado, Corinthia and Aegina. Unlike a settlement such as Plaka, a religious sanctuary, especially one situated at a coastal crossroads, is likely to be frequented by travellers, pilgrims and merchants alike thus the mixed origin for ceramic imports is to be expected.

On Salamis, the settlement and acropolis at Kanakia has already demonstrated that cooking pottery is procured from neighbouring Aegina and fineware is imported from Kontopigado, at least in part. Kanakia is the model of consumption for the Saronic as it imports tubs from Kontopigado (FG 2), Corinthia as FG 13 and FG 15 and storage jars from Aegina (FG 9B) and Corinthia as FG 16 and FG 17. Fineware is imported from Aegina, Corinthia and Kontopigado. Additionally, there are transport stirrup jars (FG 21, FG 22) and wide mouth pots (FG 23) from Crete. The situation is not much different in the burial deposits in the depths of Euripides' Cave which is located southeast of Kanakia near modern Peristeria. The vessels used to cook the feast used during the burial rites originate from Aegina, as do many of the fine drinking vessels and deep bowls. Other finewares have been imported from Kontopigado, while others again come from Corinthia as FG 11 and FG 12.

On Aegina, an island with at least two distinct pottery producing groups in the Late Mycenaean period, the scenario is much the same as on Salamis and in Attica. From the limited assemblage available from the settlement and cemetery at Lazarides in the centre of the island, it is clear that the inhabitants were able to procure vessels from off-island production centres. Many of samples analysed from Lazarides were deep bowls, it is very clear that the majority were acquired locally; however, both Corinthian and Kontopigado wares are represented.

On the western coast of the Saronic Gulf, specifically the harbour town of Kalamianos and the related settlement of Stiri, pottery consumption, at first glance, appears much more restricted. Chemical analysis of this assemblage was less fruitful that originally hoped, but when combined with petrographic data, it is clear that this assemblage demonstrates some degree of heterogeneity. There are finewares from elsewhere in Corinthia with some imports also from Kontopigado and Aegina. The coarsewares were not studied in this thesis, as they form the main part of a PhD research conducted by Debra Trusty at the University of Florida. Trusty (pers. comm.) has identified imported Aeginetan cooking pots. For a harbour site, these results are expected, but due to the nature of these sites and how the material was collected, the assemblage is inevitably biased towards vessels that are preserved and can be dated. The patterns observed here do not reflect the entire picture of consumption. However, they do show that of the kinds of vessels that are preserved, kylikes, deep bowls, stemmed bowls, are being imported, likely from Corinth and the cooking pots are from Aegina. This continues to fit the pattern observed at every other site in this study.

South of Kalamianos, on the Methana peninsula, the consumption of pottery at the settlement and sanctuary at Ayios Konstantinos is more familiar. In the discussion above, it was argued that the cooking vessels from the sanctuary are imported from Aegina. Although both Methana and Aegina have similar geological compositions, when technological practice is taken into account, it is clear that all of the cooking vessels, storage jars, large tubs and perhaps even the hand formed “offering table” (Ayios Konstantinos 12/27) are imported from Aegina, probably as a special consignment. Looking at the rest of the assemblage, finewares, including the zoomorphic (bovine) figurines are imported from Corinthia and Kontopigado.

The last site to be considered in this study is that of Myti Kommeni on the small island of Dokos. The location of Dokos is significant as it oversees the coastal waterways leading between the Saronic and Argolic Gulfs. Very few samples were taken from Myti Kommeni for study (n= 10), but there the results are much the same as has been witnessed at all of the other sites in this study. The cooking pottery, storage jars and a large tub are imported from Aegina while the rest of the fineware vessels come from Corinthia and Kontopigado with the addition of a wide mouth jar from Crete.

8.4 Is choice really a burden in the study of Bronze Age ceramic consumption?

So what happens if people of the Bronze Age are given a choice as consumers in our reconstructions of ancient political economies? Plainly the picture of movement and consumption of ceramic goods in the Late Mycenaean Saronic Gulf is a complex one – and one that should dissuade scholars from making a leap from pottery distributions – especially a single type – to geographical boundaries of early polities or to subjugating all potters to the dominant power of palatial authorities. Instead, pottery consumption is better assessed when more variables are in play. Looking at pottery assemblages that include several vessel types in a broad range of social contexts from the "small world" of the Late Mycenaean Saronic Gulf has shown that consumption is more related to aspects of reputation, of availability of products from different production centres, of need. The procurement of a particular vessel was perhaps based on differing suitabilities and affordances, whether perceived or real, known for specific wares.

Thus far, this study has revealed the regular movement of pottery types around the region and illuminating a world of everyday choices and consumption. Pottery appears to be circulating around to the various settlements, sanctuaries and places linked to craft-based industry of the Saronic Gulf with at least some degree of freedom. This reconstruction may seem innocuous at first glance, but it poses several questions about economic organisation and political control over acts of industry. For example, in Attica when the likelihood of a political centre around the Acropolis of Athens at this time is considered, it is clear that a large scale craft production centre such as that at Kontopigado would escape the interest of an elite only with difficulty. Recent evidence from Corinth of a Mycenaean town with a large area dedicated to craft production that is contemporary to the Late Mycenaean period (Tasinos, pers. comm.) further complicates the picture. At the centre of this lies the island of Aegina. The town of Kolonna which dominated the island and much of the Gulf in previous periods fell into decline during the Late Mycenaean period. Yet ceramic production and export continues well into the LH IIIC period. Did the potteries on Aegina have such a reputation and demand for their wares that it kept the potting industry alive after Kolonna's eventual downfall? If so, it would seem that politics play a rather small role in pottery systems in some areas and perhaps had a much larger role in others. It appears that, indeed, the complex picture of ceramic production, exchange and consumption, when considered on an assemblage scale, paints a very complex picture of everyday life in the Saronic Gulf and creates avenues into observing in a more nuanced picture of the many layers of economic activity in Mycenaean society.

8.5 The unwritten record: a case for market exchange in the Late Bronze Age

Looking back to the discussion of the Linear B texts, one implication that needs to be considered is the existence of different distribution mechanisms and whether political links can be found between regional producers and consumers. The existence of a Mycenaean state or polity at Aegina during this period is met with scepticism and is worthy of challenge (cf. Pullen et al. 2013; Tartaron 2010, 2014), yet specialised Aeginetan cooking vessels are found everywhere in the Saronic Gulf and many more places further afield. The political organization in Corinthia has also been questioned (Pullen and Tartaron 2007; Tartaron 2010, 2014), yet Corinthian painted finewares are exported to several areas in the Saronic Gulf and beyond, in addition to the specialised storage jars and coarse tubs that are imported by both Kanakia and Plaka. With the lack of a physical palace atop the acropolis at Athens, this region has been left underrepresented in the study of Mycenaean political economies, though recent work is starting to put this right (Privitera 2013), but there is a pottery production centre next what may be a flax linen production installation at Kontopigado, within less than a half day's walk from the urban centre (Kaza-Papageorgiou and Kardamaki 2012). While pottery production may not be well attested in the Linear B corpus, flax and linen are products that attracted considerable palatial interest (Rougemont 2007), indicating that, at least in Attica, there is good reason to believe that pottery production was potentially connected to the regional elite.

Cooking pots and large, coarse tubs are among the substantial repertoire of ceramic vessels produced at Kontopigado. This means that there are at least two distinct producers of cooking vessels and large, coarse tubs in the area of the Saronic Gulf. In the case of Plaka, at the foot of the Athenian acropolis and at the administrative centre at Kanakia, tubs from both Corinthia and Attica are present, thus adding ambiguity to the notions that regional specialists are producing goods for politically driven acts of exchange. The evidence so far has shown that there are several centres of pottery production in the Saronic Gulf at the end of the Bronze Age and that pottery of all shapes, sizes and qualities are being exchanged. The question now should reflect the mechanisms that enabled the observed manner of pottery exchange.

Recent literature has alluded to the occurrence of marketplaces and market-based economies in antiquity (cf. Feinman and Garraty 2010; Feinman and Nicholas 2010; Nakassis et al. 2011; see also various papers in Garraty and Stark 2010; Galaty et al. 2011; Parkinson et al. 2013). While not fully investigated, ideas of itinerant peddling and marketplaces, permanent or periodic, where a variety of local and imported goods are available in a single location may present a valid explanation for the variation in the consumption patterns revealed here. This viewpoint would allow for the variability and range of choices available to the consumer which is suggested by the pottery assemblages at Lazarides, Kanakia, Plaka and even at Kontopigado. Localised marketplaces do not detract from the economic activities occurring at the palatial level, but they do add another level of the movement of material goods. One thing to consider here is that all markets are not the same and this approach should not be overgeneralised to incorporate all kinds of exchange (Hirth 2010: 232). The Linear B records demonstrate that the palatial elite are participating, to a large degree, in regional and interregional economic transactions. Moreover, sites of religious or cultic nature, such as Eleusis and Ayios Konstantinos, in addition to areas where trade traffic are potentially mitigated, such as Myti Kommeni on Dokos, perhaps have alternative means for obtaining the ceramic vessels they require. In any case, the key concern here is equifinality – in other words, it may not be possible to distinguish market exchange from redistribution through pottery distributions alone (Stark and Garraty 2010: 41). So even with the current data, the role of the palace's influence in the local economy of the everyday Mycenaean person is still not fully understood.

8.6 Conclusions

In the broader context of Mycenaean political economy, aspects of political organisation and control over production and distribution of craft products are often interrogated. Linear B texts suggest that Mycenaean palatial authorities control several aspects of industry and commodity exchange. While this may be the case for pottery production in some Mycenaean regions, it is not clear the degree to which political influence affected the interregional and especially local exchange of ceramics in the Saronic Gulf. In fact, the evidence in the Saronic indicate that choices made concerning ceramic vessel consumption were most likely based on need, availability, reputation and perhaps even some degree of personal preference.

Pottery is a material that must have played a sizeable role in the everyday lives of most, if not all people in the Mycenaean world. It is used to store, prepare and serve food and drink, among other daily activities but it is also related to specialist commodities like oil – perfumed or not, and wine. It is with regard to these specialised products that we see pottery mentioned in palatial archives. So on the one hand pottery may be a regulated or perhaps mitigated in its production as containers of specialised goods or perhaps to fill the palatial stores, while on the other hand it is apparent that the ordinary inhabitant of the area obtained pottery for everyday use in one way or another outside the confines of the regulated political economy. As we and others before us have suggested previously, one method that is suitable for explaining localised exchange of this sort is existence of the marketplace and probably some itinerant peddling. The marketplaces are where things can be conveniently obtained, they provide a venue that enables people to choose between similar objects made in different places thus affording people a choice the objects they procure in manner that does not interfere with economic transactions occurring at the level of the state. The existence of the market place in Mycenaean contexts does not complicate the role of the "Royal Potter", if one was to exist in this region, or any other attached specialist craft producer related to the palaces, rather it simply explains why we see such variability in patterns of pottery consumption.

Chapter Nine: Conclusions

9.1 An approach to pottery in the Mycenaean Saronic Gulf

The aim of this thesis has been to provide a coherent synthesis of the social practice of ceramic production, exchange and consumption in the area of the Saronic Gulf at the end of the Mycenaean period of prehistory. It has presented a research framework centred around the integration of three distinct scientific analytical techniques, thin section petrography, neutron activation analysis and scanning electron microscopy, in order to investigate the role of everyday material culture in complex societies. More specifically, pottery was grouped according to petrographic and chemical composition, in order to investigate the diversity of technological practices applied to similar material culture and to broaden our current knowledge about the potential locations of regional production centres. By making observations on entire pottery assemblages that contain a wide variety of pottery shapes and fabrics from a large number of archaeological site, this thesis was able to not only uncover particular locations of production, but to identify, characterise and compare technological strategies employed around the study area. Characterisation of the different ceramic fabrics and their corresponding chemical signatures provided the means to trace the movement of certain pottery types from their respective places of production to that of consumption and eventual deposition.

The Saronic Gulf is a large topographic area which is understood to be surrounded by regional polities or political factions in the Late Bronze Age. The Late Mycenaean period marks the apex, decline and eventual fall of Mycenaean civilisation. With the archaeological literature teeming with information concerning the top tiers of the social hierarchy, this thesis has attempted to take a different perspective that does not extrapolate information regard the social elite onto the entire society. Rather it has looked at commonplace ceramic objects in order to understand how reconstructions of craft production, exchange and consumption can create a more nuanced and comprehensive view of Mycenaean society in an area that both unites and divides regional polities. The resulting reconstruction demonstrates a very different picture of Mycenaean political economies than the traditional and over simplified view of palatial control and redistribution economics. Instead, ceramic production, exchange and consumption are reconstructed as forms of interactive social practice. In this light it is easy to compare the economic role of small settlement such as Myti Kommeni on Dokos to larger potential administrative settlements such as at Kanakia, to examine burials, both in Euripides' Cave and more traditional cemeteries like that at the small settlement at Lazarides, to address places of religious or cultic significance as in Ayios Konstantinos and Eleusis and finally places where production actually occurs like Kontopigado, Attica.

9.2 Pottery analysis and places of production

First and foremost, this research has taken a large pottery assemblage from 11 contemporary archaeological sites and placed each sample into meaningful groups. Mineralogy, petrology, colour, texture and microstructure led to the characterisation of 34 discrete ceramic fabric groups. Independently, 412 of the total 487 samples were analysed by NAA with resulting data grouped according to chemical composition. In order to form compositional groups the data were subjected to a statistical programme specifically tailored to ceramic studies. Initially the tests are designed to differentiate chemical alterations caused during the production process from those caused by the natural environment in order to ensure observed variation is representative of raw materials and not post depositional contaminants. The final groups, created through a combination of cluster analysis and a modified Mahalanobis, are then taken to represent raw materials used in production and subsequently compared against reference groups of known provenance.

The results of this integrated analysis revealed the existence of multiple places of pottery production and provided the observations necessary to reconstruct technological, political and economic phenomena, in Attica especially. The archaeological context of Kontopigado makes it a prime location to understand the relationship of pottery with other crafts, such as flax linen production, but more generally, it enables a chance to investigate the role of production in political economic system of a Late Mycenaean polity.

Beyond Kontopigado, no other production centre was linked to a specific geographic location. Rather they have been assigned to more general areas within specific regions according to how samples matched to comparative material of assumed provenance combined with the geological indicators identified from petrographic composition. In this way pottery has been linked to places of production on the island of Aegina, specifically in the northern part of the island, in Corinthia near Ancient Corinth and Acrocorinth, in the northern part of Kea in the Cycladic islands and various places on Crete, including the Mirabello region in the east and the Mesara plain in south central part of the island.

The pottery from Aegina are related to specific clays sources such as the fineware of FG 10B which is highly compatible with clays of Ayios Thomas (Hein et al. 2004c) and the coarsewares of FG 9A and FG 9B to the red bedded Neogene deposits of the north centre of the island (cf. Gauss and Kiriatzi 2011). Gauss and Kiriatzi (2011) have clearly demonstrated that the potters were exploiting the Neogene deposits in the north of the island from the Early and Middle Bronze Age, it is clear that the trend continued through to the end of Late Bronze Age as well.

One of the largest chemical and petrographic fabric groups has tentatively been assigned to a provenance in Corinthia, perhaps at Ancient Corinth, however this avenue needs to be investigated further. Petrographic information from FGs 11-16 correlate well with Corinthian geology. The samples from FG 11 correlate well with pottery analysed as part of doctoral research conducted by Clare Burke at the University of Sheffield. Burke et al (in press) has shown that this group there is strong petrographic evidence to indicate that pottery is produced at Ancient Corinth (Keramidaki) during the EB II phase. On the other hand, FG 11 is highly compatible with the chemical reference group for production in the Argolid, specifically the Mycenae-Berbati (MYBE) group. The evidence for production at Ancient Corinth, as derived from Burke's current doctoral research, is quite clear, but the compositional reference groups for this region, in their most recent manifestation, do not show sufficient variability to allow for discrimination between Argive and Corinthian products. The northern Peloponnese has many chemically similar Neogene clay deposits that were exploited in antiquity. To discriminate chemical groups of Argive production from those of Ancient Corinth will need a multi-technique reassessment of the current compositional reference groups for pottery production in the Argolid, specifically at sites such as Mycenae and Tiryns.

9.3 Pottery production technology and production strategies

The identification of locations of production has provided the opportunity to reconstruct specific choices potters made during the production process and additionally to characterise distinct sets of production practices employed at different centres. Reconstructing production practices at Kontopigado make it clear that potters here were employing a cohesive production strategy that incorporated a wide variety of vessel shapes, sizes and fabric textures. Fineware vessels are manufactured with a mixture of moderately calcareous and noncalcareous clays with very few nonplastic inclusions. The coarsewares are constructed from low- or noncalcareous clays that have a higher density of inclusions. The large tubs are tempered with organic vegetal matter and the cooking pots are tempered with a fine sand. Fineware are high fired and some were subjected to three stage ORO firing regimes while coarse utilitarian pottery is moderately to low fired. This systematic distribution of firing temperatures may suggest that different vessels of were fired together with specific placement within the kiln structure.

When compared to other areas of production , such as those that must have existed on the island of Aegina, it becomes clear that individual potteries employed different sets of practices and production strategies. Kontopigado used similar raw materials and firing regimes to produce coarse and finewares alike. On Aegina, the picture is different, coarseware pottery is noncalcareous and low fired while finewares are highly calcareous, high fired and decorated. The technological requirements of each are fundamentally different, e.g. noncalcareous and calcareous fabrics require distinct firing regimes, suggesting that different potters were making different kinds of vessels. Thus it appears that there are two contemporary potting groups in the northern part of Aegina during the Late Mycenaean period. This specialisation of pottery production contrasts well with the production at Kontopigado where all vessel forms are produced using very similar sets of practices.

Despite the differences in production practices, there is very clear evidence for the sharing of specific technical knowledge among all tub producing centres in the Saronic Gulf. This is best illustrated by the presence of vegetal temper in these specific vessels. Although all five tub fabrics, FG 2, FG 9B, FG 13, FG 14 and FG 34, are clearly made from different raw materials, probably by different groups of potters, all five demonstrate this one similar trait, vegetal tempering. Upon closer inspection, it becomes more obvious that different production centres applied this technological feature in different ways, again alluding to distinctive sets of production practice. At Kontopigado organic temper is found in all large tubs, a punch-based griddles and baking trays, while Aeginetan production shows that vegetal temper is applied only to large tubs and storage jars.

9.4 Patterns of pottery consumption and archaeological implications

Understanding that production is only part of a much larger pottery system, avenues of exchange and consumption were also explored. Through the process of a site-by-site analysis several patterns revealed themselves. It is clear that pottery from Kontopigado, Aegina and Corinthia was widely distributed in the Saronic Gulf region. In fact this pattern is visible at all of the sites incorporated into this study. This single observation means that pottery from at least three different production centres were available to the people residing in rural hamlets and urban centres, they were used as part of rituals at religious sanctuaries and during burial rites for the dead. Even places where pottery of all kinds was produced, as is the case with Kontopigado, vessels manufactured elsewhere were used for everyday tasks. Pottery consumption of this kind is hardly what one would expect in a society where many areas of craft production are controlled by elite regional factions.

What factors, then, are driving pottery consumption if not those motivated by local and regional politics? Looking again at the pottery assemblages from each site it is apparent that people were using the same types of vessels from different producers. Moreover, some sites which had obvious access to products from multiple manufacturers only used particular vessel types from specific production centres. The best example of this is at Kanakia where all the cooking vessels originate from Aegina, but the rest of the assemblage has mixed origins. These critical observations are indicative of people making choices in the kinds of pottery they acquire for use. Pottery from several centres is available, however it seems that the choice-driven consumption is perhaps a range of contributing factors, specifically need and reputation. At Kanakia, it even appears that preference is being expressed for Aeginetan cooking pots over their counterparts from Kontopigado.

The picture painted thus far is one of multiple regional pottery production centres with widely distributed products. Exchange of these products crosses perceived political boundaries, i.e. Attica, Aegina, Salamis, Corinthia, Methana, Dokos, without any indication of the involvement by regional political factions. Consumption appears driven by choice as the same kinds of pottery made by different manufacturing centres are available to all. One way to explain this is the existence of marketplaces, both permanent and periodic and perhaps some degree of itinerant peddling occurred as well. Markets are not to be conflated with modern day market economies based securely on principles of supply and demand. Rather they should be viewed as venues where exchange can take place and where products from far away can be obtained if so desired. Such places do not take anything away from current notions of Mycenaean political economies; instead they add another level to their complex and interactive nature. More so, they enable common, every day goods that have a variety of uses and applications to enter the everyday lives of Mycenaean civilisations.

Providing such liberties as the choice in what kinds of pottery is obtained for use does not mean that there is no evidence for political involvement in the production side of the spectrum. At Kontopigado pottery production is evidently linked to the production of flax linen, a craft known from the Linear B tablets to be connected to the Mycenaean palatial elite. This coupled with the size of the production centre and the breadth of product distribution suggests that it would be difficult for the ruling faction to not have a vested interest in pottery production. On the other hand, the major settlement at Kolonna, which likely held the seat of power on Aegina during previous periods, does not appear to be controlling pottery production in the Late Mycenaean phase. Instead, potters from long standing traditions appear to continue production and trading their wares for more than a century after Kolonna's demise. This suggests that the role of pottery in politics is much more complex than it has appeared in the past.

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This thesis set out to investigate the place of pottery in the area of the Saronic Gulf during the Late Mycenaean period. In an attempt to tackle this arduous task, many new and exciting pieces of information were revealed. The project has been approached from the bottom up in order to withhold pre-existing social constructs imposed upon the past from influencing any interpretations. This approach has demonstrated that it is complementary to previous research of Mycenaean societies investigated from the top down. It has created an interactive framework in which all areas of society are considered as components of a much larger social system. In considering entire assemblages, where possible, this project has attempted to create a picture that is much more nuanced and complex than is found in single type studies.

Equally, employing an integrated multi-technique analytical perspective has generated robust results subject, of course, to the rigours of empirical testing and have generated a broad spectrum of key insights into the world of Late Mycenaean pottery. This study has located production places and characterised their wares. It has compared production strategies at Kontopigado to that occurring on Aegina and elsewhere. This enables the identification of shared technological information and highlighted the different ways in which it was exploited according to where it was enacted. Tracing the movement of pottery types from their respective origins has illuminated a range of consumption patterns at a variety of contemporary sites, including those driven by choice. Lastly, this research has provided alternative mechanisms of exchange to redistribution and evaluated the role of pottery in different Late Mycenaean polities from around the Saronic Gulf. In taking a stance heavily influenced by the reconstruction of ceramic technology, this research has served to reveal many of its facets as related to the study of past peoples, a goal laid out over 60 years ago by one Anna O. Shepard (1954) for archaeologists with an interest in pottery.

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Appendix I: Petrographic Descriptions

Abbreviations

Several abbreviations are used in the fabric descriptions; they are as follows:

FG	Fabric group
A	Angular
SA	Sub-angular
SR	Sub-rounded
R	Rounded
WR	Well-rounded
EQ	Equant
EL	Elongate
ARF	Argillaceous rock fragment
TCF	Textural concentration feature
$c{:}f{:}v_{=xx\mu m}$	Coarse fraction to fine fraction to voids ratio with fine fraction defined as measured value

Attic Fabrics

Fabric group 1: Micaceous low grade schist and argillaceous rock

Sample ID	Region of deposition	Vessel type
Acropolis 13/01	Attica	Plain jug
Acropolis 13/03	Attica	Dipper
Acropolis 13/04	Attica	Spouted krater
Acropolis 13/05	Attica	Spouted krater
Acropolis 13/07	Attica	Semiglobular cup
Acropolis 13/08	Attica	Tripod strainer
Acropolis 13/11	Attica	Tripod cooking pot
Acropolis 13/13	Attica	Deep bowl
Acropolis 13/15	Attica	Krater
Acropolis 13/18	Attica	Stirrup jar
Acropolis 13/19	Attica	Deep bowl
Acropolis 13/20	Attica	Deep bowl
Acropolis 13/21	Attica	Deep bowl
Acropolis 13/22	Attica	Deep bowl
Acropolis 13/23	Attica	Deep bowl
Acropolis 13/24	Attica	Deep bowl
Acropolis 13/26	Attica	Open vessel
Acropolis 13/28	Attica	Cup
Acropolis 13/29	Attica	Fine Stirrup Jar
Acropolis 13/30	Attica	Jug/jar
Acropolis 13/32	Attica	Carinated kylix
Acropolis 13/33	Attica	Conical kylix
Acropolis 13/38	Attica	Tripod cooking pot
Acropolis 13/39	Attica	Tripod cooking pot
Ayios Konstantinos 12/22	Troezinia	Basin
Ayios Konstantinos 12/23	Troezinia	Open vessel
Ayios Konstantinos 12/34	Troezinia	Zoomorphic Figurine
Ayios Konstantinos 12/36	Troezinia	Hydria
Ayios Konstantinos 12/37	Troezinia	Deep bowl
Ayios Konstantinos 12/38	Troezinia	Kylix
Ayios Konstantinos 12/40	Troezinia	Shallow bowl/kylix?
Ayios Konstantinos 12/42	Troezinia	Open vessel
Ayios Konstantinos 12/43	Troezinia	Jar
Ayios Konstantinos 12/44	Troezinia	Kylix
Ayios Konstantinos 12/45	Troezinia	Jar
Ayios Konstantinos 12/47	Troezinia	Closed vessel

Ayios Konstantinos 12/48	Troezinia	Straight-sided Alabastron
Ayios Konstantinos 12/53	Troezinia	Carinated kylix
Ayios Konstantinos 12/54	Troezinia	Deep bowl
Ayios Konstantinos 12/57	Troezinia	Closed vessel
Ayios Konstantinos 12/60	Troezinia	Open vessel
Ayios Konstantinos 12/61	Troezinia	Open vessel
Alimos 12/01	Attica	Skyphos
Alimos 12/02	Attica	Krater
Alimos 12/03	Attica	Kylix
Alimos 12/04	Attica	Kylix
Alimos 12/05	Attica	Skyphos
Alimos 12/06	Attica	Skyphos
Alimos 12/07	Attica	Kyathos
Alimos 12/08	Attica	Skyphos
Alimos 12/09	Attica	Lekane
Alimos 12/10	Attica	Cup
Alimos 12/12	Attica	False neck jug
Alimos 12/13	Attica	False neck jug
Alimos 12/14	Attica	Skyphos
Alimos 12/15	Attica	Footed Skyphos
Alimos 12/16	Attica	Skyphos
Alimos 12/18	Attica	Lid
Alimos 12/19	Attica	Krater
Alimos 12/20	Attica	Krater
Alimos 12/21	Attica	Closed vessel
Alimos 12/22	Attica	Closed vessel
Alimos 12/23	Attica	Closed vessel
Alimos 12/24	Attica	Closed vessel
Alimos 12/25	Attica	Closed vessel
Alimos 12/26	Attica	Closed vessel
Alimos 12/27	Attica	Closed vessel
Alimos 12/28	Attica	Closed vessel
Alimos 12/29	Attica	Closed vessel
Alimos 12/30	Attica	Closed vessel
Alimos 12/31	Attica	Closed vessel
Alimos 12/32	Attica	Closed vessel
Alimos 12/33	Attica	Amphora
Alimos 12/34	Attica	Skyphos
Alimos 12/35	Attica	Kylix

Alimos 12/36	Attica	Dipper
Alimos 12/37	Attica	Dipper
Alimos 12/38	Attica	Small basin
Alimos 12/39	Attica	Small basin
Alimos 12/40	Attica	Skyphos
Alimos 12/41	Attica	Kylix
Alimos 12/42	Attica	Krater
Alimos 12/43	Attica	Kylix
Alimos 12/44	Attica	Basin
Alimos 12/45	Attica	Dipper
Alimos 12/46	Attica	Kylix
Alimos 12/47	Attica	Small basin
Alimos 12/48	Attica	Krater
Alimos 12/84	Attica	Cooking pot
Alimos 12/110	Attica	Small basin
Alimos 12/111	Attica	Small basin
Alimos 12/112	Attica	Amphora
Alimos 12/114	Attica	Skyphos
Alimos 12/115	Attica	Stirrup Jar
Alimos 12/116	Attica	Amphora
Alimos 12/117	Attica	Stirrup Jar
Alimos 12/118	Attica	Skyphos
Euripides Cave12/02	Salamis	Amphora/hydria/jug
Euripides Cave12/03	Salamis	Hydria
Euripides Cave12/04	Salamis	Hydria
Euripides Cave12/05	Salamis	Amphora/hydria/jug
Euripides Cave12/06	Salamis	Hydria
Euripides Cave12/07	Salamis	Amphora/hydria/jug
Euripides Cave12/08	Salamis	Closed pot
Euripides Cave12/14	Salamis	Deep bowl
Euripides Cave12/18	Salamis	Kylix
Dokos 12/07	Argo-Saronic	Kylix
Eleusis 12/01	Attica	Amphora
Eleusis 12/02	Attica	Hydria
Eleusis 12/04	Attica	Amphora
Eleusis 12/06	Attica	Dipper
Eleusis 12/07	Attica	Jar
Eleusis 12/10	Attica	Amphora
Eleusis 12/11	Attica	Jar

Eleusis 12/15	Attica	Krater
Eleusis 12/16	Attica	Amphora
Eleusis 12/17	Attica	Basin
Kalamianos 12/06	Corinthia	Kylix
Kalamianos 12/14	Corinthia	Jar
Kalamianos 12/25	Corinthia	Kylix
Kalamianos 12/27	Corinthia	Kylix
Kalamianos 12/42	Corinthia	Stemmed bowl
Kalamianos 12/44	Corinthia	Kylix
Kalamianos 12/45	Corinthia	Stirrup jar
Kalamianos 12/61	Corinthia	Deep bowl
Kalamianos 12/64	Corinthia	Stemmed bowl
Kanakia 10/01	Salamis	amphora/hydria/jug
Kanakia 10/02	Salamis	Hydria
Kanakia 10/03	Salamis	Spouted basin
Kanakia 10/05	Salamis	Piriform jar
Kanakia 10/06	Salamis	Stirrup jar (medium)
Kanakia 07/01	Salamis	Monochrome Amphora
Kanakia 07/02	Salamis	Monochrome Amphora
Kanakia 07/03	Salamis	Monochrome Amphora
Kanakia 07/04	Salamis	Closed monochrome vessel
Kanakia 07/05	Salamis	Closed monochrome vessel
Kanakia 07/06	Salamis	Closed monochrome vessel
Kanakia 07/07	Salamis	Closed monochrome vessel
Kanakia 07/08	Salamis	Amphora
Kanakia 07/09	Salamis	Amphora
Kanakia 07/10	Salamis	Amphora
Kanakia 07/11	Salamis	Amphora/hydria/jug
Kanakia 07/12	Salamis	Hydria
Kanakia 07/13	Salamis	Amphora/hydria/jug
Kanakia 07/14	Salamis	Hydria
Kanakia 07/15	Salamis	Hydria
Kanakia 07/16	Salamis	Hydria
Kanakia 07/17	Salamis	Amphora/hydria/jug
Kanakia 07/18	Salamis	Basin
Kanakia 07/19	Salamis	Spouted basin

Kanakia 07/20	Salamis	Basin
Kanakia 07/21	Salamis	Basin
Kanakia 07/22	Salamis	Basin
Kanakia 07/23	Salamis	Basin
Kanakia 07/24	Salamis	Basin
Kanakia 07/25	Salamis	Spouted krater
Kanakia 07/26	Salamis	Spouted krater
Kanakia 07/27	Salamis	Spouted krater
Kanakia 07/28	Salamis	Spouted krater
Kanakia 07/29	Salamis	Spouted krater
Kanakia 07/30	Salamis	Spouted krater
Kanakia 07/32	Salamis	Deep bowl
Kanakia 07/34	Salamis	Stirrup jar
Kanakia 07/42	Salamis	Stirrup jar
Lazarides 12/11	Aegina	Deep bowl
Lazarides 12/12	Aegina	Deep bowl
Plaka 10/07	Attica	Closed vessel
Plaka 10/08	Attica	Closed vessel
Plaka 10/09	Attica	Closed vessel
Plaka 10/10	Attica	Closed vessel
Plaka 10/11	Attica	Closed vessel
Plaka 10/12	Attica	Closed vessel
Plaka 10/13	Attica	Closed vessel
Plaka 10/14	Attica	Closed vessel
Plaka 10/15	Attica	Closed vessel
Plaka 10/16	Attica	Closed vessel
Stiri 12/100	Corinthia	Stemmed bowl
Stiri 12/114	Corinthia	Pedestal bowl

Voids

Voids are common. There are common mesovughs and mesovesicles, few to rare microvesicles and rare to absent macrovughs. The voids have a general crude long axis orientation parallel to the vessel margins and are open-spaced. Elongate inclusions commonly have a crude long axis orientation parallel to vessel margins.

Matrix

The micromass is composed of coarse silt sized micrite particles in a predominantly heterogeneous micaceous matrix that includes quartz and feldspar. The matrix is composed of grain sizes ranging from very fine sand to very fine silt (ex. Alimos 12/114). Colour varies from brownish red to yellowish brown in XP (x50) and brown to pale yellowish brown in PPL (x50). The matrix is optically inactive to active, but commonly displays low-moderate optical activity. Secondary calcite is frequently observed on the external margins of the vessels and commonly aggregated around void walls and in cracks. Secondary calcite is predominantly partially autochthonous with common allochthonous secondary calcite as demonstrated by microgeodetic sparite on void walls and in cracks and the infilling of voids with sparite and micrite. Alimos 12/116 and 12/117 have a slightly mottled appearance and 12/117 shows a firing horizon of black on the exterior surface with bloating pores and is due to over-firing.

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 13:80:7 – 17:80:3

Coarse Fraction – 3.8 – 0.20 mm long axis

Fine Fraction – 0.20-0.01 mm long axis

El. EQ. A-WR. The inclusions have a bimodal grain size distribution, are moderately sorted and predominantly open-spaced.

Coarse Fraction

Frequent	Biotite laths. Size: <0.50 mm long axis. Mode: 0.2 mm long axis.
Common	Muscovite laths. Mode: 0.25 mm long axis. K-Feldspar (Orthoclase). Size: 0.55-0.24 mm long axis. Mode: 0.40 mm long axis. SA. Equant. Euhedral to subhedral. Simple twinning along one cleavage. Frequently no twinning is visible. Distinguishable from quartz by low optical density and cloudy alteration in PPL and rare cleavage. Quartz. Size: 0.5-0.24 mm long axis. Mode: 0.38 mm long axis. SA. Equant. Euhedral. Monocrystalline and polycrystalline varieties are present. Polycrystalline quartz is composed individual grains with sutured boundaries (not interlocking). Frequent undulose and common straight extinction. Rare intergrowth of mica (sericite?) and feldspar phenocrysts. Detritus from decomposed metamorphic rock material.
Few to absent	*Sedimentary rock fragments* Lithic Greywacke. Size: 2.02- 0.24 mm long axis. SA. Equant to elongate. Fine sand to coarse silt –sized inclusions of K-feldspar, plagioclase, phyllite and quartzite fragments set in a fine clayey Fe-rich red matrix (5-90%).Commonly the fragments grade into opaque Fe-rich mudstone with nearly

100% matrix. Many of these fragments have a single flat edge with more matrix on this side. This feature is suggestive of Iron Pan deposits that form due to particle precipitation that occurs naturally during diagenesis.

Siltstone. Size: 2.32-0.24 mm long axis. Mode: 0.40 mm long axis. SR-R. Equant to elongate. Red-brown to yellow-brown in XP (50x) and orange-brown to pale yellow in PPL (50x). Fine silt to very fine silt sized inclusions of predominantly mica laths, common feldspar and quartz and low-grade metamorphic rock fragments (10-12%) set in a clayey matrix that is concordant to ceramic matrix. Boundaries are clear to diffused to merging and optical density is commonly high. Frequently there a “flow” in the matrix is observed surrounding these inclusions with clear. These siltstones (or ARFs) are one of the main constituent raw materials used to construct this fabric. There is a high probability that these inclusions are related the “lithic greywacke/iron pan” inclusions.

Marl. Size: 0.85-0.24 mm long axis. Mode: 0.45 mm long axis. SR. Equant to amorphous (elongated, amorphous striated features). Fine silt-sized quartz, feldspar and micrite inclusions (7-9%) set in a fine clayey grey (XP 50x) matrix that is discordant to ceramic matrix. In PPL the inclusions are cloudy pale yellow to pale brown. Frequently opaque particles are observed in PPL creating a “speckled” or “mottled” appearance. Boundaries are diffused to merging in XP and clear in PPL. Optical density is low (high -). These ARF inclusions are part of the raw material mixture.

Micaceous Argillite (ARF). Size: 2.30-0.24 mm long axis. Mode: 0.48 mm long axis. R-WR. Equant to elongated, amorphous pellet. Yellow to bright yellow brown in XP (50x) and pale brownish yellow with cloudy alteration in PPL (50x). Coarse to fine silt-sized agglomerations of predominantly mica laths (Biotite? Pleochroism is rare) with rare plagioclase and quartz. Frequently a clear bedding is observed. Boundaries are clear to merging and optical density is neutral to low positive.

Few to absent	Low-grade metamorphic rock fragments. Size: 2.5-0.38 mm long axis. SA-SR. Elongate, rarely equant. Low-medium grade greenschist facies. Biotite dominant mica schist, muscovite dominant mica schist with quartzite and rare alkali feldspar (orthoclase) inclusions. Commonly schist fragments

	are observed as quartzite with mica inclusions and distinct foliation. Very rarely observed as wavy banded phyllite.
Very Few	Plagioclase. Size: <0.28 mm long axis. Mode: 0.20 mm long axis. Polysynthetic twinning.
Rare	Altered calcareous mudstone. Size: <1.30 mm long axis. R. Elongate. fine silt sized inclusions of quartz, feldspar, micrite and mica laths in a calcareous matrix.
	Serpentinite. <1.32 mm long axis. R. EQ.(Kanakia 07/3, 10/03)
Very Rare	Metamorphosed acid igneous rock fragments. Size: 1.10 mm long axis. SR. Elongate. (Alimos 12/27)
	Calcareous microfossils. Globigerina (Alimos 12/31).

Fine Fraction

Frequent	Mica laths
Common	Feldspar
	Quartz
Few	Sedimentary rock fragments
Few to absent	Metamorphic rock fragments
Rare	Serpentinite
Very Rare	Amphibole

Comment

The ARFs inclusions are the representative ingredients in the fabric recipe. They are easily observed in samples Alimos 12/09, 21, 33; Kanakia 07/08, 12, 34; Ayios Konstantinos 12/45, 57. Kanakia 07/09 has a particle of unmixed clay. There are colour differences in the ARF fragments, but this is explained through differences in optical activity. The texture of the matrix ranges in grain size, with the finest found at Kalamianos (ex. 12/06) and the most coarse at Alimos (various). Serpentinite found in Kanakia 07/07 and 10/03 indicates that there is a connection of the metamorphic and ophiolite parent rock material of the matrix components. The texture of Alimos 12/80 suggests it is over-fired. It is must be noted that Acropolis 13/38 and Alimos 12/84 are cooking pots.

Fabric Group 1Ac (Coarse)

Sample ID	**Region of Deposition**	**Vessel Type**
Plaka 10/06	Attica	Closed vessel
Plaka 10/17	Attica	Closed vessel

Voids

Common mesovesicles and equant meso- and microvughs. Voids are open spaced and have no preferred orientation.

Matrix

Same as FG 1

Inclusions

c:f:$v_{=20\mu m}$ – 9:88:3
Coarse fraction – 2.88- 0.1 mm long axis.
Fine fraction – 0.1-0.02 mm long axis.

EQ. EL. R-A. Poorly sorted, loosely packed and weakly bimodal grain size distribution. The coarse fraction is very poorly sorted and open space and the fine fraction is well sorted and single spaced.

The inclusions are the same as in FG 1 however these samples are weakly bimodal and the fine fraction has a greater abundance of inclusions that are densely packed.

Comment

These samples are from two closed vessels. They are thicker walled vessels than any other in FG 1 and have been separated due to the greater abundance and increased packing density of inclusions. There is no doubt that they are constructed from the same raw materials and in the same technological tradition as FG 1.

Fabric Group 2: Metamorphic and sedimentary rocks with organic material

Sample ID	Region of Deposition	Vessel Type
Alimos 12/49	Attica	Tub
Alimos 12/50	Attica	Tub
Alimos 12/51	Attica	Tub
Alimos 12/52	Attica	Tub
Alimos 12/53	Attica	Tub
Alimos 12/54	Attica	Tub
Alimos 12/55	Attica	Tub
Alimos 12/56	Attica	Tub
Alimos 12/57	Attica	Tub
Alimos 12/58	Attica	Tub
Alimos 12/59	Attica	Tub
Alimos 12/60	Attica	Griddle pan
Alimos 12/61	Attica	Lid
Alimos 12/62	Attica	Shallow pan

Alimos 12/63	Attica	Tub
Alimos 12/64	Attica	Tub
Alimos 12/65	Attica	Tub
Alimos 12/66	Attica	Shallow pan
Alimos 12/67	Attica	Shallow pan
Alimos 12/68	Attica	Tub
Alimos 12/69	Attica	Shallow pan
Alimos 12/70	Attica	Lid
Alimos 12/81	Attica	Tub
Alimos 12/82	Attica	Tub
Alimos 12/83	Attica	Coarse Jar
Kanakia 07/67	Salamis	Tub
Kanakia 07/68	Salamis	Tub
Kanakia 07/71	Salamis	Tub
Plaka 10/32	Attica	Tub
Plaka 10/33	Attica	Tub
Plaka 10/35	Attica	Tub
Plaka 10/36	Attica	Tub
Plaka 10/37	Attica	Tub
Plaka 10/38	Attica	Tub
Plaka 10/39	Attica	Tub

Voids

Frequent elongate and curved mega- and macroplanar voids that have a mode thickness of 0.8 mm. Common macrovughs, few mesovughs and rare megavughs and megachannels. The mega- and macroplanar voids commonly have organic matter residue on the interior. These voids were formed when organic plant matter, such as chaff, burnt out during the firing stage of the manufacture process. Predominantly the voids are orientated parallel to vessel marigins, however Alimos 12/ 57 and 12/83 have random orientation of the voids. The voids in Alimos 12/ 57 and 12/83 are more curved and some look as if the plant matter was matted up into a knot and not a single piece.

Matrix

The micromass is composed of a predominantly heterogeneous micaceous matrix that includes quartz and feldspar. The matrix is composed of grain sizes ranging from fine to coarse sand. Colour varies from dark red brown to yellow brown in XP (50x) and dark brown to pale brown in PPL (50x). The matrix is optically inactive to active (Alimos 12/51) and few samples display low-moderate optical activity. Secondary calcite is frequently observed on the external margins of the vessels and commonly aggregated around void walls and in cracks. Autochthonous and partial autochthonous secondary calcite is observe as micrite lining void walls or as micrite infilling of entire void. Autochthonous secondary calcite is common as swaths of micrite within the matrix and as amorphous micrite aggregates. The matrix is identical in composition as FG 1 and only differs in the abundance of micrite particles and relative coarseness. Alimos 12/46 demonstrates dehydrated clay particle.

Inclusions

c:f:$v_{=20\mu m}$ – 15:65:20-10:60:30
Coarse Fraction – 3.86-0.10 mm long axis.
Fine Fraction – 0.10-0.01 mm long axis

EL. EQ. R-SA. Double- to single-space, poorly sorted with strong bimodal grain size distribution. Inclusions are randomly orientated. Alimos 12/59 has all inclusions.

Coarse Fraction

Frequent to very rare	Cataclastic metamorphic rock. Size: 2.88-0.24 mm long axis. Mode: 0.88 mm long axis. EQ. EL. SA-A. Fragments are varied in texture, but composition remain consistent. Common mineral components are quartz, albite, orthoclase, biotite, chlorite, clinozoisite and opaques (highly probable this is graphite). Composition suggests low-grade greenschist facies. Frequent cataclastic texture, bedded and unbedded. *Athens Schist.*
Frequent	Quartz. Monocrystalline and polycrystalline. Size: 1.98-0.1 mm long axis. Mode: 0.28 mm long axis. EQ. EL. SR-SA. Undulose extinction with sutured boundaries. Common strained texture. Metamorphic origin.
Common to rare	Greywacke. Size: 3.12- 0.24 mm long axis. SA. Equant to elongate. Fine sand to coarse silt –sized inclusions of K-feldspar, plagioclase, phyllite and quartzite fragments set in a fine clayey Fe-rich red matrix (5-90%).Commonly the fragments grade into opaque Fe-rich mudstone with nearly 100% matrix. Many of these fragments have a single flat edge with more matrix on this side. This feature is suggestive of Iron Pan deposits that form due to particle precipitation that occurs naturally during diagenesis. Related to Fe-rich opaques. Mica schist. Size: 1.05-0.16 mm long axis. Rarely schist exhibits heavy crenulation. Contains muscovite, biotite, quartz, feldspar, chlorlite and rare opaques. *Athens Schist*.

	Plagioclase feldspar. Size: 1.24 mm long axis. Mode: 0.24 mm long axis. EQ. SA. Albite Law twinning and simple twinning. Common intergrowth with quartz and ferromagnesian mineral phenocrysts.
	Sandstones. *Arenite* and *Arenaceous metasandtone*. Size: 2.35-0.25 mm long axis. EQ. EL. SR-SA. Granoblastic texture with bands of Fe-rich minerals (mica). Feldspars are between 5-10% of entire composition. *Athens Schist.*
Few	Opaques. Size: 1.92- mm long axis. Mode: mm long axis. EL. SR. Fe-rich. *Haematite*?
Few to rare	Chert. Size: 3.36- 0.28 mm long axis. EQ. SA. Related to arenaceous metasandstone. Few demonstrate metamorphism (stretched grains and banding in PPL, see Alimos 12/58).
Few to absent	Marl. Size: 2.00-0.24 mm long axis. Mode: 0.16 mm long axis. EQ. EL. R. Fine silt sized inclusions of quartz and feldspar?

Fine Fraction

Predominant	Quartz
Frequent	Rock fragments
	Feldspar
Common	Opaque (part of greywacke matrix?)
Few	Chert
	Marl
	Mica laths

Textural concentration features

Dark brownish red TCF. SR. Equant to amorphous (elongated, amorphous striated features). Fine silt-sized quartz, feldspar and micrite? inclusions (7-9%) set in a fine clayey grey (XP 50x) matrix that is discordant to ceramic matrix. In PPL the inclusions are cloudy pale yellow to pale brown. Frequently opaque particles are observed in PPL creating a “speckled” or “mottled” appearance. Boundaries are diffused to merging in XP and clear in PPL. Optical density is low (high -). These are compatible with the siltstones in FG 1.

Comment

This fabric is composed of a nearly identical groundmass as FG 1. These fabrics differ in the relative coarseness of the inclusions and the remains of burnt out organic matter used as temper. The metamorphic and sedimentary composition of the inclusions are highly compatible with those in in FG and are representative of the geological formations described as *Athens Schist* (see description of this formation in Chapter Five). Alimos 12/52 is very optically active and has very rare inclusions, however these inclusions are the typical "iron pan". In general the samples from Plaka have more inclusions.

Fabric Group 3: Low grade schist and marble

Sample ID	Region of Deposition	Vessel Type
Alimos 12/76	Attica	Semi-globular kylix
Alimos 12/77	Attica	Pithoid jar
Alimos 12/78	Attica	Pithoid jar
Kanakia 07/84	Attica	Pithos
Kanakia 07/85	Attica	Pithoid Jar
Plaka 10/18	Attica	Pithoid Jar
Plaka 10/29	Attica	Pithoid Jar

Voids

Frequent open-spaced micro- to megavughs, few micro- to macrovesicles and very few macro channel voids. Kanakia 07/85 has common curved and elongated planar voids produced after organic material was burnt out during the firing process. Voids has a general crude long axis orientation parallel to section margins (sherd orientation on these large vessels is difficult to ascertain as they were originally too large to fit on the slide).

Matrix

Fine micromass that is pale brown to yellowish brown in XP (50x) and yellowish brown to dark yellowish brown in PPL (50x). Moderate optical activity. Autochthonous secondary calcite is observed as micrite swaths throughout the matrix.

Inclusions

c:f:$v_{=20\mu m}$ 32:63:5 – 15:73:12
Coarse Fraction – 5.00-0.20 mm long axis.
Fine Fraction – 0.20-0.01 mm long axis.

Commonly inclusions are SA, elongate with few equant, double to open spaced. They are poorly sorted and have a bimodal grain size distribution. Platy inclusions have a crude ling axis orientation sub-parallel to the vessel margins, however, more commonly inclusions have no preferred orientation.

Coarse Fraction

Frequent — Low-medium grade metamorphic rock. *White mica chlorite schist*. Size: <5.00-0.24 mm long axis. Mode: 0.60 mm long axis. EL. SA. Low-medium grade greenschist facies with

	dominant muscovite, frequent quartz, few albite, chlorite. Chlorite is commonly found recrystalised between interlocking quartz or quartz and albite grains and between muscovite laths. Frequent moderate foliation and common heavy crenulation of mica phases. Rare epidote group (clinozoisite) phenocrysts. Very few fragments have calcite (micrite) crust partially or fully surrounding borders.
Common	Carbonates
	-Marl. Size: 2.72-0.20 mm long axis. EQ. SR. Very few quartz, orthoclase and muscovite, very rare clinozoisite inclusions. Very few sparite zones. Grades into marble and meta-pelite. Grades into calcareous mudstone?
	-Marble. Size: 4.00-0.24 mm long axis. Mode: 0.72 mm long axis. EL. SA.
	-Calcite. Size : 0.45-0.20 mm long axis. EQ. SA. Disaggregated from marble?
	Plagioclase feldspar. *Albite*. Size: 0/95-.20 mm long axis. Mode: 0.45 long axis. EQ. A-SA. Weathered and altered. Frequent sericite intergrowth. Very rare polysythetic twinning, simple twinning. Commonly zoned. Rare spherolitic intergrowth. Very rare quartz intergrowth in poikoilitic texture. Disaggregated schist detritus?
	Quartz. Size: 0.72-.20 mm long axis. Mode: 0.60 mm long axis. EQ. SA. Frequent undulose extinction, common strait extinction. Larger, euhedral and subhedral grains with undulose extinction are probably disaggregated from schist. Fine grains with straight extinction are more weathered and could be part of the matrix.
Few	Opaques. Size: 0.80 -.02 mm long axis. Mode: 0.32 mm long axis. EQ. SR-R. Haematite?
Very Rare to absent	Microfossils. Size: 0.42 mm long axis. Shell. (Alimos 12/77)

Fine Fraction

Dominant	Micrite
Common	Plagioclase
	Quartz

	Mica laths
	Metamorphic rock
Very Rare	Epidote group (clinozoisite)

Textural Concentration Features

There two distinctive types of TCFs in this fabric. Common reddish brown (XP, 50x) and brown (PPL, 50x) Fe-rich pellets with clear boundaries, high optical density and a discordant matrix. These pellets commonly have an elongate "tail" leading away from the main body. There are few striations of this material in the fabric matrix. The second TCF are coarse pellets with a calcareous matrix with few silicate inclusions. These are concordant and neutral to low positive density with diffuse boundaries.

Fabric Group 4: Very coarse with greenschist

Sample ID	Region of Deposition	Vessel Type
Acropolis 13/34	Attica	Semi-globular kylix
Alimos 12/73	Attica	Pithoid jar
Alimos 12/75	Attica	Pithoid jar
Alimos 13/10	Attica	Pithos
Plaka 10/19	Attica	Pithoid Jar
Plaka 10/20	Attica	Pithoid Jar
Plaka 10/21	Attica	Pithoid Jar
Plaka 10/22	Attica	Pithoid Jar
Plaka 10/23	Attica	Pithoid Jar
Plaka 10/24	Attica	Pithoid Jar

Voids

Predominantly equant mesovughs and mesovesicles. Few macrovughs. They have no preferred alignment and are open to double spaced.

Matrix

Moderately heterogeneous micaceous, calcareous micromass. Dark brown to yellowish brown in XP (50x) and dark brown to brownish yellow in PPL (50x). Plaka 10/20 is dark red-brown in XP (50x) and reddish brown in PPL (50x). Optically active to inactive.

Inclusions

$c:f:v_{= 25\mu m}$ – 35:50:15-31:63:6
Coarse fraction – 2.96 - 0.15 mm long axis.
Fine Fraction – 0.15 - 0.01 mm long axis

Predominantly EL., few EQ. SR-SA. Single-spaced or less. Weak long axis alignment oriented parallel to vessel margins. Strongly bimodal with moderate-poor sorting of coarse fraction and moderate-well sorting of fine fraction.

Coarse Fraction

Predominant	Low grade pelitic greenschist. *Muscovite chlorite schist.* Size: <2.40 mm long axis. Mode: 0.82 mm long axis. EQ. EL. SR-SA. The dominant rock fragments consist of muscovite, quartz, rare chlorite and biotite, and opaque minerals. Very few specimens have very wavy foliation. Few fragments are closer to phyllite than schist, but they are the same rock. The amount of quartz and mica concentrations vary as the dominant mineral feature of the rock fragment. Some are quartz-rich and some are mica-rich.
Frequent	Quartzite and Polycrystalline Quartz. Size: <2.96 mm long axis. Mode: 0.45 mm long axis. EQ. EL. SR-SA. Sub- to euhedral. Strongly related to metamorphic rock fragments. Very few quartzite has small bits of Fe-rich material in short veins. Undulose to straight extinction.
Common	Quartz. Size: <0.33 mm long axis. Mode: 0.17 mm long axis. EQ. SR-SA. Euhedral. Straight to undulose extinction.
Common to Very Few	Opaques. Size: <1.12 mm long axis. Mode: 0. 19 mm long axis. EL. EQ. Distorted. WR-R. Possibly related to the opaque inclusions in the schist fragments. Mica Laths. Muscovite. Size: <0.40 mm long axis. EL. SA.
Few to Absent	Marl. Size: <1.34mm long axis. Mode: 0.60 mm long axis. EQ. SR. Very weathered with gradation into mudstone. Few specimen have voids and rare med. silt-sized quartz, albite, mica lath and mica schist (Plaka 10/23) inclusions. Absent in Plaka 10/20.
Rare to Absent	Chert. Size: 1.98 mm long axis. EQ. SR. anhedral.

Fine Fraction

Predominant	Mica laths Quartz
Frequent	Metamorphic rock fragments
Common	Quartzite/Polycrystalline quartz
Few	Opaques
Very few	Marl/mudstones

Comment

The only peculiar feature in this fabric is the presence of marl/mudstones in the matrix. These do not appear to be temper, but are likely to be an indication of clay mixing with the dominant micaceous groundmass. These mudstones are similar in texture and composition to samples Plaka 10/33-35, 37-39 in FG 2.

Fabric Group 5: Micrite

Sample ID	Region of Deposition	Vessel Type
Acropolis 13/35	Attica	Cup
Alimos 12/71	Attica	Pithoid jar
Alimos 12/72	Attica	Pithoid jar
Alimos 12/74	Attica	Pithoid jar
Alimos 12/80	Attica	Pithoid jar
Plaka 10/25	Attica	Pithoid jar
Plaka 10/26	Attica	Pithoid jar
Plaka 10/27	Attica	Pithoid jar
Plaka 10/28	Attica	Pithoid jar
Plaka 10/30	Attica	Pithoid jar
Plaka 10/31	Attica	Pithoid jar

Voids

Predominately mesovesicles with few mesovughs and very rare macro- and megavughs. Few elongate planar voids with dark infilling and boundaries; rare plant matter left in void centre. Randomly oriented with no preferred alignment. Few to autochthonous secondary calcite lining void borders and partially to completely filling voids.

Matrix

Coarse clay matrix derived from mica schist parent material. Heterogeneous due to the secondary calcite aggregates and striations. Orangish-dark brown in XP and dark brown in PPL (x50). No differentiation between core and margins. Matrix is optically active.

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 7:72:21
Coarse Fraction – 1.52 – 0.16 mm long axis.
Fine Fraction – 0.16 – 0.16 mm long axis.

EQ. El. WR-A open-spaced, poorly sorted inclusions with moderate-weak bimodal grain size distribution.

Coarse Fraction

Frequent	*Quartz*. Size: 0.45-0.16 mm long axis. Mode: 0.20 mm long axis. EQ. R-SR. Undulose extinction.
	Mica laths. *Muscovite* and *Biotite.* Size:0.45-0.16 mm long axis. Mode: 0.16 mm long axis. EL. SA-A.
Common	Marl. Size: <1.40 mm long axis. Mode: 0.25 mm long axis. ER. WR-R. Fine grain micritic aggregates. Rare inclusions of muscovite mica, biotite mica, or quartz. Same as TCF 2?
Few	Argillaceous Rock Fragments. Size: <1.52 mm long axis. Mode: 0.20 mm long axis. EQ. Rare distorted fragments. WR-R. Clear boundaries, high optical density with concordant matrix features. Brownish red to dark red brown in colour in XP (50x) and brown to dark brown in PPL (50x). Rarely opaque. Quartz and mica inclusions occur frequently.
Rare	*Quartzite*. Size: <0.50 mm long axis. EQ. SR-SA. Undulose extinction. Part of greenschist. Pelitic greenschist. Size: <0.65 mm long axis. EL. SA-A Muscovite and biotite foliates with quartzite and opaques.
Very Rare	Feldspars. *Orthoclase*. Size: <0.80 mm long axis. EQ. SR. Simple twinning. Heavily weathered/altered.

Fine Fraction

Dominant	Mica laths
Frequent	Quartz
Common	Calcite
	TCFs
Very Rare	Amphiboles

Textural Concentration Features

TCF 1: Brownish-red to greyish brown in XP (50x). EQ. WR-SR. Neutral to moderate optical density. Diffuse to merging boundaries. Contain small fragments of quartz, white mica, opaques, calcite, (clino?)zoisite, metamorphic rock fragments, chert.

TCF 2: Creamy beige, appear highly calcareous. EQ. R-SR. Neutral optical density. Diffuse boundaries. Contain small fragments of quartz, calcite, opaques, mica, feldspar, rock fragments. Calcareous mudstone? Marl?

Comment

TCF 2 may be the same as the degraded marl in FG 4. FG 4 and 5 are so similar in composition that they are probably the same fabric. They are clearly produced at the same location, perhaps the difference in marl to greenschist ratio is due to temporal perimeters.

Fabric group 6A: Sandstone, metasandstone and micrite

Sample ID	Region of Deposition	Vessel Type
Alimos 12/85	Attica	Chytra
Alimos 12/86	Attica	Chytra
Alimos 12/87	Attica	Chytra
Alimos 12/89	Attica	Chytra
Alimos 12/90	Attica	Griddle pan
Alimos 12/91	Attica	Chytra
Alimos 12/92	Attica	Chytra
Alimos 12/93	Attica	Chytra
Alimos 12/94	Attica	Askos
Alimos 12/97	Attica	Chytra
Alimos 12/108	Attica	Spouted krater
Alimos 12/109	Attica	Basin
Plaka 10/06	Attica	Closed vessel

Voids

Predominantly elongated mesovughs that are open spaced and have a preferred orientation parallel to the vessel margins. There are common equant micro- and mesovughs and few micro- to mesovesicles that are open to double spaced and have no preferred orientation. Macro voids are very rare. Autochthonous secondary calcite is rarely visible lining void walls.

Matrix

The micromass is composed of a predominantly heterogeneous micaceous matrix that includes quartz and feldspar. The matrix is composed of grain sizes ranging from fine to coarse sand. Colour varies from dark red brown to yellow red-brown in XP (50x) and dark brown to pale red-brown in PPL (50x). The matrix is optically slightly active to active and few samples display moderate optical activity. Secondary calcite is frequently observed on the external margins of the vessels and commonly aggregated around void walls and in cracks. Autochthonous secondary calcite is rarely present as micrite partially lining void walls or as partial rings surrounding limestone inclusions.

Inclusions

$c:f:v_{=20\mu m}$ – 35:53:12-40:56:4
Coarse fraction – 3.92-0.16 mm long axis.
Fine fraction – 0.16-0.04 mm long axis.

Inclusions are bimodal, single to double spaced and poorly sorted. The coarse fraction is frequently EL. SR-A with few EQ. SA. The fine fraction is EQ. SA-A and much more densely packed. Elongated inclusions have a clear preferred axis aligned parallel to the vessel margins.

Coarse fraction

Frequent	Sandstones. *Arenite* and *Arenaceous metasandtone*. Size: 3.92-0.2 mm long axis. Mode: 0.96 mm long axis. EL. EQ. SR-A. Granoblastic texture with bands of Fe-rich minerals (mica). Feldspars are between 5-10% of entire composition. Grain size varies from coarse to fine sand and the mica in the matrix, predominantly biotite with few white mica laths, grain size changes proportionally to quartz and feldspar grains. Grades between arenite and arenaceous metasandstone yet appear to have the same parent rock material. Metasandstone has distinctive foliation and can have wavy banded zones. Porphyroclasts of quartz and feldspars occur between bands. Finer grained fragments have lenses of medium sized quartzite. EQ. A. opaque inclusions. Likely part of same rock. *Athens Schist.*
Common	Quartz. Size: 3.6-0.16 mm long axis. Mode: 0.20 mm long axis. EQ. few EL. SA. Straight and undulose extinction. Predominantly euhedral, few subhedral. Poly crystalline quartz is present but has been quantified as fragments of sandstone.
Few to very few	Greywacke. Size: 3.12- 0.24 mm long axis. SA. Equant to elongate. Fine sand to coarse silt –sized inclusions of K-feldspar, plagioclase, phyllite and quartzite fragments set in a fine clayey Fe-rich red matrix (5-90%).Commonly the fragments grade into opaque Fe-rich mudstone with nearly 100% matrix. Many of these fragments have a single flat edge with more matrix on this side. This feature is suggestive of iron pan deposits that form due to particle precipitation that occurs naturally during diagenesis. Related to Fe-rich opaques.
Few to absent	Marl. Size: 1.76-0.32 mm long axis. Mode: 0.60 mm long axis. EQ. SR. Micrite with medium sand to fine silt sized

	quartz, feldspar and rare mica lath inclusions. Rarely red-brown TCF inclusions (Alimos 12/89).
Very few to absent	Calc-silicate sandstone. Size: 2.00-0.24 mm long axis. Mode: 0.16 mm long axis. EQ. EL. R. Fine silt sized inclusions of quartz and feldspar.
Rare	Opaques. Size: 1.92 mm long axis. Mode: mm long axis. EL. R. Fe-rich. Coarse silt size amphibole inclusion.
Rare to absent	Chert. Size: 0.96- 0.28 mm long axis. EQ. SA. Related to arenaceous metasandstone. Few demonstrate metamorphism (stretched grains and banding in PPL, see Alimos 12/58).
Very rare to absent	Phyllite. Size: 1.04 mm long axis. EL. SR. Optically active.

Fine fraction

Frequent	Plagioclase feldspar
	Quartz/quartzite
Common	Sandstone/metasandstone
	White mica.
	Micrite
Few	Opaques
Very rare	Amphibole

Textural concentration features

There is an isotropic TCF with frequent micrite inclusions. It is EQ. rarely EL. SR. with clear boundaries and low negative optical density. It appears to be altered micritic limestone where the micromass has devitrified or been replaced by isotropic minerals.

Acropolis 13/09 has several striations creating a striped texture of light and dark colours in PPL. In XP these striations appear are yellow-brown and optically active and concordant.

Comment

Matrix appears to be a more coarse and noncalcareous variation of FG 2.

Fabric Group 6B: Silty with metasandstone

Sample ID	Region of Deposition	Vessel Type
Acropolis 13/09	Attica	Griddle pan
Alimos 12/88	Attica	Tripod cooking pot

Voids

Frequent open spaced microvesicles, few mesovesicle and very few equant mesovughs with no observable orientation. Acropolis 13/09 has more frequent elongate macrovughs with partially autochtonous secondary calcite filling.

Matrix

The micromass is composed of medium silt and smaller sized micrite particles in a predominantly heterogeneous micaceous matrix that includes quartz and feldspar. The matrix is composed of grain sizes ranging from medium silt to fine sand. Dark red brown in XP (50x) and dark brown in PPL (50x). The matrix is optically moderately active to active. Secondary calcite is only observed on the exterior margins of calcareous inclusions. Acropolis 13/09 has several striations of differing colour and composition.

Inclusions

$c:f:v_{=20\mu m}$ – 45:50:5
Coarse fraction – 3.2-0.16 mm long axis.
Fine fracture -- <0.16 mm long axis.

The inclusions are identical to FG 6 but there are fewer of them in the coarse fraction above 0.2 mm. The majority of the inclusions are silicates with a mode of <0.16 mm long axis.

Comment

Variant of FG 6A.

Fabric Group 6C: Greywacke, metasandstone and phyllite

Sample ID	Region of Deposition	Vessel Type
Acropolis 13/36	Attica	Tripod cooking pot

Voids

Same as FG 6A

Matrix

The matrix is much more calcareous than FG 6A as can be observed by the higher concentration of micrite in the groundmass. The matrix is dark brown-yellow in XP (50x) and dark brown in PPL (50x). The matrix has low optical activity.

Inclusions

$c:f:v_{=20\mu m}$ – 42:54:4
Coarse fraction – 2.16-0.16 mm long axis.

Fine fraction – <0.16 mm long axis.

The composition of the inclusions are very similar to FG 6A. The coarse fraction is composed of common low-grade metasandstone, few phyllite fragments and marly aggregates, rare greywacke and opaques. The fine fraction has frequent micrite, undulose quartz and feldspar grains, common opaques and few mica laths.

Comment

Variant of FG 6A.

Fabric Group 6D: Silty with marl

Sample ID	Region of Deposition	Vessel Type
Alimos 12/95	Attica	Cooking pot lid

Voids

The voids are commonly elongated meso- and macrovughs that are orientated parallel to the section margins. There are very few equant meso- and microvughs that have no detected orientation. The elongated vughs follow are arranged in a linear pattern across the entire section.

Matrix

Same as FG 6B

Inclusions

The inclusions are the same as all the subgroups of FG 6 however the micrite/marl fragments are altered and have less birefringence and thus are much darker yellowy-brown in colour.

Comment

Variant of FG 6A

Fabric Group 7: Poorly mixed micaceous with marl

Sample ID	Region of Deposition	Vessel Type
Acropolis 13/10	Attica	Griddle pan/sieve?

Voids

There are common elongated and equant mesovughs with few equant/star-shaped megavughs. Voids are open spaced and have no observable orientation. No secondary calcite is visible in any voids.

Matrix

The matrix is heterogeneous and moderately coarse. It is highly micaceous and calcareous. The ground mass is reddish yellow-brown in XP (50x) and yellow-brown in PPL (50x). The matrix is optically active.

Inclusions

$c{:}f{:}v_{=20\mu m}$ 20:74:6
Coarse fraction – 2.32-0.20 mm long axis.
Fine fraction – <0.2 mm long axis.

Inclusions are predominantly rounded and equant with common subangular and elongated grains. The inclusions are very weakly bimodal with the coarse fraction is loosely packed, open-spaced and has no preferred orientation. This fraction is composed of common rounded marl aggregates that have silt-sized quartz, feldspar and mica lath inclusions (<2.32 mm) and subangular white mica laths (<0.37 mm; mode = 0.20 mm), few sub-angular mono- and polycrystalline quartz with undulose extinction (<0.45 mm, mode = 0.20 mm), rounded equant biotite (<0.24) and rare elongated and rounded opaques (<0.22 mm). The fine fraction is much more densely packed and is dominated by white mica laths and biotite grains with frequent marl aggregates, common quartz and feldspar and few opaques.

Comment

Variant of FG 6.

Fabric Group 8: Metasandstone, marl and shale

Sample ID	Region of Deposition	Vessel Type
Acropolis 13/37	Attica	Tripod cooking pot

Voids

Common equant and elongated mesovughs, few elongated macrovughs and rare amorphous megavughs. The elongated voids have a preferred orientation parallel to the vessel margins. No secondary calcite is visible in the voids.

Matrix

Moderately fine and heterogeneous mixture of micaceous and calcareous components. The groundmass is dark yellow-brown in XP (50x) and brown in PPL (50x). The matrix has moderately high optical activity.

Inclusions

$c{:}f{:}v_{=10\mu m}$ – 38:55:7

Coarse fraction – 2.15-0.15 mm long axis.
Fine fraction – <0.15 mm long axis.

Frequently elongate and subangular with common equant inclusions that are subrounded to subangular. Inclusions are poorly sort with strong bimodal grain size distribution. The coarse fraction is poorly packed and double-spaced while the fine fraction is well sorted and single to closed space. The inclusions have no observable preferred orientation.

Coarse fraction

The coarse fraction is composed of frequent metamorphic rock fragments that include arenaceous metasandstone (1.12-0.20 mm; mode = 0.30 mm), chloritic wavy banded phyllite (1.40-0.35 mm) and quartzite (1.65-0.20 mm; mode 1.00 mm), few subangular to subrounded quartz with undulose extinction (<1.30 mm) and subangular plagioclase feldspar (<1.00 mm), very few micrite aggregates/marl (<1.35 mm) and rare epidotes (0.22 mm).

Fine fraction

The fine fraction is dominated by white mice laths and micrite. There are common quartz and feldspars, few metamorphic rock fragments and rounded opaques and rare epidote group minerals.

Comment

Very similar to FG 6, but rock inclusions are not identical. Compatible with Attic geology.

Aeginetan Fabrics

Fabric Group 9A: Noncalcareous volcanic

Sample ID	**Region of Deposition**	**Vessel Type**
Acropolis 13/02	Attica	Chytra
Acropolis 13/06	Attica	Spouted krater
Alimos 12/98	Attica	Tripod cooking pot
Alimos 12/99	Attica	Chytra
Alimos 12/100	Attica	Chytra
Alimos 12/101	Attica	Chytra
Alimos 12102	Attica	Tripod cooking pot
Alimos 12/103	Attica	Chytra
Alimos 12/104	Attica	Chytra
Alimos 12/105	Attica	Chytra
Alimos 12/106	Attica	Chytra
Ayios Konstantinos 12/01	Troezinia	Chytra

Ayios Konstantinos 12/02	Troezinia	Chytra
Ayios Konstantinos 12/03	Troezinia	Chytra
Ayios Konstantinos 12/04	Troezinia	Chytra
Ayios Konstantinos 12/05	Troezinia	Chytra
Ayios Konstantinos 12/06	Troezinia	Chytra
Ayios Konstantinos 12/07	Troezinia	Chytra
Ayios Konstantinos 12/08	Troezinia	Chytra
Ayios Konstantinos 12/09	Troezinia	Chytra
Ayios Konstantinos 12/10	Troezinia	Tripod cooking pot
Ayios Konstantinos 12/11	Troezinia	Chytra
Ayios Konstantinos 12/12	Troezinia	Chytra
Ayios Konstantinos 12/13	Troezinia	Chytra
Ayios Konstantinos 12/14	Troezinia	Jar
Ayios Konstantinos 12/15	Troezinia	Jar
Ayios Konstantinos 12/16	Troezinia	Chytra
Ayios Konstantinos 12/17	Troezinia	Chytra
Ayios Konstantinos 12/18	Troezinia	Tripod cooking pot
Ayios Konstantinos 12/24	Troezinia	Chytra
Ayios Konstantinos 12/27	Troezinia	“Offering table”
Ayios Konstantinos 12/56	Troezinia	Closed vessel
Euripides Cave 12/13	Salamis	Tripod cooking pot
Dokos 12/01	Agro-Saraonic	Two-handled, flat base amphora
Dokos 12/02	Argo-Saronic	Cooking jar
Dokos 12/03	Argo-Saronic	Chytra
Dokos 12/04	Argo-Saronic	Jar
Kanakia 07/46	Salamis	Basin
Kanakia 07/47	Salamis	Basin
Kanakia 07/48	Salamis	Basin
Kanakia 07/49	Salamis	Basin
Kanakia 07/50	Salamis	Basin
Kanakia 07/51	Salamis	Basin
Kanakia 07/52	Salamis	Tripod cooking pot
Kanakia 07/53	Salamis	Tripod cooking pot
Kanakia 07/54	Salamis	Tripod cooking pot
Kanakia 07/55	Salamis	Tripod cooking pot
Kanakia 07/56	Salamis	Tripod cooking pot
Kanakia 07/57	Salamis	Tripod cooking pot
Kanakia 07/58	Salamis	Tripod cooking pot

Kanakia 07/59	Salamis	Cooking jar
Kanakia 07/60	Salamis	Cooking jar
Kanakia 07/61	Salamis	Cooking jar
Kanakia 07/62	Salamis	Cooking jar
Kanakia 07/63	Salamis	Cooking jar
Kanakia 07/64	Salamis	Lid
Kanakia 07/65	Salamis	Lid
Kanakia 07/72	Salamis	Medium closed pot
Kanakia 07/73	Salamis	Medium closed pot
Kanakia 07/74	Salamis	Pithoid jar
Kanakia 07/77	Salamis	Pithoid jar
Kanakia 10/08	Salamis	Cooking ware
Kanakia 10/09	Salamis	Cooking ware
Kanakia 10/10	Salamis	Cooking ware
Kanakia 10/11	Salamis	Cooking ware
Kanakia 10/12	Salamis	Cooking ware
Kanakia 10/13	Salamis	Closed vessel
Plaka 10/01	Attica	Chytra
Plaka 10/03	Attica	Chytra
Plaka 10/04	Attica	Chytra
Plaka 10/05	Attica	Chytra

Voids

Predominantly elongated mesovughs with frequent distorted macrovughs and elongated microvughs. Elongated micro- and mesovughs commonly display a preferred orientation parallel to the vessel margins.

Matrix

The matrix is noncalcareous and fairly coarse. Sample Plaka 10/04 has rare micrite inclusions and secondary calcite in a few voids and on the margins. Matrix contains r-sr opaque red TCFs. The colour of the matrix varies considerably at the margins and between margins and core. Margins tend to range between yellowish brown to reddish brown to dark red-brown to yellowish grey in XP and light brown to red-brown to brown in PPL (x50). The core varies between dark brown to yellowish grey in XP and grey to dark brown in PPL (x50). The matrix is predominately optically active and sometimes slightly active.

Inclusions

$c:f:v_{=20\mu m}$ – 48:42:10 - 42:55:3
Coarse Fraction – 4.7-0.2 mm long axis
Fine Fraction – 0.2-0.01 mm long axis

Predominately EQ. with some EL. Single-spaced and less. Random orientation; not aligned to the margins. Bimodal, poorly sorted grain-size distribution.

Coarse Fraction

Predominant – Frequent	Intermediate igneous rock fragments; EL. EQ. A-SR. 4.7-0.20 mm *Porphyritic Andesite-Dacite* (the amount of quarts fragments and quartz phenocryst may indicate a more intermediate-acid composition). Fragments appear fresh with occasional altered phenocrysts of plagioclase, amphibole, opaque (magnetite?), pyroxene, olivene?, and quartz. Phenocrysts are euhedral and embedded within a matrix is composed of laths and particles of pyroxenes creating a granular texture that may appear glassy.
Frequent	*Feldspars*. EQ. EL. A-SR. <1.6 mm, mode = 0.32 mm. Predominately zoned plagioclase; frequent orthoclase with simple twinning; andesine?. Euhedral. More weathered specimens have a mottled or 'sieve' textured.
Frequent to Very Rare	*Amphiboles*. EL. A. <0.65 mm, mode = 0.24 mm. *Horneblende* is the dominant mineral in the group, but there are the occasional *Pargasite* differentiated by a less intense pleochroism of greenish brown or greenish yellow. Horneblende has intense green or red brown pleochroism. Euhedral in shape with discernible cleavages.
Common to Very Few	*Quartz*. EQ. EL. SA-R. <0.45 mm, mode = 0.25 mm. Predominantly equant and euhedral in shape. Frequently undulose extinction. There is a strong likelihood that many, if not all, of the quartz inclusions are feldspars that do not display twinning, zoning or cleavage.
Few to Rare	*TCFs*. EQ. SR-WR. <0.75 mm, mode = 0.20mm. High to moderately neutral optical density. Very clear boundaries. Discordant. Frequently spheroid and opaque with occasional rims that are dark red, iron-rich clay-like material.
Very Few to Absent	*Biotite Mica*. EL. A-SA. <0.50 mm.
Very Rare to Absent	*Micrite.* <0.24 mm. No fossil material remains. Only in sample 10/04.

Fine Fraction

Dominant	Amphiboles
Frequent	Feldspars
Frequent to Few	Rock fragments
Few to Absent	Quartz; TCFs
Very Few to Absent	Biotite

Comment

Compatible with Gauss and Kiriatzi (2011) FG 1A.

Fabric Group 9B: Noncalcareous volcanic with organics

Sample ID	Region of Deposition	Vessel Type
Ayios Konstantinos 12/20	Troezinia	Tub
Ayios Konstatninos 12/21	Troezinia	Tub
Ayios Konstantinos 12/25	Troezinia	Pithoid jar
Ayios Konstantinos 12/26	Troezinia	Pithos
Dokos 12/09	Argo-Saronic	Tub
Kanakia 07/75	Salamis	Pithos
Kanakia 07/76	Salamis	Pithoid jar
Kanakia 07/78	Salamis	Pithoid jar
Kanakia 07/79	Salamis	Pithoid jar

Voids

Frequent to few (Dokos 12/9) curved and elongate macroplanar voids. Voids are single- to double-spaced and have a general long axis orientation parallel to vessel margins. The voids are characteristic of organic material that was burnt out during firing. All samples from Ayios Konstantinos (12/20, 21, 26) have black rings surrounding the void.

Matrix

Same as FG above

Inclusions

Same as FG above

Comment

This fabric is identical to FG 9A with the addition of organic vegetal matter observed in the void microstructure. The vegetal matter is intentionally added as temper. This fabric is used in the construction of large tubs and a pithos (Dokos 12/9).

Fabric Group 10Af: Fine calcareous volcanic

Sample ID	**Region of Deposition**	**Vessel Type**
Euripides Cave 12/17	Salamis	Deep bowl
Kalamianos 12/21	Corinthia	Stemmed bowl
Lazarides 12/15	Aegina	Deep bowl

Voids

Predominantly microvesicles and elongate microvughs with few elongate macrovughs. Common partial autochthonous secondary calcite in the form of micrite grains lining void wall and partially or completely infilling. Voids have a preferred long axis orientation parallel to vessel margins.

Matrix

Moderately heterogeneous calcareous micromass. Yellow brown to olive brown in XP (50x) and grey brown to greyish olive brown in PPL (50x). Mild colour changes can be seen in PPL where clay is not completely mixed. Optically slightly active. Partial autochthonous secondary calcite is visible as swaths throughout the micromass. Microfossils are present in the micromass.

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 6:90:4
Size: <1.30 mm long axis. Mode: >0.05 mm long axis

EQ. EL. SR-A. Open spaced, well sorted with unimodal grain size distribution.

Dominant	Feldspar/Quartz. Size: <0.22 mm long axis. Mode: 0.04 mm long axis. EQ. SA-A. It is difficult to differentiate between quartz and feldspar at this size to sufficiently quantify each mineral individually. Quartz has straight extinction. Feldspar has polysynthetic twinning and zoning.
Common	Calcite. Size: <0.36 mm long axis. Mode: 0.08 mm long axis. EQ. SR. Micritic aggregates. Some crystals.
Few to very rare	Volcanic rock. *Amphibole andesite.* Size: <0.80 mm long axis. Mode: 0.40 mm long axis. EQ. A. Glassy matrix with plagioclase and brown hornblende amphibole phenocrysts. The same volcanic rock as *Noncalcareous volcanic fabric*.

	Opaques. Size: 0.48 mm long axis. Mode: 0.35 mm long axis. EQ. EL. SA.
Rare	Siltstone. Size: <0.96 mm long axis. EQ. SR. Clear boundaries, neutral optical density. Matrix (5%) is grey brown in XP (50x) and grey olive brown in PPL (50x). Inclusions are fine sand to medium silt sized plagioclase, quartz, micrite, amphibole and mica. Part of clay mix?
	Brown amphibole. *Hornblende*. Size: <0.48 mm long axis. EL. A.

Textural concentration features

TCFs are rare to very rare and come in two types.

TCF 1: Fe-rich (Red-brown in both XP and PPL, 50x) EQ. EL. WR-R. clay pellets with clear boundaries and high positive optical density. Very rare fine silt silicate inclusions. Size: 0/72 mm long axis. Mode: 0.24 mm long axis. These appear to be natural textural features.

TCF 2: Very rare orange-yellowish brown in XP (50x) and yellowy brown in PPL (50x). EL. SR. Size: 0.96 mm long axis. Clear to diffuse boundaries, neutral to low positive optical density. Very rare fine silt sized silicate inclusions.

Comment

Cf. FG 2Af, Guass and Kiriatzi 2011: 100-101

Fabric Group 10Am: Moderately fine calcareous volcanic

Sample ID	Region of Deposition	Vessel Type
Euripides Cave 12/01	Salamis	Amphora/hydria/jug

Table I.16: Moderately fine calcareous volcanic fabric sample.

Voids

Predominantly micro- and mesovesicles and few moderately elongated mesovughs. Open spaced with crude preferred orientation along long axis of elongated voids (vughs). Rare autochthonous secondary calcite observed as micrite lining void walls.

Matrix

Same as above

Inclusions

$c:f:v_{=20\mu m}$ -- 15:80:5
Size: <1.45 mm long axis. Mode: 0.35 mm long axis.

EQ. SA-A. Double to single spaced, moderately sorted with strong unimodal grain size distribution. No preferred alignment. All inclusions are considered together.

Frequent	Volcanic rock. *Amphibole andesite*. Size: <1.45 mm long axis. Mode: 0.35 mm long axis. Same volcanic rock as FG 9A, 9B and 10Af.
Common	Plagioclase feldspar. *Andesine* and *Albite*. Size: <0.80 mm long axis. Mode: 0.40 mm long axis. Polysynthetic twinning and zoning.
Few	Amphibole. *Hornblende*. Size: <0.32 mm long axis. Mode: 0.24 mm long axis. EL. SA-A. Brown, moderate pleochroism.
	Opaque. Size: <0.32 mm long axis. Mode: >0.04 mm long axis. EQ to elongated amorphous pellet.
Very few	Calcite. Size: <0.56 mm long axis. Mode: 0.20 mm long axis. EQ. R. Micrite aggregates.
	Serpentinite. Size: <0.64 mm long axis. Mode: o.32 mm long axis. EQ. SR-SA.
Rare	Chert. Size: <0.35 mm long axis. EQ. SA.
Very Rare	Clinopyroxene. *Hypersthene*. Size: 0.20 mm long axis. EL. SR.

Textural concentration features

There is a large concentration of fine inclusions in the centre of the section. It is >5 mm long axis and have diffused boundaries. It is concordant to the matrix, and appears to be a part of the matrix itself.

Comment

Cf. FG 2Am, Gauss and Kiriatzi 2011: 101-102.

Fabric Group 10B: Calcareous volcanic

Sample ID	Region of Deposition	Vessel Type
Ayios Konstantinos 12/52	Troezinia	Deep bowl
Ayios Konstantinos 12/53	Troezinia	Carinated kylix
Ayios Konstantinos 12/55	Troezinia	Jar
Ayios Konstantinos 12/65	Troezinia	Carinated Kylix
Eleusis 12/05	Attica	Jar
Eleusis 12/12	Attica	Hydria
Kanakia 07/31	Salamis	Deep bowl
Kanakia 07/33	Salamis	Deep bowl
Kanakia 07/40	Salamis	Kylix
Kanakia 07/44	Salamis	Basin
Kanakia 07/83	Salamis	Deep bowl
Kanakia 07/90	Salamis	Shallow bowl
Lazarides 12/01	Aegina	Deep bowl
Lazarides 12/02	Aegina	Deep bowl
Lazarides 12/03	Aegina	Deep bowl
Lazarides 12/04	Aegina	Deep bowl
Lazarides 12/05	Aegina	Deep bowl
Lazarides 12/07	Aegina	Deep bowl
Lazarides 12/08	Aegina	Deep bowl
Lazarides 12/10	Aegina	Deep bowl
Lazarides 12/14	Aegina	Deep bowl
Lazarides 12/17	Aegina	Krater
Lazarides 12/18	Aegina	Krater
Lazarides 12/19	Aegina	Deep bowl
Lazarides 12/20	Aegina	Deep bowl
Lazarides 12/21	Aegina	Deep bowl
Lazarides 12/22	Aegina	Deep bowl
Lazarides 12/23	Aegina	Deep bowl
Lazarides 12/25	Aegina	Deep bowl
Lazarides 12/26	Aegina	Deep bowl
Lazarides 12/27	Aegina	Skyphoid krater
Lazarides 12/30	Aegina	Amphora

Voids

Voids are predominantly equant mesovughs with common to absent microvesicles, few elongated macrovughs and rare mesovesicles. Voids have a preferred orientation along the crude long axis parallel to vessel margins with the exception of Lazarides 12/08 that exhibits common mesovesicles with random orientation. Commonly autochthonous secondary calcite is observed in the form of micrite lining void walls. Voids are commonly filled with a silty sediment.

Matrix

Moderately heterogeneous calcareous micromass. Pale yellow brown to olive brown in XP (50x) and grey brown in PPL (50x). Autochthonous secondary calcite is prominent in the micromass and frequently obscures micromass colour. Optically active to moderately optically active. Foraminifera microfossils are frequently found throughout the micromass.

Inclusions

c:f:v$_{=20\mu m}$ – 15:77:8-20:74:6
Size: <2.24 mm long axis. Mode: <0.10 mm long axis

EQ. Rarely EL. SA-A. Single to double spaced, well to moderately well sorted with unimodal grain size distribution.

Predominant	Quartz/Feldspar. Size: <0.80 mm long axis. Mode: <0.10 mm long axis. EQ. SA-A. At this size it is too difficult to distinguish between quartz and feldspars for quantification. Quartz has straight extinction. Feldspar has polysynthetic twinning and zoning.
Frequent	Calcite. *Micrite* and *Holocrystalline calcite*. Size: <0.72 mm long axis. Mode: <0.20 mm long axis. EQ. R-SA.
Frequent to few	Brown amphibole. *Hornblende*. Size: <0.40 mm long axis. Mode: <0.02 mm long axis.
Common	Microfossils. *Foraminifera.* Various types. Very rare *Diatom* (Ayios Konstantinos 12/53). Shell: 2.24 mm long axis (Lazarides 12/23).
Few to very few	Opaques. Size: <0.64 mm long axis. Mode: <0.10 mm long axis. WR-SR. Very rare EL. SA.
Very few to absent	Volcanic rock. Size: <0.72 mm long axis. Mode: 0.45 mm long axis. EQ. EL. SA-A. Similar volcanic rock to FG 9A and FG 9B. Difficult to distinguish at this size, but they appear to be andesite (*Hypersthene andesite*?).
	Serpentinite. Size: <0.32 mm long axis. Mode: <0.20 mm long axis. EQ. A.

Rare to absent	Pyroxene. *Hypersthene*. Size: 0.24 mm long axis.

Textural concentration features

There are two distinctive textural features in this fabric. Both are visible in Lazarides 12/18.

TCF 1: Fe-rich pellet. Reddish brown to opaque in XP (50x) and dark reddish brown to opaque in PPL (50x). Size: <2.24 mm long axis. EL. EQ. Clear boundaries and high positive optical density. Medium to fine silt sized silicate inclusions. This occurs in nearly every sample.

TCF 2: ARF. Yellow-orangish brown to olive brown in XP (50x) and pale yellow brown in PPL (50x). Size: <0.96 mm long axis. EL. SR-A. Clear boundaries and low negative to neutral optical density. Calcareous and micaceous matrix with fine silt sized silicate inclusions.

Comment

Cf. FG 2B, Gauss and Kiriatzi 2011: 102-104. Eleusis 12/05, 12 and Ayios Konstantinos 12/55 have more coarse inclusions comparably to the rest of the fabric.

Corinthian Fabrics

Fabric Group 11: Fine greenish firing with biotite

Sample ID	Region of deposition	Vessel type
Acropolis 13/12	Attica	Carinated kylix
Acropolis 13/17	Attica	Krater
Acropolis 13/25	Attica	Closed vessel
Acropolis 13/27	Attica	Open vessel
Ayios Konstantinos 12/28	Troezinia	Bovine figurine
Ayios Konstantinos 12/31	Troezinia	Bovine figurine
Ayios Konstantinos 12/32	Troezinia	Bovine figurine
Ayios Konstantinos 12/33	Troezinia	Bovine figurine
Ayios Konstantinos 12/35	Troezinia	Bovine figurine
Ayios Konstantinos 12/37	Troezinia	Deep bowl
Ayios Konstantinos 12/46	Troezinia	Open vessel
Ayios Konstantinos 12/51	Troezinia	Basin/Deep bowl
Ayios Konstantinos 12/62	Troezinia	Deep bowl
Ayios Konstantinos 12/63	Troezinia	Deep bowl
Alimos 12/11	Attica	Alabastron
Alimos 12/17	Attica	Kalathos
Alimos 12/113	Attica	Deep bowl

Euripides Cave 12/19	Salamis	Fine stirrup jar
Euripides Cave 12/20	Salamis	Fine stirrup jar
Euripides Cave 12/21	Salamis	Stemmed bowl
Dokos 12/06	Argo-Saronic	Kylix
Dokos 12/10	Argo-Saronic	Squat stirrup jar
Eleusis 12/03	Attica	Jar
Eleusis 12/08	Attica	Kylix
Eleusis 12/14	Attica	Stirrup jar
Kalamianos 12/16	Corinthia	Kylix
Kalamianos 12/18	Corinthia	Deep/stemmed bowl
Kalamianos 12/20	Corinthia	Fine jar
Kalamianos 12/24	Corinthia	Stemmed bowl
Kalamianos 12/29	Corinthia	Askos
Kalamianos 12/31	Corinthia	Kylix
Kalamianos 12/32	Corinthia	Deep/stemmed bowl
Kalamianos 12/33	Corinthia	Deep bowl
Kalamianos 12/34	Corinthia	Deep/stemmed bowl
Kalamianos 12/35	Corinthia	Deep bowl
Kalamianos 12/36	Corinthia	Carinated Kylix
Kalamianos 12/37	Corinthia	Kylix
Kalamianos 12/39	Corinthia	Deep bowl
Kalamianos 12/41	Corinthia	Kylix
Kalamianos 12/43	Corinthia	Piriform jar
Kalamianos 12/47	Corinthia	Deep bowl
Kalamianos 12/52	Corinthia	Deep bowl
Kalamianos 12/59	Corinthia	Kylix
Kalamianos 12/62	Corinthia	Stemmed bowl
Kalamianos 12/73	Corinthia	Kylix
Kalamianos 12/74	Corinthia	Stemmed bowl
Kalamianos 12/75	Corinthia	Krater
Kanakia 07/36	Salamis	Deep bowl
Kanakia 07/37	Salamis	Deep bowl
Kanakia 07/38	Salamis	Stemmed bowl
Kanakia 07/39	Salamis	Kylix
Kanakia 07/41	Salamis	Kylix
Kanakia 07/43	Salamis	Fine stirrup jar
Lazarides 12/28	Aegina	Kylix
Stiri 12/101	Corinthia	Deep/stemmed bowl
Stiri 12/102	Corinthia	Kylix

Stiri 12/105	Corinthia	Deep/stemmed bowl
Stiri 12/108	Corinthia	Kylix
Stiri 12/109	Corinthia	Kylix
Stiri 12/125	Corinthia	Stemmed bowl
Stiri 12/126	Corinthia	Stemmed bowl
Stiri 12/127	Corinthia	Deep bowl
Stiri 12/137	Corinthia	Kylix

Voids

Predominantly elongate mesovughs with frequent microvesicles and rare macrovughs. Voids are double spaced and have a strong preferred long axis orientation parallel with vessel margins. Few samples (all kylix stems) have circular or spiral orientation.

Matrix

Very fine homogenous micaceous and micritic micromass with various textural features (see TCF section). Heavily altered by a combination of autochthonous and allochthonous secondary calcite. Micromass is olive green-brown to pale yellow in XP (50x) and pale brown in PPL (50x). Predominantly the groundmass is optically inactive with few samples optically active. Kalamianos is so rich in secondary deposits that the matrix is only visible in the optically inactive areas. Stiri 12/137 has several fragments of unmixed clay.

Inclusions

$c:f:v_{=20\mu m}$ – 2:88:10-12:85:3
Size: <2.82 mm long axis.

EQ. SR-A. Well sorted, open spaced and unimodal.

Dominant	Biotite. Size: <0.25 mm long axis. EQ. SA.
Frequent	Monocrystalline quartz. Size: < mm long axis. Mode: <0.02 mm long axis. EQ. SA. Undulose extinction.
	Plagioclase feldspar. Size: <0.25 mm long axis. EQ. SA.
	Micrite. Mode: <0.26 mm long axis. EQ. SR.
Few	Muscovite laths. Mode: <0.11 mm long axis. EL. A.
	Opaques. EL. EQ. SR. Size: 1.50-0.02 mm long axis. Mode: 0.15 mm long axis.

Few to absent	Metamorphic rock. Size: <0.90 mm long axis. EQ. SR. Quartz, feldspar, muscovite and Fe-rich opaques.
Very few to Absent	Calc-silicate siltstone. Size: <0.8 mm long axis. EQ. R. Calcareous matrix with micrite, quartz, orthoclase feldspar and serpentinite inclusions.
Rare to absent	Siltstone. Size: <2.82 mm long axis. EQ to amorphous. SR. Fe-rich matrix with micrite, quartz, mica lath, plagioclase and radiolarian microfossil inclusions. Shrink rim present.
Very Rare to absent	Microfossil. *Ostracod*.

Textural Concentration Features

There are Fe-rich opaque TCFs in nearly every sample. They are predominantly equant and rarely amorphous, have clear boundaries, moderate-low positive optical density and are concordant to the micromass of the fabric.

Comment

This is a very fine fabric with rare coarse inclusions. The fine nature of the inclusions suggests that the raw materials used to produce this fabric underwent subtractive preparation (i.e. sieving, levigation, etc.) in order to eliminate coarse particles and other contaminants. The fine grain size of the inclusions that are present make it difficult to determine a production origin, however, the radiolarian in the siltstone and other microfossils combined with the calc-silicate sandstone that includes serpentinite and the greenish firing clay suggest an origin near both ophiolite and fossiliferous neogene deposits. It must be noted that Eleusis 12/14 is a transport stirrup jar.

Fabric Group 12: Bioclastic limestone

Sample ID	Region of Deposition	Vessel Type
Euripides Cave 12/10	Attica	Medium stirrup jar
Euripides Cave 12/12	Attica	Deep bowl

Voids

Few macro- and mesovughs with long axis orientation parallel to vessel margins. Voids are open spaced. Autochthonous and partial allochthonous secondary calcite is present as lining on void walls and complete infilling.

Matrix

Fine heterogeneous calcareous matrix. Yellowy brown in XP (50x) and pale yellow brown in PPL (50x). There is frequent micrite and common clay pellet TCFs in the matrix. The matrix is optically inactive.

Inclusions

c:f:v$_{=20\mu m}$ – 35:54:11
Coarse fraction – 1.52-0.16 mm long axis.
Fine Fraction – 0.16-0.10 mm long axis.

EQ. WR-SR. Moderately well sorted and single-spaced with bimodal grain size distribution.

Frequent	B*ioclastic limestone*. Size: 1.60-0.16 mm long axis. Mode: 0.20 mm long axis. EQ. R-SR. Fine micrite matrix with elongated and sub-rounded microfossils (bivalve shells, globigerina foraminifera).
Common	Quartz. Size: 0.40- 0.16 mm long axis. Mode: .20 mm long axis. EQ. WR-SR. Mono- and polycrystalline varieties with predominately undulose extinction and strained boundaries.
	Calcareous siltstone. Size: 1.40-0.20 mm long axis. Mode:0.60 mm long axis. EQ. R-SR. Well-sorted medium-coarse silt sized grains of feldspar (Orthoclase and Albite), quartz, biotite and lithic fragments suspended in a micritic cement. Diffuse boundaries and optically neutral.
Few	Plagioclase feldspar. *Albite*. Size: 0.55-0.20 mm long axis. EQ. SR. Poikoilitic alteration with ferromagnesian mineral replacement (sericite?).
	Chert. Size: 0.50-0.16 mm long axis. EQ. SR.
Rare	Amphibole. Size: 0.25 mm long axis. EL. SA
	Opaques. Size: 0.20 long axis. EQ. SA.
Very Rare	Chlorite. Size: 0.25 mm long axis. EL. SR.

Fine Fraction

Frequent	Carbonates
Common	Calcareous siltstone
	Opaques
Few	Feldspar
	Chert

	Quartz
Rare	Mica

Textural Concentration Features

There are fine reddish brown (XP, 50x) elongate and amporhous textural features spread throughout the matrix. Mode: 0.05 mm long axis.

Comment

This fabric has a fine calcareous matrix that does not appear to be mixed. It is marked as heterogenous due to the high frequency of secondary calcite obscuring the fabric texture. Crushed bioclastic limestone has been added to the calcareous matrix as temper, while the calcareous wacke stone may be part of the matrix raw material. It is not conclusive if the limestone in each of these vessel are from the same geological deposit, rather they are formed in similar environmental conditions. These are well and high fired sherds.

Fabric Group 13: Serpentinite

Sample ID	Region of Deposition	Vessel Type
Kanakia 07/66	Salamis	Tub
Kanakia 10/15	Salamis	Tub/tile?
Plaka 10/40	Attica	Tub

Voids

Predominantly elongated macrovughs. Crude alignment parallel to margins of sample. Traces of vegetable temper. Additionally cracks that run parallel to margins of the sample. Plaka 10/40 has a 2% void ratio dominated by microvesicles with very few elongate and distorted mesovughs. Autochtonous secondary calcite lining margins to completely filling the void with micrite.

Matrix

Heterogenous matrix due to clay mixing of calcareous and non-calcareous sediments? Reddish brown to dark brown to brownish gold in XP and dark brown to dark grey brown to grey brown in PPL (x50). Plaka 10/40 has a more fine matrix. Kanakia 07/66 and 10/15 are more coarse and more heterogenous and exhibits a high degree of clay mixing. Evidence of water sieving and drying before used as a plastic material. Relic coils visible. Matrix is optically slightly active to inactive.

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 27:71:2-35:51:14

Coarse fraction – 3.20- 0.16 mm long axis.
Fine fraction – 0.16-0.10 mm long axis.

EQ. EL. WR-A. Single- to open-spaced, poorly sorted inclusions with bimodal grainsize distribution.

Coarse Fraction

Dominant	Serpentinite. Size: 3.20-0.20 mm long axis. Mode: 1.20 mm long axis. EL. EQ. SA-A. The colour ranges from low birefringence greenish greys to high first order birefringence colours, e.g. orange-red. Orange to pale orange to opaque in PPL. There is an orange-red rim on the dominant proportion of fragments. There is a varying degree of colour change, from no change (green to red) to fully changed. Frequent opaque ferromagnesian porphyroblasts suspended in the groundmass. Veining is common. Common grading into Fe-rich, opaque mudstone. Very rare specimens of relic pyroxene and olivine. Related to red mudstone.
Frequent	Quartz. Size: 2.08-0.16 mm long axis. Mode: 0.20 mm long axis.eq. euhedral. SR-SA. Undulose extinction.
Common to Very Few	Red mudstone. Size: 2.45- 0.16 mm long axis. Mode: 0.25 mm long axis. EL. EQ. SA-A. Frequent cracking and common inclusions of a mineral phenocrysts with pleochroic halos (zircon?). Grading into serpentinite? Ophiolitic.
	Gneiss. Size: 1.45-0.16 mm long axis. Strained quartzite with bands of kyanite and potphyroblasts of quartz and plagioclase (anorthite?).
Few	Tuffaceous mudstones. Size: 2.88- 0.60 mm long axis. Mode: 0.80 mm long axis. EQ. SA. Matte appearance. Milky, brownish grey colour in XP, pencil grey in PPL (50x). Can contain orange brown schlieren, rare quartz or rock fragment inclusions. Commonly microstructure is "cracked", this results in a fine, fractured appearance in PPL. Rare fragments have a volcanic "flow" in PPL. These appear linked to the heavily altered plutonic rock with devitrified glass structure. Grading into mudstone. Related to tuffaceous rock in FG 14 and FG 15.
Few to absent	Heavily altered igneous rock. Size: 2.65-0.20 mm long axis. EQ. WR-R. Sericitised matrix with relic minerals with serpentiniferous alteration. Micrite replacement of matrix is

	observed in few fragments. Related to heavily altered plutonic rock in FG 14 and FG 15(below).
Very Rare to Absent	Feldspars. Size: 0.90-0.16 mm long axis. EQ. SR. Simple twinning. Orthoclase?

Fine Fraction

Dominant	Serpentinite
Frequent	Quartz
Common	Gneiss
Few	Siltstones
	Mudstones
Very Few	Mica laths
	Opaques
Rare	Muscovite Mica

Comment

This fabric is defined by the coarse serpentinite rock fragments, tuffaceous mudstone and heavily altered igneous rock. The raw materials are derived from geologically very old deposits of tuffaceous material that is grading into mudstone and serpentiniferous deposits from ophiolite outcrops. Plaka 10/40 is higher fired and is absent of the heavily altered plutonic rocks. It is also absent of organics. However, the micromass and serpentinite are compatible to the other samples within this fabric grou and thus it was not sub-grouped.

Fabric Group 14: Volcanoclastic with and vegetal temper.

Sample ID	Region of Deposition	Vessel Type
Kanakia 07/69	Salamis	Tub
Kanakia 07/70	Salamis	Tub

Voids

Elongated macro- and megavughs. Alignment of the voids parallel to the margins of the sample surface, not so much in Kanakia 07/70, this appears to be due to the way of cutting the sherd for thin section: judging from the organic remains in the voids, this sample has been cut perpendicular to the longest axis of most of the vegetable temper, rather than parallel to them. Voids can contain organic remnants. Autochthonous secondary calcite is observed as infilling of voids with micrite. Voids are also infilled with very fine silt-sized particles.

Matrix

Semi-coarse, moderately heterogeneous micromass. Orange-brown in PPL, orange-brown to greyish orange-brown in XP (50x). Optically slightly active to inactive.

Inclusions

$c:f:v_{=20\mu m}$ – 40:53:7-43:45:12
Coarse Fraction – 5.40-0.20 mm long axis.
Fine Fraction – 0.20-0.10 mm long axis.

EQ. EL. WR-A. Single spaced or less. No alignment to margins of samples. (Weakly) bimodal, poorly sorted grain size distribution.

Coarse fraction

Frequent to common	Micritic limestone. Size: 5.4-0.20 mm long axis. Mode: 0.8 mm. EQ. EL. WR-SA. Very fine, micritic structure. Can contain iron oxides, either as euhedral crystals, as amorphous round blobs, or in veins.
Common	Tuffaceous rock; *Tuffite*. Size: 2.20-0.20 mm long axis. Mode: 0.25 mm long axis. Predominantly EQ. R-A. Matte appearance. Milky, brownish grey colour in XP, pencil grey in PPL (50x). Can contain orange brown schlieren, rare quartz or rock fragment inclusions. Commonly microstructure is "cracked", this results in a fine, fractured appearance in PPL. Rare fragments have a volcanic "flow" in PPL. These appear linked to the heavily altered plutonic rock with devitrified glass structure. Grading into mudstone.
Few to rare	Heavily altered plutonic rock. Size: 3.36-0.40 mm long axis. Mode: 1.4 mm long axis. EL. SR-A. Appear pale yellow in PPL, with darker coloured veins. The minerals are not really recognisable, however some very coarse sand to small granule sized sericitized feldspar grains that are recognisable. The fragments have speckled appearance (micrite?) and contain what might be devitrified groundmass (yellow to orange in PPL). One piece with flow-like structure in Kanakia 07/69. Rare iron rich veins. Related to tuffaceous and micritic limestone rock.
Rare	Serpentinite. Size: 0.42-0.20 mm long axis.
Very Few	Opaques. Size: 0.32-0.20 mm long axis. Mode: 0.20 mm long axis. EQ. R-SA.
Very few to very rare	Chert. Size: 2.60- 0.32 mm long axis. Mode: 1.00 mm long axis. EQ. SR.

Very few to absent	Iron-rich fine sandstone. Size: 1.80-0.42 mm long axis. Mode: 1.oo mm long axis. EQ. SR-SA. Contains tuffaceous rock fragments, quartzite, quartz, and heavily altered rock fragments.
Rare	Feldspar. Size: 0.20 mm long axis. EQ. SA.
Very rare	Mudstone. Size: Dark orange mottled texture. Size: 1.95 mm long axis. EL. SR. Unmixed clay?

Fine fraction

Dominant to frequent	Micritic limestone
	Heavily altered plutonic rock
Frequent to common	Quartz
Few	Opaques
Few to very few	Tuffaceous rock
	Mica
Very few	Feldspars

Comment

The tuffaceous rock, mudstone and micritic limestone all appear to be related to each other. The lithic wacke sandstone is also related because it contains all three within a Fe-rich matrix. The tuffaceous rock derives from paleovolcanic deposits. The presence of Serpentinite is indicative of ophiolite outcrops.

Fabric Group 15: Volcanoclastic

Sample ID	Region of Deposition	Vessel Type
Kanakia 07/81	Salamis	Pithoid jar
Kanakia 07/82	Salamis	Pithoid jar
Kanakia 10/14	Salamis	Pithos/pithoid jar

Voids

Consisting of mainly elongated macro- and megavughs (planar voids?) and interconnecting cracks (especially in 82). In 81 additionally equant macro vughs and a crack which runs perpendicular to the margins of the section. Aligned to margin of sections. A few voids in sample 82 are filled with secondary calcite.

Matrix

Orange-brown to yellowish-greenish brown in PPL, beigeish orange-brown to orange-brown in XP (50x). (Moderately) heterogeneous appearance due to TCFs (81) or clay mixing. Optically active.

Inclusions

$c:f:v_{=20\mu m}$ – 48:40:12- 40:52:8
Coarse fraction – 4.20-0.20 mm long axi.s
Fine fraction – 0.20-0.10 mm long axis.

EQ. EL. WR-A. Single spaced or less. Not aligned to margins of samples. Weakly bimodal, poorly sorted grain size distribution.

Coarse fraction

Frequent:	Altered igneous rocks. Size: 4.2-0.40 mm long axis. Mode: 2.0 mm long axis. EQ. EL. SA-A. Minerals are not easily recognisable. Mainly altered quartz/feldspars in sericitized groundmass. Additionally 'chert-like and patchy parts. Fine feldspars of volcanic origin? Rare opaques and coarse silt sized mineral inclusions with high relief and first to second order birefringence.
Frequent to common:	Tuffaceous rocks with sericitized feldspars. Size: 3.6-0.20 mm long axis. Mode: 1.2 mm long axis. EQ, EL. R-A. Appears yellow - orange in PPL, can contain darker veins and inclusions. In some the sericite forms criss-cross patterns, others show a more layered arrangement of alteration products. Related to altered igneous rocks.
Common:	TCFs. Size: 2.4- 0.20 mm long axis. Mode: 0.50 mm long axis. EQ. WR-SR. Orange-brown to red or dark brown to black. High to almost neutral optical density or neutral to low optical density (dark TCFs). Clear to merging boundaries. Few inclusions of quartz, opaques and small rock fragments, but frequently none or less than the surrounding ceramic body.
Very few - rare:	Calcite. Size: <1.2 mm long axis. Mode: 0.28 mm long axis. EQ. SR-A. Predominantly micritic aggregates, rare sparite.
	Quartz; Size: <0.5 mm long axis. Mode: 0.2 mm long axis. EQ. SR-A.

Rare - very rare:	Chert. Size: <0.80 mm long axis. Mode: 0.24 mm long axis. EQ. EL. R-SA.

Fine fraction

Dominant to frequent	Quartz
Common	Rock fragments
Few	Feldspars (incl. sericitized fragments)
	Calcite/micrite aggregates
Few - absent	TCF
Very few	Chert
	Opaques
Very few - very rare	Mica
Very rare - absent	(Clino)zoisite
	Amphibole

Comments

This fabric is related to the Volcanoclastic with vegetal temper fabric (FG 14).

Fabric Group 16: Tuffite and altered basic igneous rock

Sample ID	Region of Deposition	Vessel Type
Kanakia 07/80	Salamis	Pithoid jar

Voids

Consisting of, sometimes interconnected, elongated macrovughs, aligned parallel to sample surface and cracks which run perpendicular (from preparation slide?). Can contain secondary calcite.

Matrix

Brown-grey in PPL, yellowish grey in XP (50x). Optically active.

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 20:75:5
Coarse fraction – 4.80-0.10 mm long axis.
Fine fraction -- <0.10 mm long axis.

EQ. EL. WR-A. Single spaced, but difficult to judge, as inclusions are clustered, resulting in regionally open and closed spaced patterns. No alignment to margins of samples. Moderately sorted bimodal grain size distribution.

Coarse fraction

Frequent	Tuffaceous rock. Size: 4.8-0.64 mm long axis. Mode: 1.4 mm long axis. EL. SA. Can contain, quartz, chert, feldspar and iron-rich veins. Grey relic structures. Microfossils in matrix are common. Few with iron-rich rims. Rare red core.
Very Few	One altered basic rock fragment; eq. r 1.8 mm. Minerals not recognisable (except some feldspars?)
	Opaques. Size: 0.40-0.10 mm long axis. Mode: 0.12 mm long axis. EQ. WR-SR.
Rare	Quartz. Size: 0.24 mm long axis. EQ. SA. Undulose extinction.

Fine fraction

Frequent	Quartz
Common	Mica
Few	Opaques
Rare	Calcite (sparite aggregates)

Textural Concentration Features

Clay pellet – EQ. R Size: 1.2 mm long axis. Groundmass yellowish grey. Low optical density. Clear to merging boundaries. Contains fine quartz, mica and opaques. Seems more packed with fine inclusions than the surrounding ceramic body.

Comments

The tuffaceous altered basic igneous rock links this sample to FG 14 and FG 15.

Kean fabrics

Fabric Group 17A: Medium blueschist

Sample ID	Region of Deposition	Vessel Type
Alimos 12/96	Acropolis	Chytra

Voids

Few equant mesovughs, very few elongated macrovughs and rare equant microvughs. Voids are open space and elongated voids have a long axis preferred orientation parallel to vessel margins.

Matrix

Medium coarse, homogeneous micaceous micromass. Orange-red to yellow orange in XP (50x) and brown red in PPL (50x). Colour change may be due to thinning of the section at the margins. Micromass is rich in white mica and opaque inclusions. Optically active.

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 32:64:4
Coarse fraction – 1.92-0.24 mm long axis.
Fine Fraction – 0.24-0.10 mm long axis.

EQ. EL. SR-A, frequently SA-A. Single to double spaced, poorly sorted and moderately strong bimodal grain size distribution.

The coarse fraction is dominated by EL. SA-A. blueschist facies metamorphic rock fragments of <1.92 mm long axis and a mode of 0.42 mm long axis. The blueschist is a metabasite and is composed of albite, clinozoisite, hornblende amphibole, white mica, quartz, opaques, glaucophane, anthophyliite?/cummintonite?, olivine. There are very fine euhedral minerals (<0.02 mm) that are hexagonal, pale green and are not pleochroic. Birefringency is difficult to determine. Some fragments have more granoblastic texture while the rest are commonly foliated. The rest of the coarse fraction appears to be detritus from the metabasite blueschist. Common EQ. EL. SA-A. albite measuring <0.88 mm long axis and a mode of 0.32 mm long axis and overgrowth of ferromagnesian minerals, epidote group minerals. Common EQ. EL. SA-A. epidote group (predominantly clinozoisite) measuring <1.32 mm long axis with a mode of 0.40 mm long axis and overgrowth of ferromagnesian minerals (actinolite?). Few subhedral, undulose EQ. SA. Quartz with a mode of 0.64 mm long axis. Few EL. SA-A white mica laths with a mode of 0.24 mm long axis. Very few EQ. A. brown amphibole (hornblende?) measuring <0.48 mm long axis. Very rare EQ. SA. Pyroxene (hypersthene?) measuring 0.60 mm long axis. Very rare EQ. R-SA. opaques at 0.25 mm long axis.

The fine fraction is compose of the same material in the coarse fraction with the addition of frequent white mica laths, common EQ. SA. undulose monocrystalline quartz, rare olivine and pyroxene.

Textural concentration features

There are brown-red, EQ. EL. WR-R pellets with low positive optical density, clear boundaries and a concordant matrix. These are probably a natural feature of the groundmass.

Comment

This fabric is characterised by a medium coarse matrix derived from a mica-rich metamorphic parent rock material with very coarse to fine sand sized subangular blueschist facies metamorphic inclusions. The constituent materisl are suggestive of a metabasite formation. Metabasite blueschist occurs in areas of regional metamorphism. The bimodal distribution of subangular disaggregated fragments of the rock material suggests that the schist was crushed up and added to the matrix as temper. The homogeneous colour and texture combined with the high optical activity of the matrix indicate that this vessel was low fired in a consistently oxidized atmosphere. A potential region of production is in the Attic-Cycladic Metamorphic belt (massif), perhaps the southern tip of Attica where there are known blueschist outcrops. This fabric is found in one tripod cooking pot.

Fabric Group 17B: Coarse blueschist

Sample ID	Region of Deposition	Vessel Type
Alimos 12/79	Attica	Pithoid jar

Voids

Predominant elongated channel voids with few elongated macro- and mesovughs and common equant mesovughs. Voids are single spaced with no observed orientation. The channel voids link to shrink rims surrounding various types of inclusions.

Matrix

Same as FG 17A

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 40:40:20
Coarse fraction – 3.68-0.32 mm long axis.
Fine fraction – 0.320-0.1 mm long axis.

Predominantly EL. with common EQ. SR-SA. Single to double spaced, poorly sorted with strong bimodal grainsize distribution. No preferred orientation.

Both fractions are predominantly composed of the same inclusions as FG 17A. The blueschist in this fabric are more densely populated with brown amphiboles and are generally larger in size and in grainsize of the constituent minerals. Additionally there are common EL. A. pyroxene, few EL. A. olivine and rare EQ. R. calcite.

Comment

The matrix is micaceous and is derivative from decomposition of metamorphic parent rock. The texture of the groundmass suggests that the raw materials were likely processed in some manner in order to remove larger inclusions and impurities; however it appears too coarse to have been levigated. The colour is lighter near the edges and darker towards the core of the section and the groundmass is optically active. This indicates that the vessel was fired at relatively low temperatures in a mostly oxidising atmosphere. The dark core suggests that the vessel did not completely oxidise due to changes in the firing atmosphere. The bimodal grain size distribution of the inclusions, and the lack inclusions larger than medium sand in the matrix, indicate that the rock fragments were added to the matrix as temper. There are channel voids that connect to shrink rims that surround many of the inclusions. A potential region of production is in the Attic-Cycladic Metamorphic belt (massif), perhaps the southern tip of Attica where there are known blueschist outcrops. This fabric is found in a large storage jar (pithoid jar).

Cretan fabrics

Fabric Group 18: Biotite-Hornblende schist and phyllite

Sample ID	Region of Deposition	Vessel Type
Kanakia 07/86	Salamis	Wide-mouth jar

Voids

Common elongated mesovughs and few irregular macrovughs. Open spaced with a preferred orientation parallel to vessel margins. Partial allochthonous secondary calcite partially filling in voids as micrite aggregates and autochthonous secondary calcite as micrite in the micromass.

Matrix

Moderately fine heterogeneous micromass containing biotite and silicates. Heterogeneous due to amount of secondary calcite. Chocolate brown in XP (50x) and grey-brown in PPL (50x). Optically slightly active.

Inclusions

$c:f:v_{=20\mu m}$ – 35:60:5
Coarse fraction – 2.7-0.1 mm long axis.
Fine fraction – 0.1-0.01 mm long axis.

Predominately EL. with few EQ. SR-SA. Weakly bimodal, poorly sorted grain size distribution. Elongated inclusions have crude long axis alignment with vessel margins

Coarse fraction

Frequent	Low grade metamorphic rock. Size: <2.7 mm long axis. Mode: 0.56 mm long axis. EL. EQ. SR. These are low grade greenschist facies schist and phyllite fragments. They are composed of biotite, quartz, zoned feldspar, hornblende amphibole and rare white mica. They are foliated with few fragments demonstrating slight S-curve crenulation. Very few fragments show intercalations with quartzite.
Very few	Plagioclase feldspar. Size: <0.50 mm long axis. Mode: 0.20 mm long axis. EQ. SR. Euhedral to subhedral. Polysynthetic twinning; twinning not always visible. Mineral overgrowth.
	Mono- and polycrystalline quartz. Size: <0.42 mm long axis. Mode: 0.24 long axis. EQ. SR. Euhedral. Undulose extinction.
Rare	Micrite. Size: 0.8-0.15 mm long axis. EQ. SR.

Fine fraction

Dominant	Plagioclase
Frequent	Quartz
	Micrite
	Biotite
Common	Opaques
Few	Amphibole
	Micrite

Comment

This fabric is composed of a micaceous, calcareous clay derived from weathering of metamorphic rock. The groundmass is fairly fine, however there is no obvious evidence for any kind of levigation or subtractive clay processing. The slight optical activity and consistent colouring suggest that this vessel was fired at relatively high temperatures in a constant oxidising atmosphere. The metamorphic rock inclusions are derived from phyllite-quartzite series outcrops well known from south central Crete. There are several examples of comparative ceramic thin sections from the Kommos kiln study by Shaw et al. (2001) that have identical geological composition. This fabric comes from a wide-mouth jar.

Fabric Group 19: Granodiorite

Sample ID	Region of Deposition	Vessel Type
Alimos 12/119	Attica	Transport stirrup jar

Voids

Few elongated and equant meso- and macrovughs. Rare elongated megavugh. Voids display no preferred orientation. No secondary calcite is visible within the voids.

Matrix

The matrix is fine and heterogeneous. The groundmass has a matte texture that is dark olive green with red-brown splotches throughout the section (XP, 50x). The groundmass is grey-green with dark brown splotches in PPL (50x). The matrix is optically inactive. Autochthonous secondary calcite is visible as micrite aggregates that form loose striations parallel to the vessel margins.

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 25:72:3
Coarse fraction – 2.40-0.10 mm long axis.
Fine fraction – <0.10 mm long axis.

Predominantly equant with common elongate inclusions. Subrounded to angular, but predominantly angular. Poorly sorted, loosely packed and strongly bimodal grainsize distribution. The coarse fraction is single to double spaced and poorly sorted with no preferred orientation. The fine fraction is well sorted with no preferred orientation.

Coarse fraction

Frequent	Intermediate igneous rock. *Granodiorite*. Size: 2.40-0.10mm long axis. Mode: 0.32 mm long axis. EL. EQ. SA-A. Altered with opaque veins. Rarely these veins take on an acicular shape.
Few	Plagioclase. Size: 0.85-0.10 mm long axis. Mode: 0.28 long axis. Altered with opaque veins. Various twinning textures: polysynthetic and granophyric. Consertal intergrowth with quartz and other plagioclase minerals. Disaggregated fragments of granodiorite.
Very Few	Quartz. Size: 0.70-0.10 mm long axis. Mode 0.2 mm long axis. EQ. EL. SR-A. Udulose extinction. Altered. Disaggregated fragments of granodiorite.
Rare	Opaques. Size: <0.30 mm long axis. EQ. SR-A.

Fine fraction

Frequent	Quartz/feldspar. Too difficult to distinguish minerals enough to quantify each individually.
Common	Igneous rock fragments
Few	Opaques
Very rare	Mica laths

Comment

This fabric is a transport stirrup jar that comes from east Crete. It is identical to the fabric classified as Type XIV within the coarseware fabric classification generated by Haggis and Mook (1997: 276). Haggis and Mook are unclear of the dating for this fabric, but had it placed between types XIII and XV which are both recorded as Late Minoan III and Late Minoa IIIC respectively. This vessels comes from the site of Kontopigado, Alimou which is dated to the transitional LHIIIB-LHIIIC early period and thus places this vessel type into the chronological range inferred by Haggis and Mook. Although they did not provide a clear production location for this fabric, Haggis and Mook suggested that the phyllitic fragments come from a phyllite quartzite series and the igneous rock fragments come from a granitic-dioritic series. Both of these rock tpyes are found in the Mirabello area of east Crete.

Fabric Group 20: Quartzite, phyllite and schist

Sample ID	Region of Deposition	Vessel Type
Dokos 12/5	Argo-Saronic	Closed vessel
Kanakia 07/87	Salamis	Closed vessel

Voids

Common mesovesicles and few elongated macrovughs with long axis crude preferred orientation parallel to vessel margins. Voids are open space. Rare allochthonous secondary calcite observed as micrite lining the void walls.

Matrix

Heterogeneous fine micaceous and calcareous micromass. Dark brown to grey-brown in XP (50x) and brown to grey-brown in PPL (50x). The core of Kanakia 07/87 is grey. Optically active.

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 40:55:5
Coarse fraction – 2.00-0.25 mm long axis.
Fine fraction – <0.25 mm long axis.

EL. EQ. SR-A. Bimodal, poorly sorted grain size distribution. Single to double spaced. No preferred orientation.

Coarse fraction

Frequent quartzite, schist and phyllite, quartz. Few TCFs with very high optical activity, dark red matrix and quartz inclusions and very rare (ortho?)pyroxene

Fine fraction

The fine fraction contains mainly quartz, in addition micas and opaques.

Comment

The phyllite fragments contain needle shaped dark brown and opaque crystals. This fabric is likely derived from a phyllite quartzite series outcrops, unfortunately these kinds of rock formations are common throughout Greece. The dark shaped needle inclusions are diagnostic of fabric, but they are common enough that they are not diagnostic in provenance determination.

Fabric Group 21: Phyllites and argillaceous rock

Sample ID	Region of Deposition	Vessel Type
Kanakia 07/35	Salamis	Coarse stirrup jar

Voids

Elongated meso- to megavughs, aligned parallel to sample margins. Appear filled with secondary material.

Matrix

Orange-brown in PPL and orange-brown in XP (50x). Optically active.

Inclusions

$c:f:v_{=20\mu m}$ – 35:64:1
Coarse fraction – 1.60-0.1 mm long axis.
Fine fraction -- <0.10 mm long axis.

EL. EQ. WR-A. Bimodal, poorly sorted grain size distribution, single spaced.

Dominant ARF inclusions that are EQ. WR-SA, that are <1.6 mm long axis (mode = 0.6 mm). These ARF inclusions are discordant, have very high optical density, clear boundaries, felsic, mica and micrite inclusions. Few pieces are close to single spaced and contain larger fragments (mode = 0.2 mm) of quartz and quartzites (one chert). Few Phyllites that are EL. WR-SR and <1.4 mm long axis (mode = 0.3 mm), very few quartzites (<0.8 mm, mode = 0.6 mm) and EQ. quartz (<1 mm long axis, mode = 0.3 mm). Finally, the sample contains a few TCFs with lower optical density than the surrounding matrix and clear to merging boundaries.

The fine fraction contains frequent quartz (mode = 0.04 mm), few amorphous opaques and very few micas.

Comment

The textural features indicate that this fabric was very poorly mixed and inclused at least two distinct clay materials. This fabric is very similar to FG 20, it was separated from this fabric group due to the coarse, unmixed nature of the groundmass. It is used in the manufacture of a closed vessel (jar/jug/hydria) and has no identifiable provenance.

Fabrics of unknown origin

Fabric Group 22: Fine red with red TCFs

Sample ID	Region of Deposition	Vessel Type
Ayios Konstantinos 12/41	Troezinia	Deep basin
Ayios Konstantinos 12/58	Troezinia	Closed vessel
Ayios Konstantinos 12/59	Troezinia	Closed vessel
Dokos 12/08	Argo-Saronic	Kylix
Kalamianos 12/56	Corinthia	Kylix
Kalamianos 12/60	Corinthia	Deep bowl
Lazarides 12/06	Aegina	Cup
Lazarides 12/09	Aegina	Deep bowl
Lazarides 12/12	Aegina	Deep bowl
Lazarides 12/13	Aegina	Deep bowl

Voids

Elongate and few equant micro- and mesovughs. Very few macrovughs and rare microvesicles. Voids are double to open spaced and have a long axis orientation parallel to vessel margins. Partial autochthonous secondary calcite infilling of voids. Few voids are filled with silt.

Matrix

Predominantly homogeneous micaceous micromass. Orange-red to brown in XP (50x) and pale brown to yellowish pale brown in PPL (50x). Optically moderately active.

Inclusions

$c:f:v_{=20\mu m}$ – 4:84:12
Size: <1.30 mm long axis.

EQ. SR-SA. Open spaced and well sorted with unimodal grain size distribution. No preferred orientation.

Predominant — Mica laths. Size: <0.16 mm long axis. Mode: >0.02 mm long axis.

Common — Biotite. Size: <0.32 mm long axis. Mode >0.04 mm long axis. EQ. SA. Weak yellow brown pleochroism.

Micrite. Size: <0.32 mm long axis. Mode: 0.04 mm long axis. EQ. R-SR Constituent of micromass and aggregated as autochthonous secondary calcite.

Common to few	Quartz. Size: <0.14 mm long axis. Mode: >0.02 mm long axis. Predominately undulose extinction with few specimen demonstrating straight extinction.
Very few	Feldspar. Size: <0.80 mm long axis. EQ. SA-A.
	Siltstone. Size: <1.30 mm long axis. EQ. SR. Grey (XP, 50x) matrix with medium silt sized micrite, mica, quartz and feldspar inclusions. Matrix is pale yellowy grey in PPL.
	Microfossils. *Foraminifera (Gastropods).*

Textural concentration features

There are two main TCFs in this fabric. TCF1 is the main feature of the fabric.

TCF1: Fe-rich equant and elongated, well rounded clay pellet that has clear to diffuse boundaries and has high optical density. This TCF is commonly found in amorphous blobs scattered throughout the matrix. Red brown to opaque in XP and brown to opaque in PPL.

TCF2: Isotropic (milky grey), elongated and sub-rounded. In PPL these TCFs are pale yellow with a cloudy alteration that is reminiscent of volcanic flow.

Comment

This is very fine fabric mica rich and red firing with very few inclusions. The main identifying features are the TCFs and the moderate optical activity.

Fabric Group 23: Quartz Mylonite

Sample ID	Region of Deposition	Vessel Type
Acropolis 13/14	Attica	Coarse stirrup jar
Ayios Konstantinos 12/39	Troezinia	Closed vessel
Euripides Cave 12/11	Salamis	Closed vessel
Kanakia 07/88	Salamis	Wide-mouth jar
Kanakia 10/04	Salamis	Piriform jar
Kanakia 10/07	Salamis	Medium stirrup jar

Voids

Voids are commonly macrovughs, few megavughs and rare meso-microvesicles. They have a crude long axis orientation parallel to vessel margins, are open-spaced with few margining into shrink rims than encircle voids. Rare allochthonous secondary calcite is visible as dog-toothed interlocking sparite grains lining walls of vughs and vesicles and is heavily aggregated on the exterior of vessel walls.

Matrix

Fine heterogeneous micritic and micaceous micromass. Brownish red textural features (striations; see TCF section below) are common. The micromass is dark reddish brown in XP (50x) and dark brown in PPL (50x). Optically inactive (Euripides Cave 12/11) to active (Kanakia 10/4). Very fine orange-red clay matrix on exterior is paint used for surface finish.

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 38:58:4-14:80:6
Coarse fraction – 2.36-0.24 mm long axis.
Fine Fraction – 0.24-0.08 mm long axis.

EQ. El. SR-A. Moderately sorted with strong bimodal grainsize distribution. The coarse fraction is poorly sorted, single to open spaced and has no preferred orientation. The fine fraction is poorly sorted, open spaced and has no preferred orientation

Coarse fraction

Frequent	Metamorphic rock fragment. *Quartz Mylonite? Phyllomylonite?*. Size: xx mm long axis. Mode: 2.36-0.24 long axis. Mode: 0.35 mm long axis. EQ. A. Cataclastic textured metamorphic rock fragments with porphyroblasts of quartz and albite. Foliated bands are formed from quartz , biotite (cordierite?) and albite.
Few	Plagioclase feldspar. *Albite.* Size: 0.35-0.24 mm long axis. EQ. SA. Rare polysynthetic twinning. Common twinning by Albite Law, poikoilitic twinning with porphyoblasts of quartz or ferromagnesian minerals (e.g. sericite). Metamorphic texture suggests these minerals are part of a the metamorphic rock, *Q. Mylonite* above.
	Quartzite. Size: 0.70-0.24 mm long axis. Mode: 0.40 mm long axis. EQ. SA. Undulose extinction. Constituent of *Q. Mylonite* above?
Few to very rare	Monocrystalline quartz. Size: 0.40-0.24 mm. Mode: 0.3 mm long diameter. EQ. SA. Undulose extinction.
Rare	Mica laths. *Muscovite*. Size: xx mm long axis. EL. SA.
Very rare	Opaques. Size: 0.30 mm long axis. EQ. SR.
Very rare to absent	Calcite. 0.24 mm long axis. EQ. A.

Fine fraction

Dominant	Cataclastic metamorphic rock.
Frequent	Plagioclase feldspar
	Monocrystalline quartz
Common	Quartzite
	Micrite
Few	Mica laths
Rare	Opaques.

Textural Concentration Features

There are two different TCFs in this fabric. TCF 1 is brownish red (XP, 50x) EQ. R-WR, high-density pellets with clear to diffuse boundaries, few of these have "tails" trailing parallel to vessel margins through the micromass. TCF 2 is a pale brown red (XP, 50x), elongate and amorphous striation that has a similar colour and texture as the paint layer found on the vessel exterior of Kanakia 10/4.

Comment

The texture of the TCFs present in this fabric are highly suggestive of clay mixing. The micrite aggregates indicate that one of the raw materials was calcareous. The poor sorting and bimodal distribution of the inclusions indicate that the Mylonite was added to the clay mixture as temper. Cataclastic inclusions are indicative of dynamic metamorphism, and is suggestive of the Attic-Cycladic Metamorphic Belt (massif). The similarity of TCF 2 to the paint layer may suggest that that these two components come from the same raw material. The fine texture of the micromass in comparison to the grain size distribution of the inclusions may indicate that a subtractive clay separation process occurred in the production process. This fabric was not assigned an Attic provenance as there are no comparative material and this form of rock can be found in many areas of the Attic-Cycladic Massif, including Evvia.

Fabric Group 24: Volcanic with limestone and schist

Sample ID	Region of Deposition	Vessel Type
Plaka 10/02	Attica	Chytra

Voids

Predominately distorted meso- and macrovughs with frequent elongated meso- and macrovughs. Voids have a general preferred alignment parallel to the vessel margins. There is calcite accretions in many of the voids along the margin where a calcareous slip is present, additionally there are voids that have accumulated secondary calcite accretion. Some voids have remains of vegetable matter around the borders.

Matrix

The matrix is semi-coarse, fairly homogeneous throughout the section and is non-calcareous. The colour is dark brown in both XP and PPL (x40) with no differentiation between the margins and core. There are rare dark red brown TCFs of which some have quartz inclusions. The matrix is optically inactive.

Inclusions

c:f:v$_{=20\mu m}$ – 6:52:42
Coarse Fraction – 3.24 - 0.24 mm long axis.
Fine Fraction – 0.24-0.01 mm long axis.

EQ. EL. WR-A. Single-spaced and less. Random orientation; not aligned to the margins. Bimodal, poorly sorted grain-size distribution.

Coarse Fraction

Frequent	*Quartz*. Size: <0.40 mm long axis. Mode: 0.24 mm long axis. EQ. WR-SR. Straight and undulose extinction. Eu- to subhedral.
	Feldspar. *Plagioclase*; few *Orthoclase.* Size: <0.72 mm long axis. Mode: 0.32 mm long axis. EQ. SR-SA. Euhedral.
Common	Amphiboles. *Horneblende*. Size: <0.40 mm long axis. Mode: 0.25 mm long axis. EL. EQ. SA-A. Dark brown and green pleochroism. Accentuated cleavage. High first to high second order birefringence colours.
Few	Intermediate igneous rock fragments. *Porphyritic Andesite-Dacite*. Size: <1.75 mm long axis. EQ. SR-SA. Amphibole and euhedral plagioclase phenocrysts embedded in a matrix of fine needles of plagioclase with a granular texture. Some fragments have very small pyroxene phenocrysts.
	Low grade metamorphic rock fragment. el. sr-r. <3.24 mm. *Mica Schist*. Foliation. Low grade metamorphic rock fragment. el. wr. <1.20 mm. *Phyllite.* Colour varies from dark brown to reddish brown. Accentuated crenulation cleavage.
	Micritic Limestone. eq. sr-r. <2.10 mm, mode = 0.85 mm. Few are moderately altered.
Very Few	*Quartzite*. eq. sa-sr. <1.00 mm. Undulose extinction.

Rare	*Sepentinite*. eq. a-sa. <1.20 mm. Orange in colour with some extinction. One specimen exhibits an embedded pyroxene phenocryst.

Fine Fraction

Predominant	Amphiboles
Frequent	Plagioclase
Common	Quartz
Few	TCFs
	Metamorphic rock fragments. *Phyllite*
	Micrtitic Limestone
	Biotite
Rare	Serpentinite

Comment

There is a considerable difference in the abundance of andesite-dacite in this fabric, but its presence, the abundance of amphiboles, and the clay texture and composition indicate that this fabric is related to FG 10. The limestone and schist inclusions suggest that, although likely produced on the island of Aegina, this fabric was produced in a different volcanic environment than FG 10. The only other regions with this kind of rock in the Aegean are Melos, Poros, Methana and west of Ayios Theodoros on the southwest coast of the isthmus of Corinth.

Fabric Group 25: Calcareous with foraminifera microfossils.

Sample ID	Region of Deposition	Vessel Type
Lazarides 12/16	Aegina	Deep bowl
Lazarides 12/24	Aegina	Deep bowl

Voids

Very few microvesicles and micro vughs with rare mesovughs and very rare macrovughs. Open spaced with crude long axis orientation parallel to vessel margins.

Matrix

Moderately heterogeneous calcareous, fossiliferous micromass. Brownish yellow in XP (50x) and yellow in PPL (50x). Darker rings around voids and near margins. Moderate optical activity.

Inclusions

$c{:}f{:}v_{=20\mu m}$ – 5:91:4
Size: <0.90 mm long axis. Mode: <0.10 mm long axis.

Inclusions are EQ. SA. Open spaced and well sorted with a unimodal grain size distribution. The inclusions are comprised of frequent microfossils, few EQ. A. quartz with straight extinction measured to a mode of <0.10 mm long axis and few EQ. SR. micrite, mode: <0.10 mm long axis and a very rare fragment of EQ. A. fossiliferous microsparite limestone, <0.35 mm long axis. There are orange-brown EQ. R. micaceous TCFs with medium-coarse silt sized silicate inclusions, clear boundaries and low positive optical density.

Comment

The main feature of this fabric are the microfossils. These include various diatom species, globagerinids and sponge spicules.

Fabric Group 26: Ultrafine grey-green with microvesicles

Sample ID	Region of Deposition	Vessel Type
Ayios Konstantinos 12/30	Methana	Bovine figurine

Voids

Predominantly microvesicles, few elongate and rare equant mesovughs. Single to double spaced. Mesovughs a commonly filled with silty sediment.

Matrix

Homogeneous ultrafine micaceous micromass. Greyish green to grey brown in XP (50x) and brownish grey in PPL (50x). Optically slightly active.

Inclusions

$c{:}f{:}v_{=10\mu m}$ – 1:94:5
Size: <0.32 mm long axis. Mode: <0.10 mm long axis.

The inclusions are open spaced and well sorted with a unimodal grain size distribution. The inclusions are comprised of predominantly EL. A. muscovite mica laths, very few EQ. A. quartz/feldspar, rare EQ. A. brown amphibole measuring <0.24 mm long axis and rare EQ. SR. opaque TCFs. All of the inclusions are part of the matrix.

Comment

The colour differentiation of the micromass is suggestive of quick high temperature firing.

Fabric Group 27: Ultrafine micaceous with round voids

Sample ID	Region of Deposition	Vessel Type
Ayios Konstantinos 12/29	Methana	Bovine figurine

Voids

Predominantly microvesicles and equant microvughs, rare equant mesovughs and very rare macrovughs. Double to open spaced with no preferred orientation.

Matrix

Very fine homogeneous micromass. Reddish brown in XP (50x) and brown in PPL (50x). Optically inactive.

Inclusions

c:f:v$_{=20\mu m}$ – 6:86:8
Size: <0.88 mm long axis. Mode: <0.10 mm long axis.

There are very few medium to find sand sized inclusions in this fabric. The inclusions are comprised of common muscovite laths measuring <0.32 mm long axis with a mode of <0.10 mm long axis, very few EQ. SA. poly- and monocrystalline quartz with undulose extinction measured <0.32 mm long axis with a mode of <0.10 mm long axis, rare EQ. SA. Feldspar measuring to <0.24 mm long axis, rare EQ. SR-SA metamorphic rock fragments measuring to <0.24 mm long axis, rare EL. SA. Biotite measuring 0.08 mm long axis and very rare pyroxene measuring <0.04 mm long axis.

Comment

There is an inclusion of what could be a fine calcareous grog fragment? with igneous rock and zoned feldspar inclusions. There is the infilling of a large crack with the same calcareous matrix and zoned plagioclase. This may be a calcareous slip used for the pale coloured decoration to the bovine figurine.

Fabric Group 28: Very fine micaceous

Sample ID	Region of Deposition	Vessel Type
Ayios Konstaninos 12/50	Methana	Kylix
Euripides Cave 12/16	Salamis	Deep bowl

Voids

Open spaced, elongated micro- and mesovughs with a preferred orientation parallel to vessel margins.

Matrix

Fine silty, homogeneous micromass. Orangey brown in XP (50x) and pale brown in PPL (50x). Optically active.

Inclusions

c:f:v$_{=20\mu m}$ – 1:97:2
Size: <0.72 mm long axis. Mode: <0.10 mm long axis.

Inclusions are well sorted and open spaced with unimodal grain size distribution. Inclusions larger than 0.2 mm are very rare and include one EQ. R. micaceous siltstone measuring 0.72 mm long axis. Predominantly inclusions are ER. SR and <0.20 mm long axis. These include EQ. SA. Biotite, EQ. SA. Monocrystalline quartz, EL and EQ. SR. micrite aggregates and EQ. A. plagioclase feldspar.

Comments

Suggestive of a metamorphic environment.

Fabric Group 29: Angular quartz

Sample ID	Region of Deposition	Vessel Type
Lazarides 12/29	Aegina	Slender necked jar

Voids

Equant and elongated micro- and mesovughs with a crude long axis orientation oblique to vessel margins.

Matrix

Fine heterogeneous micaceous micromass. Brown-red in XP (50x) and brown in PPL (50x). Optically active.

Inclusions

c:f:v$_{=20\mu m}$ – 1:91:8
Size: <0.64 mm long axis. Mode: <0.08 mm long axis.

Inclusions are unimodal, well sorted and singe to double spaced medium-fine sand sized EQ. SR. undulose quartz, EQ. SR feldspar, mica laths, EQ. SA. Amphibole/biotite?, grey siltstone?, red and grey mudstone with devitrified microstructure.

Comment

Suggestive of a metamorphic environment.

Fabric Group 30: Opaques and microfossils

Sample ID	Region of Deposition	Vessel Type
Acropolis 13/16	Attica	Mug/tankard

Voids

Predominantly equant microvughs with very few mesovughs and rare EQ. EL. macrovughs. Very crude long axis orientation parallel to vessel margin. Open spaced.

Matrix

Fine homogeneous micaceous and calcareous matrix. Greyish brown in XP (50x) and brown in PPL (50x). Optically active.

Inclusions

c:f:$v_{=6\mu m}$ – 3:89:8
Size: <0.75 mm long axis. Mode: <0.06 mm long axis.

Inclusions are unimodal, well sorted, single to double spaced fine sand sized and smaller EL. A muscovite laths, EQ. SA. undulose monocrystalline quartz, EQ. A. zoned plagioclase, foraminifera microfossils. EQ. A. amphibole and EQ. WR. Opaques. The only examples of coarse inclusions are the EQ. EL. R. TCFs that dark reddish brown in XP and dark brown in PPL with merging boundaries and a concordant matrix (<0.75 mm long axis).

Comment

This is a micaceous and calcareous fabric that has distinctive muscovite and foraminifera in the micromass.

Fabric Group 31: Fine micaceous with quartzite and low grade metamorphic rock

Sample ID	Region of Deposition	Vessel Type
Kanakia 07/89	Salamis	Shallow bowl

Voids:

Rare elongated and equant mesovughs. Open spaced. No preferred orientation.

Matrix:

Fine heterogeneous micaceous and calcareous micromass. Brown yellow in XP (50x) and orange-brown in PPL (50x). Optically active.

Inclusions

c:f:$v_{=20\mu m}$ – 10:89:1
Coarse fraction – 0.56-0.01 mm long axis. Mode: 0.35 mm long axis.
Fine fraction <0.01 mm long axis.

EQ. EL. SR-A. Strongly bimodal, very well sorted and single to open spaced.

The coarse fraction consists of sand-sized quartz, quartzite, metamorphic rock fragments and rare plagioclase feldspars and opaques. The metamorphic rock fragments contain quartz (undulose extinction and interlocking grains), opaques, mica (mainly biotite, rarely mica) and feldspars. Few fragments appear to contain substantial amounts of feldspars. Few TCFs in the same size range as the rock fragments, with almost neutral to slightly positive optical density and merging boundaries.

The fine fraction contains quartz, mica and opaques

Comment

There is a slip on one side (talc?) with a thickness of ca. 0.12 mm. This fabric comes from a metamorphic environment. The rock fragments are reminiscent of the greenschist described in many of the Attic fabrics above. These fragments are too small to give any provenance with a high degree of certainty. However, it is safe to suggest that there is a good chance that this fabric is from Attica. The fabric is used in the production of a shallow bowl.

Fabric Group 32: Psammitic greenschist and greywacke

Sample ID	Region of Deposition	Vessel Type
Eleusis 12/09	Attica	Krater
Eleusis 12/13	Attica	Hydria

Voids

Predominantly microvesicles with frequent equant microvughs and very few elongate mesovughs. Open to double spaced with no preferred orientation.

Matrix

Fine homogeneous calcareous matrix with swaths of autochthonous secondary calcite throughout the matrix. Dark olive brow to grey brown in XP (50x) and pale grey brown in PPL (50x). Secondary calcite is concentrated towards the core and radiates out from voids, although voids are not filled in. Optically slightly active.

Inclusions

$c:f:v_{=20\mu m}$ – 19:75:6
Coarse fraction – Size: 0.88-0.10 mm long axis.
Fine Fraction -- <0.10 mm long axis.

Predominately EQ. with rare EL. R-SA. Double to open space, moderate-poor sorting with moderate bimodal grain size distribution.

The coarse fraction consists of frequent EQ. SA. Subhedral, undulose quartz measuring 0.88-0.10 mm long axis with a mode of 0.32 mm long axis, common EL and EQ. SA sub-anhedral plagioclase (*Albite, anorthite*?) 0.56-0.20 mm long axis with a mode of 0.24 mm long axis, few EL. EQ. R-SA metamorphic rock (psammitic greenschist facies) made up of irregular polygonal quartz, plagioclase and mica (biotite?) measuring 0.88-0.24 mm long axis, very few EQ. with rare EL. SR. opaques measuring 0.80 mm long axis, rare EQ. SR. greywacke measuring 0.56-0.32 mm long axis, rare EQ. R. TCFs dark brown in XP and pale brown in PPL (50x) with fine sand feldspar and quartz inclusions, diffused boundaries and neutral to low negative optical density, and very rare hornblende amphibole measuring 0.24 mm long axis. Few feldspar grains are moderately to heavily altered with mineral intergrowth and sericitic replacement metamorphism.

The fine fraction consists of predominant micrite grains (mode: <0.01 mm) frequent EQ. SR quartz and plagioclase (mode: <0.08, common mucscovite mica laths (mode: <0.1 mm) and opaques (mode: <0.08 mm).

Comment

The inclusions in this fabric are derivative of psammitic greenschist facies rock material. The matrix is moderate-high fired and calcareous. There are no comparable samples of this fabric and at present, there is not enough information to prescribe a provenance location for this vessel. The fabric is used in the construction of a krater (Eleusis 12/9) and a hydria (Eleusis 12/13).

Fabric Group 33: Muscovite-chlorite schist

Sample ID	Region of Deposition	Vessel Type
Ayios Konstantinos 12/19	Methana	Jar

Voids

Predominantly elongated macro- and mesovughs with few microvesicles. Voids are double to open spaced with no observable preferred orientation.

Matrix

Coarse heterogeneous heavily micaceous micromass. Orangish yellow-brown to brown in XP (50x) and yellow brown to greyish brown in PPL (50x). Optically active.

Inclusions

$c:f:v_{=20\mu m}$ – 28:58:14
Coarse fraction – 2.28-0.20 mm long axis.
Fine fraction – <0.20 mm long axis.

Frequently EL. with few EL. SR-A, predominantly SA-A. Single spaced, very poorly sorted with moderate-strong bimodal grain size distribution.

The coarse fraction is dominated by metamorphic rock fragments and disaggregated metamorphic rock detritus. The rock fragments are EL. SA-A and measure to <2.28 mm long axis with a crude mode of 0.96 mm, they consist of muscovite, chlorite, quartz/quartzite and EQ. and EL. Fe-rich opaque minerals. The remaining inclusions are common EQ. SA. undulose quartzite with a mode of 0.64 mm long axis, plagioclase feldspar with a mode of 0.56 mm long axis and tabular, EL. SA-A muscovite crystals with mode of 0.45 mm long axis. There are very few EL. SA. opaque minerals measuring <0.80 mm long axis.

The fine fraction consists of muscovite, quartz/quartzite, plagioclase, opaques, biotites and rock fragments.

Comment

The matrix is coarse and heavily laden with muscovite crystals with crushed up muscovite-chlorite schist used as temper. The origin of this fabric is metamorphic and probably comes from somewhere in the Attic-Cycladic Metamorphic belt (massif). Ayia Irini, on the northern coast of Kea is one possible place of production.

Fabric Group 34: Mudstone and organic vegetal matter

Sample ID	Region of Deposition	Vessel Type
Ayios Konstantinos 12/64	Aegina	Tub

Voids

Dominated by curved, elongated macro- and megavughs with very few mesovesicles and rare equant microvughs. Double spaced with a preferred long axis orientation parallel to vessel margins. Commonly elongated macro- and megavughs are partially filled with silt or organic remains. These voids are consistent with burnt out organic vegetal matter, perhaps chaff.

Matrix

The micromass is homogeneous, silty and rich in silicate minerals. Dark grey brown to orange brown on the exterior margin in XP (50x) and grey to brown on the margin in PPL (50x). Optically inactive. The colour is much lighter near the exterior surface, interior surface is not preserved in thin section. This suggests incomplete oxidation during firing.

Inclusions

$c:f:v_{=20\mu m}$ – 25:45:30
Coarse fraction – >5-0.64 mm long axis.
Fine fraction – 0.64-0.08 mm long axis.

Frequently EL. with common EL. grains. SR-A. Single spaced and strongly bimodal. Coarse fraction is well sorted and fine fraction is poorly sorted.

The coarse fraction consists of dominant EL. R-SR grey brown in XP and grey-black in PPL (50x) mudstone with fine to coarse silt sized silicate and white mica inclusions. The mudstones have Fe-rich veins and have an optically active matrix, clear to diffuse boundaries and have low positive to neutral optical density. One fragment is heavily altered (sericitized?). The mudstones measure to >5-0.64 mm long axis with a mode of 1.44 mm long axis. Additionally, there are very few EQ. SA. undulose quartzite with a mode of 0.64 mm long axis, very rare EL. A. arkosic sandstone measuring 0.64 mm long axis.

The fine fraction consists of silicate inclusions with a mode of <0.10 mm long axis. Predominate EQ. SA-A undulose quartz and EQ. EL. SA-A plagioclase feldspars with polysynthetic and albite twinning and rare perthitic texture, common EQ. SA. biotite, few low grade metamorphic rock fragments measuring <0.44 mm long axis, rare brown amphibole.

Comment

The matrix is derivative from a micaceous metamorphic environment. The mudstone appears to be added to the matrix as a tempering agent. One fragment near the exterior surface appears brecciated. Mudstones and brecciated mudstone are found throughout Corinthia and the Argolic peninsula. It is likely that this vessel, a large tub, came from this region, however it is difficult to distinguish anything more than this. There are brecciated mudstones near the area of Epidavros, but there is no evidence, archaeologically or other, to suggest that there is pottery production in that area at present.

Fabric Group 35: Fine micaceous

Sample ID	Region of Deposition	Vessel Type
Euripides Cave 12/15	Salamis	Deep bowl

Voids

Commonly elongated mesovughs with few microvughs and vesicles. Double to open spaced with long axis orientation parallel to vessel margins. Rare autochthonous secondary calcite found as micrite ling void walls.

Matrix

Fine homogeneous calcareous micromass. Grey brown in XP (50x) and pale brown in PPL (50x). Optically slightly active. Autochthonous secondary calcite is prevalent as micrite swaths spread throughout the matrix.

Inclusions

$c:f:v_{=20\mu m}$ – 3:91:6
Size: <0.65 mm long axis. Mode: <0.15 mm long axis.

There are few inclusions, open spaced, well sorted with unimodal grain size distribution, in this fabric. Inclusions are few EQ. SR. micrite aggregates that measure <0.5 mm long axis with a mode of <0.25 mm long axis. Commonly these micrite aggregates have a calcareous halo radiating from the inclusion. There are Few EQ. SA. Biotite grains measuring to a mode of <0.20 mm long axis, very few quartz and feldspar grains that are <0.40 mm long axis with a mode of <0.15 mm long axis. The feldspars can be zoned and the quartz have predominately undulose extinction and very samples have straight extinction. Chert exhibiting very rare radiolarian microfossils are rare, EQ. SA. and measures to <0.65 mm long axis. Serpentinite is very rare, EQ. A. and measures to 0.16 mm long axis.

Comment

This fabric is distinctive from the rest of the assemblage, but it is not diagnostic enough to determine provenance. It likely comes from a metamorphic environment that includes chert and/or radiolarian chert. It is used in the construction of a deep bowl.

Fabric Group 36: Sandy clay and chert-rich with low grade metamorphic rock

Sample ID	**Region of Deposition**	**Vessel Type**
Alimos 12/107	Attica	Wide-mouth jar

Voids

Micro- to mesovesicles; very rare mesovughs and macrovughs and vesicles. Double spaced. No preferred alignment. Secondary calcite rare in voids, however it fills entire void with micrite.

Matrix

Not homogeneous. Micritic and micaceous micromass. Dark core, dark grey brown in XP and grey greenish brown in PPL (x50). Borders are light in colour, brown in XP and pale grey brown in PPL (x50). Low optical activity. Secondary calcite occurs on the sherd surface.

Inclusions

$c:f:v_{=20\mu m}$ – 38:50:12
Size: <1.40 mm long axis.

EQ. EL. SR-SA. Single spaced, poorly sorted with no discernible modality.

Dominant	Quartz. ≤0.50 mm long axis. Mode: 0.12 mm long axis. EQ. SA. Eu-subhedral. Straight and undulose extinction. Difficult to distinguish from Alkali feldspar (albite) Alkali feldspar (Albite). ≤0.60 mm long axis. EQ. SA. Subhedral. Simple twinning. Alteration is common and is the easiest way to distinguish from quartz. Sericite intergrowth.
Common	Quartz Arenite fragments. ≤0.85 mm long axis. EL. EQ. SA. Monocrystalline quartz with sutured boundaries with >5% feldspar; >5% matrix. Matrix is iron-rich. Mica Laths (Muscovite?) ≤0.35 mm long axis. Mode: 0. 10 mm long axis.
Few	Quartzite. ≤0.45 mm long axis. EL. EQ. SR.
Very Few	Plagioclase feldspar. ≤0.45mm long axis. Zoned. Low grade metamorphic rock fragments (Greenschist). ≤1.30 mm long axis. Quartzite and mica. Foliated.
Rare	Grey phyllite. ≤1.35 mm long axis. EQ. SR.
Very Rare	Wavy banded phyllite. 0.34 mm long axis. High degree of crenulation.

Comment

Matrix is iron-rich. Quartz-rich and feldspathic sand is perhaps added as temper, though likely, this hypothesis cannot be tested with so few samples. Sand contains a mixtures of metamorphic and sedimentary rock fragments. This fabric is used in the construction of a wide-mouth jar.

Fabric Group 37: Calcareous ARFs and organics

Sample ID	Region of Deposition	Vessel Type
Plaka 10/34	Attica	Tub

Voids

Common elongated and curved meso- and macrovughs that are characteristic of burned out organic matter and few equant meso- and macrovughs. Voids are open spaced and have no observed preferred orientation. Some voids create loops or partial loops that are also indicative of burned out organic matter.

Matrix

Semi-coarse heterogenous calcareous micromass. Pale yellow brown in XP (50x) and brown in PPL (50x). Optically inactive.

Inclusions

$c{:}f{:}v_{=25\mu m}$ – 6:82:12
Inclusions – <1.92 mm long axis.

EQ. WR-A. Moderately well sorted, densely packed, single spaced inclusions with a unimodal grain size distribution.

Inclusions are dominated by quartz, feldspar and micrite (mode = 0.08 mm long axis). Mica laths and amorphous opaques (mode = 0.1 mm long axis) are common and there are few EQ. WR calcareous ARFS (1.92-0.32 mm long axis) that have low positive optical density, clear to merging boundaries and are concordant, but optically active.

Comment

This is fabric comes from a large tub. The voids indicate that this vessel was tempered with organic, vegetal matter. There is one TCF that is compose of micrite with silt sized felsic inclusions. This TCF is part of a marl that is incompletely mixed into the groundmass. The mixing can be observed by the merging to invisible margins on the TCF. It is composed of all the minerals that are found within the fabric. This groundmass of this fabric is reminiscent of samples Kontopigado 12/35, 49, Plaka 10/17, 37 and Kanakia 07/68. All of this samples have been assigned an Attic provenance. This fabric is different and does not have enough diagnostic inclusions to prescribe a provenance location.

Appendix II

Abbreviations

AK – Ayios Konstantinos, Methana
ALM – Kontopigado, Alimos, Attica
EC – Cave of Euripides/Euripides' Cave, Salamis
DOK – Myti Kommeni, Dokos
ELF – Eleusis, Attica
KAL – Kalamianos, Corinthia
KAN – Kanakia, Salamis
Stiri – Stiri, Corinthia

Saronic Gulf Chemical Composition Groups

Core Group 1

Group 1	Fit	Ca (%)	Sc	Cr	Fe (%)	Co	Zn	Rb	Zr	Cs	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
AK 12/22	1.03	3.76	23.2	724.3	5.72	34.1	120.6	115.6	105.3	23.8	383.4	28.3	58.9	6.01	1.20	0.74	2.73	0.42	4.64	0.97	9.59	2.86
AK 12/23	1.03	3.93	20.4	623.1	4.84	38.0	121.8	129.2	132.0	17.6	620.1	31.0	67.8	5.81	1.09	0.64	2.38	0.38	4.61	0.94	10.42	2.30
AK 12/36	1.03	4.98	22.9	893.7	5.88	38.4	123.8	125.2	119.5	18.2	463.0	28.7	62.1	5.81	1.16	0.59	2.44	0.34	4.20	0.91	10.35	2.01
AK 12/42	0.98	4.97	20.8	504.8	5.60	31.3	142.8	146.2	95.1	23.2	481.2	30.4	65.0	5.95	1.20	0.68	2.49	0.37	4.27	0.92	9.80	1.81
AK 12/45	1.07	6.06	20.2	560.6	4.98	35.0	98.0	119.1	125.1	15.3	580.4	25.9	54.8	5.36	1.08	0.64	2.34	0.35	4.31	0.81	8.68	1.93
AK 12/47	1.12	5.44	20.1	628.0	5.05	37.8	104.6	108.8	108.3	13.5	536.9	23.1	54.1	4.77	0.95	0.56	2.15	0.32	4.07	0.87	8.62	2.21
AK 12/57	1.17	4.07	20.4	704.1	4.98	32.8	116.0	111.6	120.5	18.0	588.7	21.8	51.0	4.23	0.82	0.45	2.08	0.28	4.28	0.82	8.04	1.99
AK 12/58	0.88	6.12	23.8	724.0	6.97	41.0	156.6	174.3	100.1	32.2	447.5	31.7	67.7	5.94	1.24	0.72	2.42	0.33	3.80	1.11	10.86	2.85
AK 12/59	0.91	6.92	23.3	659.8	6.52	40.1	133.7	163.5	93.7	27.5	460.0	32.5	67.2	6.11	1.22	0.69	2.70	0.33	3.66	1.02	10.93	2.65
ALM 12/01	0.98	5.39	23.1	820.9	6.18	39.5	130.0	92.4	143.6	11.2	491.6	29.5	62.5	6.06	1.20	0.86	3.06	0.37	4.62	0.95	10.13	2.00
ALM 12/02	1.00	4.92	23.5	710.9	6.20	47.2	129.4	89.5	135.1	11.0	533.1	29.4	63.5	6.06	1.24	0.66	2.81	0.39	4.57	1.00	10.27	1.79
ALM 12/03	1.07	2.95	21.5	615.2	5.67	33.0	129.1	106.2	138.7	12.9	658.1	27.4	61.2	5.65	1.12	0.56	2.56	0.40	4.82	0.98	9.83	1.29
ALM 12/04	1.02	5.05	22.3	646.1	5.97	35.5	127.4	64.8	163.4	6.4	750.6	31.1	67.4	6.35	1.17	0.84	3.18	0.51	5.92	1.05	13.20	2.51
ALM 12/05	0.95	6.23	21.8	732.6	6.57	42.2	195.6	59.7	131.3	15.7	411.2	28.1	60.5	5.85	1.28	0.79	2.80	0.46	4.50	0.99	9.69	2.37
ALM 12/06	1.06	6.50	22.3	617.4	5.22	34.7	114.5	121.5	98.2	17.4	403.7	27.0	56.6	5.51	1.17	0.72	2.49	0.39	4.06	0.86	8.96	1.54
ALM 12/07	1.04	4.86	21.7	565.6	5.28	31.7	106.6	118.4	105.7	19.9	443.3	27.8	58.4	5.63	1.15	0.81	2.35	0.35	4.45	0.80	8.82	2.51
ALM 12/08	1.01	6.02	21.4	621.7	5.89	37.1	111.4	126.5	132.3	18.4	469.5	27.2	57.9	5.53	1.13	0.57	2.49	0.36	4.03	0.86	9.14	2.66
ALM 12/09	1.06	5.01	22.2	709.8	5.88	39.1	120.9	123.1	97.2	16.5	463.6	25.8	54.6	5.46	1.08	0.65	2.35	0.35	3.89	0.80	8.97	2.08
ALM 12/13	1.07	3.22	21.3	709.5	5.76	35.7	135.1	84.9	110.1	9.0	510.7	28.3	61.1	5.80	1.18	0.71	2.74	0.43	5.01	0.92	9.83	2.44
ALM 12/14	0.98	5.24	22.0	645.4	5.57	36.7	112.4	119.8	139.8	17.1	472.3	27.1	58.2	5.64	1.11	0.65	2.42	0.40	4.16	0.90	9.12	3.07
ALM 12/15	1.01	4.90	23.4	513.6	5.67	34.7	108.2	130.6	110.4	27.8	423.0	28.1	58.2	5.90	1.22	0.88	2.77	0.36	3.96	0.90	9.07	1.53
ALM 12/16	1.09	5.85	20.7	909.0	6.34	40.8	112.8	81.5	96.6	11.9	482.0	23.7	51.5	4.71	0.96	0.46	2.29	0.36	4.46	0.93	9.51	1.86

ALM 12/18	0.98	7.40	22.9	786.0	5.92	45.2	123.6	128.8	97.2	18.0	412.3	28.2	60.0	5.82	1.18	0.64	2.70	0.38	4.03	0.88	9.50	2.64
ALM 12/19	1.02	5.15	22.5	563.9	6.03	37.8	127.8	129.1	132.4	13.3	493.0	31.1	71.0	6.39	1.21	0.63	2.57	0.37	4.47	1.02	11.46	1.74
ALM 12/20	1.07	5.90	20.6	588.7	5.16	30.6	111.2	136.5	110.8	16.9	334.6	35.0	71.9	6.68	1.35	0.94	2.53	0.42	4.81	1.06	10.81	2.92
ALM 12/21	1.02	7.10	22.0	631.4	5.04	36.9	109.7	121.2	119.5	16.3	369.8	28.7	61.1	5.67	1.16	0.83	2.46	0.39	4.42	0.87	9.45	1.79
ALM 12/22	1.12	6.06	19.8	505.1	4.87	32.5	162.8	99.1	105.0	12.9	254.8	26.7	53.7	5.50	1.11	0.92	2.52	0.39	4.33	0.86	8.22	1.80
ALM 12/23	1.03	7.68	21.7	826.8	5.26	37.6	112.7	128.2	101.6	18.3	353.1	26.6	55.6	5.68	1.13	0.61	2.62	0.38	4.42	0.80	9.11	1.99
ALM 12/24	0.98	7.97	21.2	549.6	5.03	33.0	119.8	125.5	109.9	13.5	366.4	32.9	69.8	6.51	1.24	0.89	2.62	0.37	4.35	0.93	10.64	2.58
ALM 12/25	1.08	7.75	20.1	641.4	5.05	33.9	95.1	101.2	113.7	18.6	421.9	26.1	52.0	5.36	1.12	0.62	2.59	0.37	3.89	0.80	8.01	2.57
ALM 12/27	1.20	2.81	20.4	527.1	4.62	26.3	122.7	123.2	107.3	34.4	244.9	24.9	53.8	5.16	1.06	0.77	2.29	0.34	4.54	0.78	7.99	1.57
ALM 12/28	1.03	4.93	22.5	625.3	5.58	35.6	118.2	111.7	77.8	14.4	507.4	28.8	60.4	5.71	1.15	0.75	2.75	0.42	4.38	0.94	10.00	2.02
ALM 12/29	1.03	6.20	21.2	740.8	5.93	34.6	115.4	137.6	87.9	13.6	410.6	29.4	63.7	5.78	1.14	0.62	2.45	0.36	4.01	0.90	10.36	1.97
ALM 12/30	1.04	5.98	18.7	576.6	5.37	29.7	114.1	129.3	96.8	15.9	443.9	28.9	63.2	5.93	1.11	0.56	2.40	0.37	4.38	0.88	10.00	2.02
ALM 12/31	1.04	4.11	21.4	403.2	5.81	31.8	113.3	125.9	109.6	9.0	420.7	31.7	68.0	6.44	1.26	0.92	3.03	0.42	4.29	0.94	10.25	2.60
ALM 12/32	1.02	4.61	20.1	640.9	5.59	30.9	112.7	141.5	134.4	14.2	475.0	27.9	61.5	5.63	1.07	0.58	2.39	0.36	4.45	0.86	10.07	2.37
ALM 12/33	1.01	4.00	21.3	752.5	5.62	45.0	126.7	120.8	112.0	12.4	421.3	32.1	71.3	6.29	1.21	0.57	2.46	0.38	4.84	1.09	11.30	2.37
ALM 12/34	1.08	4.98	20.8	667.1	5.53	40.9	105.5	100.6	133.9	11.4	578.7	25.0	56.0	5.51	1.06	0.56	2.46	0.37	4.23	0.81	9.01	1.84
ALM 12/36	1.00	4.00	20.5	883.5	4.90	34.5	112.1	131.8	105.2	14.1	514.4	31.1	64.6	5.87	1.14	0.81	2.73	0.44	5.04	0.96	10.38	2.71
ALM 12/37	1.04	4.63	22.9	486.3	5.21	34.1	117.1	125.6	105.0	12.6	425.0	26.5	60.1	5.72	1.12	0.77	2.54	0.42	4.53	0.87	10.05	1.83
ALM 12/38	1.05	4.66	20.7	650.9	5.28	33.6	116.9	78.6	124.6	7.6	495.8	32.5	67.4	6.49	1.25	0.83	2.74	0.41	4.95	1.02	10.83	2.60
ALM 12/39	0.97	3.77	19.2	579.3	5.67	35.6	194.4	89.2	131.2	8.7	481.8	33.2	72.0	6.58	1.25	1.06	2.67	0.43	5.44	1.06	11.10	2.53
ALM 12/40	1.05	4.49	22.1	593.2	5.69	41.6	127.5	104.4	119.1	9.5	388.7	26.3	58.6	5.61	1.11	0.55	2.36	0.35	4.14	0.98	10.16	2.43
ALM 12/41	1.05	5.20	19.8	847.0	5.74	39.3	136.6	85.8	129.9	9.0	466.5	29.0	64.0	5.88	1.12	0.58	2.48	0.36	4.96	0.97	10.71	2.20
ALM 12/42	1.01	3.40	19.1	571.8	5.23	29.3	114.0	144.2	80.9	34.2	329.2	32.7	69.8	6.38	1.23	0.88	2.48	0.36	4.70	1.05	10.42	2.54
ALM 12/43	1.07	5.10	19.7	884.4	5.27	35.4	111.5	144.8	111.7	16.3	478.3	28.6	61.0	5.72	1.09	0.76	2.50	0.35	4.47	0.86	9.46	1.96
ALM 12/45	0.99	3.62	21.3	723.7	5.16	40.6	113.1	141.8	95.0	24.0	428.2	32.4	69.6	6.28	1.24	0.63	2.71	0.40	4.47	0.93	10.63	3.26
ALM 12/46	1.04	6.45	20.0	605.0	5.57	34.7	109.3	126.0	77.3	15.9	461.7	27.0	58.9	5.42	1.03	0.50	2.44	0.39	4.37	0.84	9.54	2.97
ALM 12/47	0.99	6.45	21.8	733.6	6.12	41.4	112.6	97.7	92.4	13.3	692.3	28.0	59.1	5.97	1.19	0.58	2.91	0.43	4.14	0.82	9.25	2.13

ALM 12/48	1.10	4.94	22.2	788.4	6.37	46.0	119.4	133.4	113.7	16.9	390.2	21.8	49.0	4.71	0.89	0.44	2.25	0.34	3.75	0.78	8.61	1.48
ALM 12/49	1.06	5.37	20.9	619.6	5.65	37.2	106.9	112.1	90.9	15.2	448.3	25.7	55.0	5.26	1.07	0.74	2.29	0.36	4.38	0.83	8.57	2.22
ALM 12/50	1.06	7.11	20.4	546.7	5.47	34.6	107.5	113.8	111.7	12.9	472.3	27.3	57.1	5.81	1.13	0.64	2.33	0.39	4.26	0.82	9.03	2.23
ALM 12/51	1.05	5.75	21.7	588.2	5.25	34.8	109.9	120.2	121.8	16.2	432.7	26.6	55.8	5.38	1.09	0.64	2.43	0.42	4.13	0.84	8.80	2.41
ALM 12/52	1.10	4.94	21.7	616.7	6.16	38.2	111.1	99.5	98.0	11.2	441.0	26.3	60.2	5.45	1.04	0.54	2.60	0.36	4.63	1.00	10.78	2.50
ALM 12/53	1.01	3.95	22.6	707.6	6.66	40.0	131.1	127.9	105.0	17.9	399.6	23.8	56.0	4.98	0.98	0.58	2.39	0.39	4.51	0.84	9.57	3.01
ALM 12/54	1.02	4.65	21.9	675.1	5.83	36.5	110.0	123.9	115.8	17.7	415.1	26.1	58.9	5.52	1.09	0.63	2.38	0.38	4.59	0.88	9.44	2.89
ALM 12/55	1.00	3.75	20.6	683.7	6.32	39.6	135.4	85.3	107.6	7.6	589.4	33.8	74.7	6.74	1.28	0.62	3.27	0.43	5.46	1.11	12.36	2.74
ALM 12/56	1.09	6.08	23.0	566.5	5.66	38.7	133.3	70.5	122.2	5.8	565.8	28.8	61.2	6.06	1.21	0.85	2.74	0.41	4.62	0.95	11.36	2.11
ALM 12/57	1.13	5.63	21.0	675.2	5.69	36.7	117.5	123.7	103.7	16.5	344.8	26.0	55.6	5.56	1.06	0.53	2.50	0.37	4.32	0.82	9.05	2.71
ALM 12/58	0.96	3.15	20.1	673.9	5.66	38.6	215.8	107.8	108.8	14.7	489.1	29.9	68.4	6.00	1.10	0.77	2.68	0.44	5.17	1.08	11.31	2.90
ALM 12/65	1.01	5.32	20.7	509.8	5.60	32.6	165.7	117.4	106.8	13.8	404.3	28.0	60.6	5.95	1.15	0.82	2.32	0.39	4.21	0.88	9.25	2.48
ALM 12/80	1.04	5.46	20.5	562.4	5.63	32.6	113.1	110.2	81.0	12.6	506.4	28.8	61.3	6.06	1.15	0.66	2.72	0.45	4.61	0.94	10.06	2.28
ALM 12/81	1.02	5.82	21.6	559.6	5.46	33.9	112.5	124.1	126.9	16.5	475.9	26.0	57.6	5.60	1.06	0.57	2.79	0.36	4.40	0.83	9.30	2.85
ALM 12/82	0.94	5.00	20.4	556.3	5.51	38.6	200.3	131.5	106.5	15.6	389.8	34.9	73.4	6.79	1.33	1.06	3.16	0.43	5.03	0.99	10.68	2.43
ALM 12/110	1.10	5.94	19.8	556.3	4.93	28.2	119.2	61.7	105.8	6.7	654.1	31.9	67.0	6.39	1.25	0.73	2.82	0.43	4.81	0.98	10.83	1.84
ALM 12/111	1.10	5.30	19.6	625.1	4.88	33.8	107.5	102.5	110.9	13.7	633.4	25.2	52.9	5.29	1.04	0.74	2.42	0.37	4.02	0.75	8.25	2.17
ALM 12/112	1.05	3.89	20.9	868.1	5.92	40.5	101.7	111.8	111.5	15.7	512.0	24.3	54.2	5.22	1.00	0.69	2.54	0.38	4.31	0.81	8.42	2.83
ALM 12/116	0.97	6.14	23.0	642.3	6.26	39.8	122.7	102.9	118.2	14.0	480.0	29.7	62.6	6.28	1.20	0.84	2.88	0.36	4.50	0.91	10.20	1.66
ALM 12/117	1.15	2.98	21.2	727.3	5.85	34.2	115.8	53.2	106.2	6.2	603.5	27.7	59.0	5.82	1.15	0.87	2.71	0.42	4.85	0.87	8.89	2.03
ALM 12/118	0.98	6.21	21.1	561.0	6.32	39.5	123.2	112.8	105.1	11.0	460.5	30.6	67.8	6.42	1.25	0.65	2.70	0.42	3.89	0.88	10.47	2.43
ALM 13/01	0.98	5.32	21.5	584.4	6.55	46.7	135.7	90.0	114.1	8.5	625.6	31.2	69.4	6.50	1.27	0.62	2.58	0.38	4.03	0.95	10.76	2.50
ALM 13/02	1.12	5.67	21.9	714.1	6.07	38.6	125.7	108.0	82.1	12.0	433.6	25.1	52.5	5.13	1.07	0.60	2.55	0.39	4.06	0.82	8.69	2.19
ALM 13/03	1.12	4.62	19.8	434.7	5.28	29.6	162.4	114.6	59.4	21.1	345.5	25.0	51.8	5.16	1.05	0.75	2.66	0.38	3.65	0.79	8.12	1.97
ALM 13/04	1.05	3.54	19.8	515.6	5.25	30.5	107.3	104.7	132.9	14.5	443.7	27.6	59.2	5.49	1.14	0.67	2.53	0.39	4.42	0.92	9.20	2.21
ALM 13/06	1.12	5.75	18.7	415.7	4.39	24.7	104.4	76.3	108.4	14.0	373.8	26.6	55.1	5.47	1.18	0.65	2.58	0.40	4.64	0.85	8.47	1.92
ALM 13/07	1.01	2.90	19.0	565.9	5.36	32.4	100.0	119.5	178.0	13.3	566.8	29.8	66.7	5.58	1.06	0.77	2.49	0.42	4.94	1.07	11.18	2.38

ALM 13/09	1.07	2.78	18.2	518.9	5.11	33.0	101.8	108.2	141.6	12.6	612.6	29.5	64.7	5.61	1.12	0.65	2.70	0.41	4.78	1.01	10.56	1.78
EC 12/02	1.15	7.60	18.9	480.2	4.62	30.2	123.7	103.5	109.8	12.9	354.7	23.7	50.7	5.06	1.00	0.45	2.38	0.38	4.32	0.82	8.52	2.34
EC 12/03	1.18	7.20	18.4	473.6	4.48	29.5	119.5	104.4	123.1	12.9	374.5	24.0	51.9	4.94	0.97	0.50	2.00	0.37	4.22	0.82	8.24	1.79
EC 12/04	1.12	7.71	20.0	587.9	5.18	34.1	215.9	102.9	114.4	14.4	334.9	24.1	51.5	5.10	1.01	0.55	2.27	0.31	3.68	0.78	8.72	2.01
EC 12/05	1.15	7.24	18.7	483.3	4.65	30.0	131.1	102.6	113.9	12.6	274.8	25.8	54.2	5.34	1.04	0.51	2.39	0.36	4.30	0.80	8.53	1.88
EC 12/06	1.07	6.47	19.8	633.5	5.08	35.0	135.5	116.6	113.0	13.4	365.4	26.3	55.5	5.43	1.08	0.53	2.16	0.34	3.97	0.81	8.76	2.33
EC 12/07	1.09	5.39	21.9	639.8	5.52	35.4	296.4	124.9	99.8	16.8	330.9	23.9	54.1	5.13	1.00	0.56	2.34	0.37	3.86	0.85	8.97	2.20
EC 12/08	1.05	7.70	19.6	539.4	4.73	31.1	140.3	110.6	102.4	17.5	442.5	31.2	66.2	6.24	1.20	0.61	2.45	0.38	4.18	0.96	10.00	3.29
EC 12/14	1.08	7.04	20.1	579.4	5.10	34.4	179.1	120.3	106.8	14.8	469.7	25.3	54.3	5.35	1.04	0.53	2.13	0.35	3.81	0.78	8.74	1.73
EC 12/18	1.01	6.40	20.4	531.5	4.50	31.1	248.2	126.5	104.0	13.8	402.9	29.2	63.2	6.11	1.17	0.80	2.81	0.37	4.03	0.93	9.70	2.38
ELF 12/02	1.02	5.30	21.9	808.7	5.68	37.3	131.0	123.2	114.9	16.9	486.7	25.3	53.8	5.20	1.09	0.61	2.25	0.31	3.89	0.77	8.71	2.10
ELF 12/06	0.95	5.05	22.3	575.2	5.40	37.5	126.2	154.7	98.8	17.2	523.9	34.6	76.3	6.61	1.30	0.71	2.21	0.32	3.77	1.03	11.78	2.60
ELF 12/07	1.00	7.18	20.8	744.8	5.23	34.0	136.6	111.5	128.8	12.0	359.8	27.1	58.5	5.47	1.15	0.65	2.37	0.34	4.00	0.94	9.30	2.61
ELF 12/09	1.12	9.53	18.3	546.9	4.97	34.1	79.3	114.5	87.9	35.2	456.9	23.9	47.9	4.66	0.99	0.55	2.07	0.29	3.44	0.70	7.23	2.30
ELF 12/10	1.02	4.30	21.5	694.8	5.47	40.4	109.7	135.0	104.1	17.6	371.9	27.9	63.4	5.44	1.10	0.61	2.35	0.35	4.01	0.91	9.87	2.01
ELF 12/11	1.03	3.69	20.9	509.0	5.23	34.0	119.4	120.1	150.9	12.5	401.1	30.5	69.6	6.13	1.24	0.72	2.63	0.35	4.70	0.92	10.14	2.57
ELF 12/13	1.24	9.51	18.4	527.3	4.25	30.7	71.3	96.3	86.7	21.0	322.3	25.0	50.0	4.96	1.08	0.64	2.27	0.29	3.33	0.83	7.56	1.21
ELF 12/15	0.98	4.82	21.3	543.4	5.13	38.4	107.3	141.8	134.4	15.3	414.9	33.0	73.9	6.33	1.25	0.71	2.43	0.32	4.02	1.00	11.37	2.52
ELF 12/17	1.06	6.40	21.2	521.9	5.29	32.6	117.8	113.2	101.0	15.6	462.5	27.6	57.4	5.56	1.19	0.69	2.74	0.39	4.13	0.77	8.60	2.11
KAL 12/45	1.11	8.94	17.7	521.7	4.36	28.1	108.3	109.9	113.7	11.3	318.8	28.9	60.7	5.37	1.06	0.66	2.21	0.37	4.13	0.83	9.00	2.67
KAN 07/01	0.98	2.88	21.8	599.6	5.23	30.5	116.9	135.1	134.5	16.1	478.9	34.5	73.4	6.45	1.24	1.12	2.81	0.42	5.45	1.11	11.93	3.07
KAN 07/02	0.96	3.89	21.5	559.7	5.15	33.5	124.7	139.0	102.0	14.5	670.2	32.4	68.4	6.04	1.23	0.79	2.63	0.36	4.65	1.00	11.02	2.46
KAN 07/03	1.02	4.33	21.6	714.4	5.44	41.6	116.5	134.1	87.9	18.1	444.6	28.3	62.8	5.22	1.06	0.70	2.32	0.33	4.61	0.88	9.82	2.59
KAN 07/04	1.01	5.17	19.1	510.2	4.89	33.2	116.1	87.5	111.3	8.7	692.7	32.2	69.2	5.92	1.19	0.90	2.72	0.36	5.15	0.99	10.54	2.25
KAN 07/05	0.97	4.55	20.1	653.4	5.31	40.0	108.4	118.8	112.4	16.3	743.9	29.0	64.4	5.58	1.13	0.70	2.37	0.35	5.05	0.97	10.24	2.60
KAN 07/06	1.05	3.63	20.9	610.8	4.48	34.3	118.4	123.9	104.6	11.2	602.2	33.7	69.5	6.31	1.31	0.81	2.65	0.36	5.14	1.00	11.03	2.41
KAN 07/07	0.98	2.90	22.4	721.9	5.69	38.8	140.0	99.8	92.1	11.2	556.0	33.6	74.6	6.23	1.26	0.76	2.75	0.38	5.16	1.10	12.20	2.91

KAN 07/08	1.00	3.34	20.8	687.1	5.30	32.9	121.4	131.8	92.3	15.7	1066.7	32.1	68.4	5.83	1.15	0.83	2.41	0.38	4.78	1.01	10.86	2.19
KAN 07/09	0.92	4.81	20.8	819.4	5.02	41.8	130.4	131.2	101.4	16.0	668.5	31.5	65.6	6.09	1.24	0.85	2.48	0.38	4.89	0.93	10.16	3.02
KAN 07/10	1.16	4.60	21.9	781.8	5.45	34.8	108.6	105.4	115.6	10.4	773.6	23.8	53.9	4.67	0.95	0.66	2.43	0.34	4.99	0.89	8.95	2.23
KAN 07/11	1.02	4.34	21.2	826.5	5.04	34.6	128.9	112.4	117.8	10.6	645.3	31.2	65.1	5.97	1.19	0.74	2.49	0.35	4.92	1.00	10.62	2.31
KAN 07/12	1.06	4.37	21.9	725.4	5.24	35.7	111.7	128.1	124.6	12.6	667.7	25.1	53.4	5.03	1.05	0.85	2.48	0.31	4.69	0.85	9.09	2.15
KAN 07/13	1.00	4.06	20.3	810.2	5.12	36.3	124.3	94.1	104.4	10.0	571.1	31.7	66.5	6.13	1.24	0.86	2.62	0.38	5.15	0.96	10.40	2.77
KAN 07/14	0.99	3.33	21.0	733.7	5.04	33.6	126.7	113.1	123.0	15.1	630.6	33.0	68.6	6.06	1.21	0.75	2.44	0.37	5.05	1.01	10.57	2.69
KAN 07/15	1.04	3.33	19.9	625.3	4.87	31.0	120.3	89.4	107.3	8.4	708.2	33.3	70.7	6.25	1.21	0.86	2.90	0.36	5.19	1.03	11.28	2.36
KAN 07/16	0.96	4.23	20.5	786.1	4.95	41.2	123.3	98.0	101.8	11.6	585.1	31.2	65.3	6.08	1.24	0.88	2.59	0.37	4.78	0.92	10.14	2.79
KAN 07/17	1.07	4.36	20.6	802.7	4.93	33.8	122.2	120.5	118.1	11.4	693.0	29.9	62.6	5.52	1.09	0.64	2.45	0.33	4.82	0.96	10.02	2.99
KAN 07/18	1.08	4.63	20.6	801.1	4.86	32.9	102.5	115.7	96.0	16.3	481.0	24.9	53.4	4.92	0.99	0.71	2.30	0.33	4.72	0.82	8.62	2.21
KAN 07/19	1.03	4.46	20.7	802.0	5.01	34.3	126.0	117.3	104.9	10.9	592.5	30.1	63.6	5.60	1.12	0.75	2.41	0.34	4.78	0.98	10.25	2.42
KAN 07/20	1.03	3.99	20.3	578.6	4.65	29.4	110.5	133.8	115.3	15.9	842.3	32.1	65.9	6.01	1.21	0.82	2.38	0.35	4.88	1.01	10.52	2.44
KAN 07/21	1.06	3.75	20.7	567.7	4.70	30.7	122.9	94.5	104.6	7.3	711.3	34.5	71.8	6.45	1.29	0.83	2.76	0.39	5.28	1.07	11.54	2.25
KAN 07/22	1.10	5.35	22.8	831.2	5.67	34.7	113.2	109.6	73.1	12.7	757.2	24.3	53.1	4.92	1.02	0.60	2.21	0.34	4.29	0.86	8.79	2.15
KAN 07/23	1.00	3.96	21.0	570.7	4.98	32.5	124.5	99.6	110.2	7.8	785.5	33.5	70.5	6.38	1.30	0.85	2.85	0.41	5.56	1.09	11.52	2.91
KAN 07/24	0.97	5.24	23.0	689.1	6.01	39.4	119.4	133.4	97.8	17.8	860.9	26.3	57.4	5.29	1.07	0.85	2.38	0.33	4.42	0.85	9.05	2.63
KAN 07/25	0.96	3.72	21.0	610.1	5.22	35.7	122.2	125.2	121.2	14.5	662.2	33.8	71.9	6.29	1.24	0.84	2.57	0.40	5.52	1.05	11.45	2.59
KAN 07/26	1.02	4.31	21.6	682.0	6.03	34.2	119.2	100.4	95.3	12.8	604.2	27.7	59.3	5.61	1.15	0.85	2.54	0.31	4.68	0.96	9.98	2.19
KAN 07/27	1.02	5.01	22.7	676.4	5.62	39.8	114.9	123.4	86.4	14.3	651.4	28.0	59.4	5.53	1.14	0.75	2.54	0.36	4.56	0.91	9.57	2.10
KAN 07/28	1.04	3.65	20.9	549.5	4.79	34.0	120.2	108.4	108.3	8.2	536.1	33.6	71.0	6.41	1.31	0.85	2.63	0.37	5.33	1.04	11.20	2.66
KAN 07/29	0.99	5.46	23.0	693.8	5.82	42.8	118.8	118.5	98.9	13.2	742.7	28.0	61.1	5.68	1.17	0.74	2.77	0.34	4.57	0.86	9.80	1.95
KAN 07/30	0.98	4.95	20.5	657.4	4.47	31.5	109.7	116.6	125.1	13.5	863.0	33.2	69.8	6.35	1.25	0.90	2.66	0.34	5.41	1.01	10.85	2.48
KAN 07/34	1.08	1.77	22.0	987.5	5.61	36.8	127.7	107.5	87.3	11.6	862.9	28.3	65.3	5.48	1.09	0.70	2.37	0.35	4.92	0.99	10.65	2.86
KAN 07/67	0.95	6.31	20.9	600.4	5.21	31.9	110.1	98.3	104.8	13.0	821.1	31.5	67.7	6.14	1.25	1.06	3.03	0.40	4.60	0.95	10.56	2.96
KAN 07/68	0.92	6.36	20.3	565.0	5.71	32.3	120.1	102.4	92.8	12.3	942.3	31.6	66.4	6.20	1.28	0.85	2.70	0.37	4.50	0.97	10.40	2.99
KAN 10/01	0.97	3.02	20.6	698.2	5.66	42.0	177.7	98.8	136.7	10.6	1205.2	29.0	66.0	6.02	1.15	0.72	2.61	0.41	5.14	0.97	10.22	2.39

KAN 10/02	1.06	4.67	18.3	625.8	4.92	33.6	116.9	72.0	150.9	6.4	1060.4	30.6	67.2	6.01	1.13	0.64	2.56	0.38	5.01	1.01	10.76	2.25
KAN 10/05	1.10	4.20	23.0	798.9	5.98	37.6	199.4	114.3	92.6	14.8	547.1	23.9	53.8	5.11	0.97	0.43	2.52	0.37	4.84	0.95	9.95	2.79
LAZ 12/12	1.02	4.95	18.9	503.9	4.11	27.9	125.6	119.7	129.7	11.1	513.4	33.3	74.4	6.31	1.26	0.71	2.65	0.39	5.34	1.01	10.91	2.40
Mean		5.11	21.0	645.7	5.41	35.6	126.2	113.6	110.6	14.6	526.0	28.8	61.9	5.75	1.14	0.71	2.54	0.37	4.52	0.92	9.88	2.34
SD		1.4	1.3	113.4	0.5	4.3	29.4	20.0	17.9	5.2	165.7	3.2	6.8	0.5	0.1	0.1	0.2	0.0	0.5	0.1	1.1	0.4
SD (%)		28.0	6.2	17.6	10.0	12.0	23.3	17.6	16.2	35.7	31.5	11.1	10.9	8.9	8.6	19.3	9.0	9.8	10.7	10.0	10.9	17.7

Group 1A	Fit	Ca (%)	Sc	Cr	Fe (%)	Co	Zn	Rb	Zr	Cs	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
ALM 12/59	0.98	2.14	14.6	289.2	4.47	19.1	73.3	94.0	146.0	14.6	362.9	33.3	70.1	5.67	1.05	0.76	2.69	0.410	6.17	1.28	10.99	3.27
ALM 12/60	1.15	1.14	19.3	329.6	5.44	26.0	152.3	52.5	85.8	9.6	389.4	21.2	46.8	4.73	1.01	1.10	2.66	0.372	4.09	0.67	6.77	1.15
ALM 12/62	1.12	0.96	22.8	323.6	6.35	32.0	126.5	102.6	138.2	8.1	163.6	23.6	50.7	4.91	1.06	0.66	2.79	0.470	4.63	0.69	7.09	2.29
ALM 12/63	1.02	1.09	20.3	306.2	5.29	24.3	89.5	111.5	123.7	20.7	267.3	24.1	52.6	5.37	1.23	0.69	2.71	0.453	4.88	0.72	7.25	1.82
ALM 12/66	1.04	1.15	20.5	381.0	5.17	24.0	92.0	109.9	129.9	21.6	299.0	23.5	52.2	4.86	1.08	0.60	2.61	0.394	4.55	0.72	7.51	2.30
ALM 12/68	1.05	1.07	20.0	320.8	5.19	24.1	88.8	111.2	133.3	20.8	204.6	22.1	48.8	5.12	1.16	0.73	2.65	0.431	4.48	0.70	6.98	1.72
ALM 12/69	1.06	1.32	19.6	309.5	5.11	20.6	87.3	99.1	124.9	22.2	264.5	24.3	50.7	5.22	1.17	0.68	2.68	0.399	4.81	0.74	7.16	1.57
ALM 12/73	0.95	2.47	18.4	264.7	5.69	23.7	87.9	105.5	178.7	7.6	500.8	30.1	85.2	6.28	1.26	0.73	2.89	0.427	6.42	1.41	14.57	2.24
ALM 12/86	0.96	1.26	20.1	341.3	5.03	24.7	99.0	150.5	125.7	54.8	302.4	24.8	54.0	5.14	1.15	0.73	2.55	0.421	4.94	0.82	7.89	1.82
ALM 12/87	1.27	1.59	18.7	288.2	5.21	23.6	91.5	88.8	103.7	8.3	157.2	21.3	48.2	4.45	0.96	0.57	2.11	0.323	4.51	0.71	6.63	1.61
ALM 12/89	1.14	2.72	18.1	293.2	5.05	22.5	84.9	85.1	125.8	7.9	359.0	22.2	50.2	4.56	0.99	0.52	2.18	0.337	4.62	0.71	6.90	1.86
ALM 12/90	1.06	1.00	18.7	341.9	5.06	27.3	107.8	82.7	144.1	10.4	382.6	27.9	57.7	5.31	1.13	0.68	2.67	0.444	5.19	0.85	7.67	1.70
ALM 12/92	1.04	1.79	20.2	312.4	6.34	25.1	101.9	85.7	127.7	10.2	345.2	25.6	50.8	5.33	1.20	0.90	2.71	0.430	5.36	0.69	7.40	1.46
ALM 12/95	0.90	1.34	21.8	326.8	5.95	28.1	107.3	97.7	123.3	11.6	641.9	31.3	63.2	6.50	1.41	1.11	3.23	0.510	5.38	1.03	9.43	2.12
ALM 12/107	1.05	1.76	20.0	328.7	5.26	23.0	95.5	115.8	140.7	14.0	251.2	25.9	53.1	5.30	1.15	0.90	2.52	0.412	4.37	0.74	7.62	1.70
ALM 12/108	1.10	1.29	19.9	343.5	5.63	23.8	97.1	106.8	97.4	13.0	266.7	24.6	51.2	5.13	1.10	0.85	2.67	0.409	4.56	0.76	7.71	1.88
ALM 12/109	1.10	0.99	18.1	358.2	6.26	31.7	97.6	58.2	109.9	10.4	445.0	20.8	47.1	4.56	0.98	0.57	2.45	0.402	5.29	0.69	6.79	1.33
Mean		1.48	19.5	321.1	5.44	24.9	98.8	97.5	127.0	15.6	329.6	25.1	54.9	5.20	1.12	0.75	2.63	0.414	4.96	0.82	8.02	1.87

SD		0.5	1.8	28.5	0.5	3.4	18.0	22.4	21.1	11.3	122.9	3.6	9.8	0.6	0.1	0.2	0.3	0.0	0.6	0.2	2.0	0.5
SD (%)		36.2	9.1	8.9	9.7	13.5	18.2	23.0	16.6	72.4	37.3	14.5	17.9	10.7	10.1	22.8	9.5	10.8	12.5	26.4	25.0	25.8

Group 1B	Fit	Ca (%)	Sc	Cr	Fe (%)	Co	Zn	Rb	Zr	Cs	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
ALM 13/10	1.16	0.61	18.1	267.1	5.21	23.2	93.7	97.8	167.9	6.2	609.4	34.3	83.3	6.47	1.36	1.02	3.14	0.442	6.43	1.34	13.01	1.66
ALM 12/84	1.02	0.50	21.3	357.3	5.72	21.8	93.2	137.0	110.8	19.7	341.1	30.2	60.9	6.05	1.34	0.98	2.89	0.426	4.93	0.99	9.44	2.05
ALM 12/88	0.94	0.54	21.2	411.3	5.50	26.5	104.4	152.6	144.9	33.7	262.6	30.7	67.9	6.36	1.39	0.84	2.98	0.466	5.07	0.87	9.28	2.38
ALM 12/91	1.02	0.40	20.0	353.5	5.72	19.3	96.4	118.1	122.4	45.4	362.9	29.2	58.0	6.13	1.32	0.77	2.87	0.416	4.75	0.81	8.23	2.26
ALM 12/93	1.04	0.58	19.0	339.8	5.29	26.3	91.3	123.1	92.0	36.4	333.5	25.0	49.6	5.53	1.25	0.69	2.71	0.400	4.59	0.78	7.47	1.72
ALM 12/94	1.17	0.66	20.3	332.9	5.34	24.1	98.8	111.2	108.5	21.6	218.6	21.8	51.5	4.62	1.00	0.56	2.56	0.372	4.48	0.73	7.26	1.42
ALM 12/97	1.05	0.73	20.5	361.0	6.01	31.3	99.2	115.0	143.4	20.6	310.2	22.6	54.9	4.76	1.02	0.54	2.54	0.403	4.91	0.73	7.60	2.34
Mean		0.58	20.1	346.1	5.54	24.6	96.7	122.1	127.1	26.2	348.3	27.7	60.9	5.70	1.24	0.77	2.81	0.418	5.02	0.89	8.90	1.98
SD		0.1	1.2	43.0	0.3	3.9	4.5	17.9	26.2	13.1	125.4	4.6	11.6	0.8	0.2	0.2	0.2	0.03	0.7	0.2	2.0	0.4
SD (%)		18.8	5.8	12.4	5.2	15.6	4.6	14.7	20.6	49.8	36.0	16.7	19.1	13.2	13.0	24.4	7.9	7.4	13.0	24.3	22.6	19.0

Group 1C	Fit	Ca (%)	Sc	Cr	Fe (%)	Co	Zn	Rb	Zr	Cs	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
ALM 12/71	1.06	6.21	22.3	162.9	5.59	26.0	123.7	100.6	139.6	6.6	592.9	34.5	75.0	6.80	1.46	0.85	3.25	0.594	5.46	1.12	11.76	2.92
ALM 12/76	1.12	6.52	15.7	124.6	4.42	17.8	171.8	105.5	134.8	6.5	546.8	30.3	73.5	5.64	1.07	0.66	2.33	0.367	5.04	1.35	12.27	1.71
ALM 12/77	1.17	6.58	17.1	137.6	4.78	18.3	104.6	111.0	126.5	7.1	508.3	31.5	73.7	5.70	1.10	0.74	2.59	0.422	4.55	1.40	12.44	1.94
ELF 12/01	0.96	6.44	19.8	207.4	5.01	19.7	64.4	142.7	140.3	8.7	558.9	37.7	78.0	6.77	1.41	0.83	2.90	0.394	4.81	1.11	13.04	2.25
KAL 12/20	1.14	5.13	20.3	244.5	5.49	25.4	108.1	85.9	72.4	6.4	373.5	26.1	52.9	5.77	1.34	0.76	3.45	0.471	3.30	0.75	8.98	1.23
Mean		6.18	19.1	175.4	5.06	21.4	114.5	109.1	122.7	7.0	516.1	32.0	70.6	6.1	1.3	0.8	2.9	0.4	4.63	1.15	11.70	2.01
SD		0.6	2.6	49.9	0.5	3.9	38.8	21.0	28.6	1.0	85.2	4.4	10.1	0.6	0.2	0.1	0.5	0.1	0.8	0.3	1.6	0.6
SD (%)		9.7	13.8	28.5	9.6	18.4	33.9	19.2	23.3	13.9	16.5	13.7	14.2	9.7	13.9	9.7	15.8	19.9	17.6	22.5	13.6	31.4

Core Group 2

Group 2	Fit	Ca (%)	Sc	Cr	Fe (%)	Co	Zn	Rb	Zr	Cs	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
AK 12/01	1.00	3.31	15.1	70.4	4.51	15.7	80.3	61.4	146.5	4.60	853.0	28.8	63.0	5.32	1.18	0.70	2.74	0.4	4.84	0.90	10.46	1.87
AK 12/02	0.88	2.51	17.7	116.3	5.17	21.9	72.3	99.0	162.0	6.32	466.0	36.8	85.8	5.59	1.29	0.82	2.86	0.4	5.97	1.28	15.34	1.44
AK 12/03	0.94	2.57	17.4	100.1	4.97	20.5	67.4	88.0	133.7	6.01	415.7	35.7	81.8	5.63	1.30	0.75	2.83	0.4	5.70	1.18	14.58	1.37
AK 12/04	1.09	2.78	15.9	94.1	4.39	18.0	66.5	70.3	101.4	4.09	821.1	25.7	56.5	4.41	1.06	0.54	2.28	0.3	4.86	1.01	11.48	1.20
AK 12/05	0.99	3.83	15.5	144.5	4.60	17.0	82.2	79.4	131.4	6.81	616.0	25.7	57.9	4.75	1.10	0.66	2.72	0.3	4.84	0.91	9.47	1.78
AK 12/06	0.96	3.17	18.0	95.5	4.65	17.7	63.7	70.4	136.7	4.30	837.5	30.4	66.1	5.34	1.19	0.67	2.75	0.4	4.79	0.97	13.27	1.86
AK 12/07	0.98	2.60	16.8	95.3	4.83	17.9	66.8	92.9	163.2	5.66	362.5	32.7	69.1	5.03	1.17	0.66	2.52	0.3	5.81	1.12	13.77	1.57
AK 12/08	1.08	2.98	16.7	98.9	4.76	17.0	64.4	60.3	133.0	3.73	894.1	24.2	60.8	4.20	1.04	0.53	2.26	0.3	4.93	1.03	12.52	1.11
AK 12/09	1.02	3.75	15.5	111.6	4.48	18.2	64.9	62.5	175.2	3.34	861.4	28.9	64.5	4.76	1.13	0.66	2.31	0.34	6.27	1.03	11.72	1.33
AK 12/10	1.04	2.71	16.5	90.0	4.70	18.4	66.6	80.6	113.7	5.21	380.9	29.1	65.6	4.68	1.12	0.64	2.55	0.33	5.06	1.02	13.30	1.39
AK 12/11	1.03	3.18	14.5	147.2	4.51	16.4	87.9	68.4	148.7	5.15	844.1	23.0	51.7	4.35	0.99	0.54	2.28	0.35	4.96	0.79	9.09	1.98
AK 12/12	0.90	2.92	16.2	98.6	4.70	18.9	83.5	80.4	149.7	5.17	622.5	36.3	76.1	5.52	1.27	0.73	2.75	0.39	5.49	1.19	14.21	1.62
AK 12/13	0.93	2.40	16.5	110.2	4.77	20.3	88.6	86.3	134.4	5.28	464.8	34.8	74.7	5.58	1.29	0.69	2.77	0.40	6.00	1.16	13.24	1.45
AK 12/14	0.93	2.62	15.9	111.1	4.87	21.3	77.7	90.7	137.0	5.05	499.9	34.0	72.0	5.26	1.24	0.67	2.67	0.37	5.93	1.15	12.71	1.62
AK 12/15	0.99	2.24	17.2	103.4	4.76	17.7	76.2	81.0	145.5	3.93	849.0	28.6	64.4	4.76	1.11	0.61	2.28	0.35	4.90	1.01	11.92	1.70
AK 12/16	1.02	2.49	15.9	61.9	5.37	16.9	83.6	84.1	148.9	5.73	627.4	28.0	63.1	4.52	1.02	0.51	2.66	0.35	5.53	1.04	12.02	1.64
AK 12/17	0.94	3.35	18.1	97.9	5.82	22.2	95.6	88.4	147.5	5.83	522.3	30.6	65.9	5.28	1.20	0.65	2.82	0.36	5.46	1.01	11.52	1.79
AK 12/18	1.10	2.34	13.9	72.5	3.86	12.5	60.8	69.9	134.8	4.18	776.5	25.5	55.1	4.97	1.12	0.68	2.43	0.35	4.78	0.83	9.60	2.05
AK 12/21	0.94	1.85	17.2	160.8	4.45	21.1	92.4	115.7	147.2	6.51	533.9	31.2	66.0	4.92	0.97	0.59	2.47	0.36	5.32	1.10	12.53	2.69
AK 12/24	1.04	3.08	13.6	59.8	4.16	12.2	77.1	78.4	171.4	5.34	581.8	27.5	65.1	5.00	1.11	0.68	2.44	0.33	4.99	0.86	10.48	2.42
AK 12/25	0.99	2.70	15.6	112.6	4.67	20.8	76.9	75.7	151.2	4.25	585.5	30.5	69.7	5.02	1.20	0.66	2.50	0.37	5.78	1.06	11.69	1.11
AK 12/26	1.01	2.92	18.1	105.0	4.71	17.3	71.2	52.0	129.5	3.36	600.3	31.1	63.4	5.06	1.21	0.64	2.65	0.35	5.46	1.04	13.26	1.35
AK 12/56	1.16	3.46	13.7	50.4	3.67	12.4	73.5	75.2	117.3	4.46	642.4	29.5	60.2	5.31	1.21	0.71	2.87	0.38	5.16	0.83	9.94	1.60
ALM 12/99	1.04	4.07	13.1	87.2	4.05	12.1	78.5	64.5	142.5	3.89	606.7	24.8	56.5	4.85	1.12	0.66	2.55	0.41	4.87	0.81	9.67	1.40

ALM 12/100	0.98	3.47	15.5	72.8	4.67	15.0	86.4	78.4	117.2	5.78	864.9	26.8	62.1	4.93	1.11	0.62	2.60	0.42	5.01	1.00	11.75	1.84
ALM 12/101	0.98	3.65	15.0	108.0	4.29	13.7	78.9	78.8	122.4	5.14	625.4	27.8	62.6	5.17	1.17	0.63	2.64	0.42	5.10	0.94	10.96	1.58
ALM 12/102	1.01	3.27	17.9	66.2	4.58	15.3	81.6	79.1	135.0	7.11	654.5	26.0	56.0	4.78	1.14	0.58	2.42	0.38	4.55	0.85	9.68	1.94
ALM 12/103	1.06	3.38	15.1	58.4	4.26	14.8	81.6	92.6	114.5	6.74	486.7	25.3	59.5	4.39	1.02	0.55	2.51	0.36	4.58	0.96	11.32	2.32
ALM 12/104	1.07	3.40	14.1	63.1	4.12	12.9	77.1	76.6	120.5	4.77	613.6	26.9	58.6	4.71	1.07	0.60	2.59	0.40	4.53	0.82	10.30	2.39
ALM 12/105	1.08	3.76	14.2	78.5	4.23	16.8	69.6	57.2	139.3	4.53	655.5	22.0	59.0	4.21	0.99	0.52	2.37	0.35	4.55	0.82	9.80	1.56
ALM 12/106	1.05	5.11	14.0	62.4	4.05	12.6	73.7	71.1	129.2	4.71	556.0	27.5	57.7	5.14	1.15	0.58	2.96	0.45	4.67	0.77	9.31	1.73
EC 12/13	1.25	4.75	12.9	58.3	3.87	10.7	79.2	51.1	149.4	3.21	521.6	25.0	54.8	4.25	1.00	0.53	2.51	0.36	5.66	0.69	8.60	1.20
DOK 12/01	0.98	3.32	19.1	127.2	4.66	17.0	74.4	76.9	142.7	5.88	324.2	33.2	64.4	5.15	1.18	0.60	2.51	0.37	5.94	1.04	13.21	1.97
DOK 12/02	0.97	4.33	20.8	103.7	4.47	19.3	84.6	74.3	141.0	5.97	223.9	48.3	100.9	6.10	1.24	0.68	2.47	0.37	6.95	1.00	20.37	2.55
DOK 12/03	0.95	2.84	18.0	108.0	4.9	19.2	82.3	89.3	137.9	5.23	390.8	33.7	67.8	5.33	1.27	0.73	2.72	0.44	5.8	1.15	13.43	1.82
DOK 12/04	1.01	3.51	19.7	124.6	4.82	20.3	80.3	59.1	192.8	4.38	294.1	27.7	67.1	4.57	1.08	0.55	2.36	0.38	7.71	1.05	13.71	2.37
DOK 12/09	0.97	3.47	20.1	119.1	4.72	20.2	82.8	74.6	155.4	5.41	306.1	29.9	65.9	4.96	1.13	0.64	2.43	0.40	6.49	1.00	12.91	2.57
KAN 07/46	1.23	4.22	13.3	60.7	3.82	10.6	75.4	55.9	85.5	3.11	829.3	26.5	55.3	4.72	1.13	0.71	2.65	0.33	4.44	0.67	9.10	1.61
KAN 07/47	1.10	3.38	17.2	60.2	4.48	14.4	83.8	66.8	97.2	5.18	807.4	22.4	52.8	4.52	1.11	0.68	2.32	0.31	4.57	0.81	9.64	1.40
KAN 07/48	1.14	5.35	14.3	70.3	4.07	12.8	85.7	51.5	107.2	2.60	807.0	26.6	58.0	5.09	1.16	0.77	2.97	0.36	4.99	0.80	9.19	2.03
KAN 07/49	1.09	3.53	17.0	71.8	4.37	15.8	81.9	59.8	98.5	4.42	976.2	23.1	56.8	4.27	1.05	0.54	2.19	0.33	4.96	0.78	9.91	1.70
KAN 07/50	1.07	3.41	15.1	59.3	4.42	14.5	70.0	65.5	100.1	5.06	1118.9	23.6	52.6	4.31	1.02	0.67	2.39	0.30	4.94	0.85	9.95	2.01
KAN 07/51	1.04	3.31	15.5	68.9	4.25	16.9	68.1	75.1	126.0	4.06	1041.8	28.1	60.3	4.51	1.04	0.62	2.16	0.34	5.25	0.94	12.20	2.77
KAN 07/52	1.19	3.63	17.0	71.5	4.48	19.0	83.3	80.7	94.6	5.06	894.3	18.4	49.1	3.08	0.80	0.37	1.61	0.28	3.74	0.79	11.31	2.72
KAN 07/53	1.06	3.73	13.7	64.5	4.00	12.8	67.1	60.9	161.6	3.77	1697.1	24.3	61.4	4.74	1.10	0.75	2.58	0.33	4.99	0.82	10.08	2.09
KAN 07/54	1.15	3.34	14.6	53.5	4.69	24.4	69.9	57.0	119.0	4.51	809.8	18.4	54.8	3.45	0.88	0.45	1.95	0.28	5.36	0.82	9.73	1.80
KAN 07/55	1.03	3.79	20.9	149.4	5.16	21.2	70.4	63.6	97.1	4.27	1151.1	20.3	57.3	4.20	1.02	0.58	2.12	0.31	4.59	0.94	11.39	1.70
KAN 07/56	1.17	4.22	13.9	59.3	4.19	14.6	77.7	45.1	112.6	3.48	640.4	20.8	52.7	4.23	1.01	0.63	2.54	0.35	4.99	0.70	9.02	1.75
KAN 07/57	1.07	4.03	19.8	94.2	4.92	20.0	65.0	54.5	148.9	3.59	1096.8	19.8	52.2	3.73	0.94	0.50	1.88	0.30	5.78	0.88	12.27	2.19
KAN 07/58	1.11	3.71	14.3	48.4	4.43	14.0	66.0	53.4	114.2	4.25	1316.3	22.8	55.2	4.29	1.02	0.64	2.17	0.32	4.90	0.85	10.12	2.16
KAN 07/59	1.08	2.31	16.4	109.6	4.77	19.6	61.1	78.6	115.9	5.14	1238.3	20.3	53.5	3.39	0.83	0.45	1.86	0.28	4.78	0.85	10.88	2.70

KAN 07/60	1.08	2.88	16.7	59.6	4.34	15.7	65.2	77.3	111.4	5.41	761.8	24.1	55.4	4.16	1.00	0.58	2.36	0.33	4.84	0.82	9.99	2.28
KAN 07/61	1.12	3.77	15.1	65.4	4.33	13.7	71.3	47.8	133.2	3.22	1163.3	23.9	54.5	4.41	1.13	0.67	2.77	0.32	5.48	0.73	9.34	1.95
KAN 07/62	1.05	2.60	16.7	119.9	4.84	15.9	74.9	67.1	112.7	4.15	953.3	24.2	53.6	3.85	1.00	0.57	2.10	0.31	5.62	0.98	10.97	1.61
KAN 07/63	1.01	2.38	19.0	118.6	5.04	17.8	70.1	69.5	96.0	3.89	1218.8	26.6	56.9	4.62	1.11	0.68	2.41	0.36	4.82	0.89	11.19	2.32
KAN 07/64	1.06	3.36	16.5	79.1	4.68	15.8	73.9	68.7	129.7	4.93	625.3	23.1	56.2	4.37	1.09	0.71	2.34	0.32	5.18	0.89	10.68	1.83
KAN 07/65	0.98	4.01	14.6	91.4	4.26	16.3	75.5	67.6	130.8	4.85	1012.2	27.0	64.9	4.89	1.14	0.73	2.32	0.32	5.39	0.95	10.93	1.80
KAN 07/73	0.94	3.31	16.4	100.4	4.82	15.4	78.2	73.0	147.7	5.96	797.1	24.5	57.8	4.18	0.96	0.66	2.12	0.32	6.58	1.29	12.89	2.10
KAN 07/74	1.10	3.60	13.8	65.8	4.13	14.5	68.1	48.8	107.9	3.14	926.6	32.3	67.7	4.34	1.04	0.56	2.31	0.33	4.96	0.76	11.05	1.76
KAN 07/75	1.14	3.26	16.7	100.3	4.89	15.9	64.2	56.2	107.8	4.61	624.2	19.6	41.7	3.31	0.91	0.40	1.79	0.29	5.45	1.07	11.17	1.46
KAN 07/76	1.02	3.40	14.8	92.3	4.19	14.9	73.6	77.6	107.0	5.16	721.4	28.0	57.7	4.89	1.11	0.76	2.36	0.31	4.93	0.81	10.03	1.81
KAN 07/78	1.07	3.55	15.5	64.3	5.06	15.1	72.8	58.9	135.2	4.11	1188.5	23.7	52.6	4.32	1.07	0.61	2.28	0.30	4.95	0.85	10.10	1.41
KAN 07/79	0.97	3.63	14.7	83.3	4.19	14.1	65.1	59.0	129.1	3.59	1279.7	35.7	73.3	5.47	1.20	0.87	2.70	0.33	5.15	0.83	11.79	1.57
KAN 10/10	1.28	4.02	13.8	56.1	3.94	11.6	125.7	37.8	114.9	2.63	921.8	20.5	53.1	4.13	1.06	0.68	2.52	0.39	4.49	0.67	8.39	1.17
KAN 10/11	1.07	4.38	13.8	67.8	4.51	13.0	139.4	45.3	143.4	3.70	1106.8	23.4	57.4	4.70	1.07	0.55	2.89	0.42	4.49	0.76	9.10	1.61
KAN 10/12	1.06	3.25	16.3	125.7	4.83	19.3	67.7	65.6	99.5	3.79	892.9	20.8	57.4	4.25	1.00	0.74	2.18	0.31	4.73	0.95	11.47	1.75
KAN 10/13	1.11	3.90	13.9	68.8	4.17	13.6	78.4	71.5	107.3	4.26	595.9	27.4	61.1	5.00	1.15	0.55	2.50	0.37	4.84	0.84	10.29	1.54
Mean		3.36	16.0	88.7	4.5	16.5	76.7	70.1	129.7	4.67	761.1	27.1	61.3	4.7	1.09	0.6	2.5	0.3	5.2	0.9	11.3	1.8
SD		0.7	1.9	27.0	0.4	3.1	12.7	14.3	21.9	1.0	287.7	5.2	9.1	0.6	0.1	0.1	0.3	0.0	0.7	0.1	2.0	0.4
RSD		20.0	12.0	30.4	8.7	18.9	16.5	20.4	16.9	21.9	37.8	19.4	14.8	12.5	9.7	14.8	11.6	11.0	12.5	15.6	17.3	22.8

Group 2B	Fit	Ca (%)	Sc	Cr	Fe (%)	Co	Zn	Rb	Zr	Cs	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
AK 12/44	1.03	2.69	15.6	231.2	4.29	22.1	84.2	111.1	147.5	5.6	569.9	30.7	64.13	5.47	1.08	0.65	2.74	0.398	5.91	1.12	10.75	2.26
AK 12/48	0.97	2.00	18.1	231.9	4.87	26.7	96.3	133.7	157.3	7.1	512.7	34.0	74.01	5.82	1.14	0.68	2.97	0.422	5.92	1.22	12.28	2.50
AK 12/60	0.98	2.41	16.5	282.3	4.58	23.5	89.2	112.5	190.0	5.9	482.1	31.8	67.08	5.82	1.15	0.76	2.88	0.408	6.84	1.10	11.40	2.42
AK 12/61	1.21	1.63	14.1	210.5	3.80	17.7	82.2	108.6	162.6	5.3	464.2	26.2	54.70	4.35	0.86	0.53	2.35	0.319	5.36	0.98	9.55	2.47
KAN 07/45	0.93	3.53	17.3	247.6	4.76	26.7	100.3	105.1	144.8	4.8	753.2	33.7	69.86	5.97	1.24	0.90	2.78	0.391	6.01	1.10	11.44	2.39
KAN 07/72	1.00	3.50	23.1	237.2	5.66	30.5	89.3	70.1	140.8	3.8	523.8	32.5	71.22	5.42	1.27	0.77	3.26	0.338	5.34	1.02	11.53	1.76
KAN 07/77	1.07	3.47	18.2	196.9	4.76	20.4	79.8	64.7	111.4	5.2	####	27.0	60.26	4.98	1.16	0.78	2.56	0.356	5.10	0.84	9.79	2.57
Mean		2.75	17.6	234.0	4.67	23.9	88.8	100.8	150.6	5.4	619.0	30.8	65.89	5.40	1.13	0.72	2.79	0.376	5.78	1.06	10.96	2.34
SD		0.8	2.8	27.3	0.6	4.3	7.5	24.7	23.8	1.0	204.2	3.1	6.7	0.6	0.1	0.1	0.3	0.04	0.6	0.1	1.0	0.3
SD (%)		28.2	16.1	11.7	12.2	18.2	8.4	24.5	15.8	19.1	33.0	10.1	10.2	10.6	11.8	16.2	10.4	10.3	10.1	11.8	9.1	11.6

Core Group 3

Group 3	Fit	Ca (%)	Sc	Cr	Fe (%)	Co	Zn	Rb	Zr	Cs	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
AK 12/28	1.02	6.54	21.8	254.2	5.70	27.0	94.3	141.3	83.1	8.3	403.3	32.4	61.8	5.7	1.2	0.7	2.7	0.4	3.7	1.0	10.9	2.3
AK 12/30	0.99	7.65	21.0	242.9	5.12	28.1	118.6	155.2	100.8	9.5	777.6	32.4	62.7	5.3	1.1	0.7	2.3	0.4	3.2	0.9	10.8	2.3
AK 12/33	0.98	8.93	20.0	246.4	5.29	25.7	74.6	107.3	94.0	8.7	494.5	35.6	59.7	6.5	1.3	0.9	2.9	0.4	3.8	1.0	10.7	1.9
AK 12/34	1.01	5.61	20.5	236.7	5.44	25.6	87.0	129.7	119.0	7.7	385.0	32.6	64.5	5.9	1.2	0.7	2.7	0.4	4.0	0.9	10.9	2.3
AK 12/35	0.94	8.59	22.4	236.1	5.54	30.8	125.7	146.7	74.1	9.8	315.5	34.8	67.2	5.9	1.2	0.7	2.7	0.5	3.6	1.0	11.6	2.7
AK 12/37	0.99	11.53	20.6	222.8	5.43	28.4	108.3	125.0	98.6	8.1	429.4	33.0	64.7	5.8	1.2	0.7	2.8	0.4	3.5	0.9	10.7	2.7
AK 12/38	1.06	9.19	18.7	222.2	5.09	27.5	79.0	130.3	119.6	9.4	481.2	29.4	61.2	5.3	1.0	0.7	2.3	0.3	3.7	0.9	10.1	2.8
AK 12/41	0.93	10.86	21.2	214.9	5.64	28.0	93.0	149.9	101.8	9.2	392.4	34.7	66.6	6.0	1.2	0.7	2.6	0.4	3.1	1.0	10.9	2.6
AK 12/46	0.96	8.85	22.9	247.6	5.60	31.1	95.6	161.9	113.3	9.7	399.4	35.4	67.4	5.9	1.2	0.7	2.6	0.4	3.4	1.0	11.3	2.0
AK 12/54	1.05	8.57	18.3	202.6	4.71	25.4	109.9	127.4	71.3	8.6	646.6	28.9	60.0	5.2	1.0	0.7	2.3	0.3	3.4	0.9	10.2	2.1
AK 12/62	1.02	8.20	20.8	225.9	5.19	28.6	94.9	151.4	127.1	8.9	403.3	32.1	66.9	5.5	1.2	0.6	2.7	0.4	3.7	0.9	11.1	2.1
AK 12/63	1.02	9.94	20.3	231.2	5.46	29.1	96.3	97.8	88.6	8.8	320.9	32.9	66.3	5.7	1.2	0.6	2.4	0.4	3.8	1.0	10.9	2.1
ALM 12/12	1.01	7.53	20.8	276.0	6.07	28.3	84.2	78.3	106.1	4.6	384.2	31.5	63.9	5.9	1.2	0.5	2.4	0.4	4.1	1.0	11.5	2.6
ALM 12/113	1.05	13.68	16.3	184.1	4.70	26.6	85.7	100.4	77.2	9.5	509.6	26.4	53.8	5.0	1.0	0.6	2.0	0.3	3.2	0.8	9.2	1.9
ALM 12/114	0.92	7.75	21.6	275.0	6.02	30.7	160.1	101.4	113.3	6.5	484.9	31.3	66.0	5.9	1.2	0.5	2.6	0.4	4.3	1.1	12.1	2.4

ALM 12/115	1.01	7.40	18.8	267.6	5.30	27.8	91.4	74.1	130.1	4.1	381.4	31.7	66.0	6.1	1.2	0.6	2.6	0.4	4.3	1.0	11.1	2.0
EC 12/09	1.04	11.29	17.0	249.5	4.19	30.3	121.7	113.4	80.8	8.1	262.0	29.1	55.2	5.4	1.1	0.8	2.4	0.3	3.3	0.8	9.0	1.9
EC 12/16	1.03	8.29	18.3	189.2	5.18	24.1	116.5	123.3	83.6	6.8	326.2	30.0	61.5	5.8	1.2	0.8	2.6	0.4	3.4	0.9	9.9	2.5
EC 12/19	1.02	10.25	20.8	225.7	5.03	29.0	136.2	81.6	96.9	9.0	202.8	32.0	62.7	5.5	1.1	0.7	2.5	0.4	3.4	0.9	10.5	2.4
DOK 12/06	0.93	10.99	22.3	261.5	5.27	36.3	124.5	82.4	102.6	8.6	223.3	35.6	65.0	6.2	1.3	0.8	2.6	0.4	3.6	1.0	11.5	2.4
DOK 12/08	0.91	6.69	22.7	254.6	6.15	33.3	91.9	124.0	108.1	7.2	453.7	32.4	69.6	5.9	1.2	0.8	2.7	0.5	4.0	1.0	12.4	2.8
DOK12/10	0.96	9.13	21.8	246.7	5.57	27.3	91.4	98.7	98.5	5.5	456.9	34.8	69.2	6.04	1.27	1.08	2.99	0.47	4.05	1.03	11.81	2.46
ELF 12/03	1.00	9.30	20.1	221.5	5.26	27.5	104.4	140.7	102.9	8.8	338.7	30.4	61.8	5.31	1.14	0.56	2.31	0.32	3.57	0.92	10.82	2.38
ELF 12/14	1.06	10.05	17.9	219.8	4.41	22.8	79.5	127.7	63.6	10.2	401.5	27.5	53.5	4.79	0.95	0.61	2.21	0.30	3.06	0.83	9.31	2.81
KAL 12/14	1.15	15.54	15.0	173.8	3.98	24.9	111.7	105.1	75.5	8.1	365.7	25.0	47.7	4.55	0.95	0.44	2.14	0.30	2.62	0.64	7.74	2.16
KAL 12/16	1.03	13.19	18.7	206.1	4.87	25.1	130.9	123.9	114.5	8.7	306.9	30.5	59.8	5.58	1.15	0.79	2.49	0.36	3.25	0.82	9.64	2.14
KAL 12/18	1.12	12.90	16.7	222.3	4.43	23.8	99.4	109.0	93.4	7.0	300.2	27.4	54.1	5.07	1.03	0.54	2.20	0.32	3.36	0.75	8.81	1.58
KAL 12/21	1.04	13.60	18.2	196.3	4.76	23.1	120.7	130.6	73.2	8.6	405.3	29.5	57.6	5.05	1.05	0.57	2.28	0.33	2.90	0.77	9.25	2.42
KAL 12/22	1.17	14.21	15.6	180.3	4.11	21.6	126.9	109.2	86.1	6.6	349.2	26.2	52.6	4.72	0.96	0.51	2.08	0.31	3.02	0.73	8.36	1.83
KAL 12/24	1.17	19.42	16.8	186.5	4.35	21.1	110.2	63.3	54.4	4.0	252.3	29.9	56.3	5.25	1.13	0.77	2.18	0.37	2.81	0.74	8.76	1.51
KAL 12/25	1.10	12.40	16.9	204.1	4.50	22.9	105.4	110.3	100.8	6.8	301.4	28.1	55.5	4.95	1.07	0.65	2.26	0.36	3.54	0.78	9.02	2.21
KAL 12/27	1.02	9.90	19.0	223.2	4.97	27.3	127.8	129.9	102.0	7.7	358.1	30.3	59.6	5.19	1.14	0.67	2.29	0.37	3.62	0.84	9.87	2.09
KAL 12/31	0.98	9.60	21.0	241.6	5.36	27.3	120.8	124.6	95.3	8.9	340.1	34.3	67.9	5.90	1.25	0.72	2.54	0.41	3.91	0.96	11.29	2.46
KAL 12/32	1.03	13.89	16.7	200.2	4.31	24.1	118.0	106.3	74.3	6.6	515.0	28.3	54.9	5.15	1.10	0.69	2.54	0.34	3.11	0.72	8.82	2.08
KAL 12/33	1.18	16.37	14.8	172.7	3.83	22.0	101.0	93.3	60.9	5.8	397.2	24.9	48.6	4.53	0.96	0.58	2.13	0.30	2.69	0.64	7.81	2.07
KAL 12/35	1.07	14.29	16.2	185.2	4.17	23.8	108.3	105.7	73.5	6.7	500.0	27.7	53.2	5.02	1.05	0.68	2.37	0.34	3.02	0.76	8.53	2.17
KAL 12/36	1.12	11.67	16.8	174.7	4.34	23.0	106.9	117.0	73.0	7.3	243.2	26.7	52.7	4.59	0.96	0.61	1.94	0.35	2.72	0.73	8.63	2.32
KAL 12/37	1.10	13.28	16.1	193.2	4.23	24.9	113.1	110.4	86.0	6.7	197.2	27.9	53.0	4.99	1.07	0.65	2.19	0.36	3.15	0.73	8.55	2.24
KAL 12/39	0.97	9.61	21.2	238.4	5.17	28.6	120.2	145.1	96.5	8.6	329.7	32.6	62.9	5.40	1.14	0.68	2.67	0.39	3.37	0.89	10.58	2.14
KAL 12/42	1.02	11.11	17.5	200.1	4.40	22.9	115.4	116.6	101.6	7.6	448.3	29.8	58.2	5.39	1.13	0.75	2.35	0.35	3.45	0.81	9.29	2.46
KAL 12/43	1.02	11.51	19.5	209.4	5.01	26.1	130.5	134.4	90.1	8.0	343.4	30.1	58.8	5.11	1.07	0.78	2.26	0.38	3.13	0.78	9.88	2.89
KAL 12/44	0.91	8.57	20.7	241.3	5.37	29.3	112.6	132.8	97.4	8.0	463.1	34.2	67.7	5.95	1.21	0.76	2.55	0.46	3.98	0.96	11.21	2.97
KAL 12/47	1.20	16.96	14.5	175.5	3.93	21.4	104.4	98.5	82.1	6.3	301.7	23.6	45.8	4.28	0.90	0.52	2.00	0.31	2.76	0.66	7.51	1.72
KAL 12/52	1.02	12.76	19.3	208.2	4.64	26.4	126.5	108.2	81.4	6.2	237.0	31.6	62.1	5.45	1.14	0.74	2.59	0.36	3.33	0.88	10.28	1.92
KAL 12/59	0.99	13.56	19.2	200.6	4.89	25.5	118.4	131.0	102.3	8.7	370.4	30.9	60.1	5.41	1.17	0.76	2.55	0.34	3.02	0.83	9.88	2.21
KAL 12/61	1.18	15.45	15.7	183.1	4.00	23.5	97.7	105.1	74.3	6.7	275.6	25.5	49.5	4.54	0.96	0.54	2.01	0.31	2.87	0.68	8.14	2.23
KAL 12/62	1.04	11.78	18.4	210.1	4.80	26.0	125.8	117.4	62.2	7.1	297.4	30.4	59.6	5.31	1.10	0.67	2.63	0.36	3.48	0.84	9.75	2.34
KAL 12/64	1.23	14.12	13.9	187.8	3.59	22.5	87.0	92.4	87.3	5.6	324.5	23.5	45.0	4.26	0.92	0.56	1.94	0.31	3.08	0.65	7.41	1.31
KAL 12/73	1.06	11.16	18.0	207.8	4.52	25.0	107.6	125.7	105.9	7.3	295.0	28.6	56.0	5.00	1.04	0.63	2.22	0.35	3.28	0.80	9.23	1.93
KAL 12/74	1.12	13.66	16.3	187.2	4.31	23.0	105.1	99.1	62.6	6.2	267.3	27.5	53.6	4.85	1.02	0.65	2.19	0.34	3.21	0.76	8.84	2.22
KAL 12/75	0.98	12.11	21.8	235.8	5.36	31.0	128.6	120.4	119.8	10.0	263.1	33.8	66.2	5.73	1.18	0.67	2.40	0.38	3.41	0.91	10.99	1.61
KAL 12/127	1.22	14.00	15.1	176.5	3.97	21.0	105.1	95.6	58.0	5.8	330.0	24.7	48.5	4.40	0.92	0.48	1.98	0.29	2.92	0.69	7.95	1.72

KAL 12/137	1.18	14.47	15.9	194.8	4.18	24.1	102.0	107.1	74.9	7.2	290.2	25.5	48.4	4.46	0.93	0.49	2.04	0.32	2.69	0.70	7.98	1.85
KAN 07/37	1.00	6.39	19.8	252.7	5.33	27.2	84.9	125.2	80.0	7.1	1031.8	28.6	59.6	5.02	1.09	0.67	2.46	0.30	4.11	0.94	10.64	2.80
KAN 07/38	0.94	9.62	22.5	228.7	6.02	29.2	125.1	85.9	103.0	10.7	538.9	33.9	66.2	5.83	1.24	0.77	2.40	0.36	3.57	0.96	11.26	3.11
KAN 07/39	0.94	7.71	20.5	231.1	5.33	28.2	106.4	145.7	70.0	8.1	648.8	31.9	64.2	5.38	1.12	0.63	2.89	0.34	3.86	1.00	11.21	2.39
KAN 07/42	1.01	6.51	20.1	246.9	5.54	26.5	98.5	84.4	88.9	4.6	716.2	30.2	61.4	5.24	1.12	0.58	2.72	0.36	4.40	0.99	11.09	2.80
KAN 07/43	0.97	7.96	19.2	261.5	5.40	24.8	89.2	109.5	110.9	6.5	858.2	30.2	61.2	5.41	1.11	0.74	2.49	0.34	4.25	0.98	10.79	2.07
LAZ 12/06	1.06	12.09	17.9	182.0	4.70	24.3	101.1	119.9	80.6	7.2	575.9	29.3	57.2	5.18	1.10	0.58	2.42	0.37	3.06	0.78	9.36	2.09
LAZ 12/09	0.97	10.02	19.1	205.2	5.00	24.7	103.6	127.8	109.4	8.6	505.3	32.6	64.2	5.71	1.22	0.66	2.46	0.42	3.62	0.92	10.44	2.35
LAZ 12/11	1.01	9.49	20.7	229.1	5.14	29.3	122.3	148.0	96.1	10.3	485.2	30.5	60.8	5.11	1.08	0.65	2.28	0.35	3.38	0.85	10.25	2.37
LAZ 12/28	0.99	10.35	21.2	233.8	5.54	27.4	103.3	134.4	83.6	9.0	415.9	25.9	57.1	4.64	1.01	0.61	2.39	0.36	3.33	0.87	10.65	2.71
LAZ 12/29	1.04	6.65	19.7	242.6	5.02	26.6	95.5	138.2	98.7	8.1	632.3	28.0	57.1	4.94	1.03	0.54	2.31	0.37	3.92	0.89	10.34	1.91
STIR 12/100	1.09	10.77	15.8	175.8	4.23	21.1	122.5	104.0	88.6	6.5	349.1	28.4	56.1	5.33	1.13	0.62	2.45	0.38	3.51	0.75	8.81	1.88
STIR 12/101	0.97	12.11	19.4	208.0	5.07	24.7	112.3	115.5	108.5	7.1	381.6	32.0	61.4	5.56	1.16	0.69	2.64	0.39	3.06	0.83	10.11	2.75
STIR 12/102	0.96	12.88	19.4	216.1	4.87	27.0	171.4	132.5	105.8	8.7	444.4	31.5	62.2	5.69	1.19	0.68	2.69	0.37	3.45	0.84	10.25	2.41
STIR 12/105	1.04	16.26	18.4	227.2	4.62	28.7	147.5	120.5	95.9	8.7	460.7	29.3	54.6	5.20	1.10	0.77	2.10	0.34	2.82	0.73	8.85	1.67
STIR 12/108	1.13	13.41	17.8	202.9	4.40	23.1	144.2	123.2	50.5	8.0	298.0	28.1	55.2	4.94	1.01	0.47	2.48	0.31	2.92	0.74	9.06	1.86
STIR 12/109	1.00	10.05	20.8	224.2	5.33	28.1	164.8	140.9	66.5	8.8	327.7	32.2	63.7	5.73	1.15	0.77	2.78	0.35	3.61	0.94	10.67	1.92
Mean		11.02	18.9	218.0	4.92	26.3	110.8	117.3	90.6	7.7	408.9	30.1	59.4	5.32	1.11	0.66	2.42	0.36	3.42	0.85	9.96	2.23
SD		2.9	2.3	27.4	0.6	3.1	19.7	20.9	18.1	1.5	151.8	3.0	6.0	0.5	0.1	0.1	0.2	0.04	0.4	0.1	1.2	0.4
SD (%)		26.6	12.1	12.6	12.2	11.6	17.8	17.8	20.0	19.3	37.1	10.0	10.2	9.4	8.9	16.3	10.3	11.8	12.8	12.7	12.2	16.9

Group 4	Fit	Ca (%)	Sc	Cr	Fe (%)	Co	Zn	Rb	Zr	Cs	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
ELF 12/05	1.03	6.39	16.7	443.4	4.54	17.8	75.9	78.7	138.2	6.3	291.8	23.5	50.5	4.57	1.00	0.55	2.19	0.274	4.63	0.86	8.10	2.71
ELF 12/12	1.07	8.40	16.7	422.7	4.36	17.9	90.8	77.9	104.4	6.2	356.4	23.3	48.9	4.41	1.00	0.51	2.08	0.287	4.05	0.75	7.91	1.84
KAN 07/31	1.02	11.46	16.3	505.9	4.23	17.3	83.3	48.4	84.7	4.7	874.6	23.0	47.1	4.64	1.01	0.71	2.26	0.303	4.30	0.77	6.98	2.56
KAN 07/33	0.99	10.50	15.5	472.3	4.25	21.9	101.5	67.6	99.5	5.6	579.5	23.3	45.6	4.53	0.98	0.65	2.14	0.308	4.10	0.77	7.17	2.25
KAN 07/40	0.95	8.83	16.1	546.1	4.64	24.2	98.5	64.3	100.4	5.0	708.9	23.2	49.7	4.68	0.99	0.67	2.06	0.302	4.65	0.89	8.09	2.36
KAN 07/44	1.03	11.23	13.9	449.9	3.67	17.0	89.8	72.9	100.7	6.0	896.3	20.9	41.4	4.18	0.88	0.63	1.96	0.257	3.91	0.74	6.40	2.42
KAN 07/83	1.06	11.86	15.0	491.7	3.93	19.1	82.2	49.7	93.5	3.7	990.1	20.5	41.1	4.20	0.92	0.70	2.05	0.289	4.05	0.70	6.23	2.30
LAZ 12/02	0.98	12.10	17.0	466.1	4.67	23.0	95.9	81.8	111.2	7.6	589.3	24.2	48.5	4.70	1.03	0.62	2.04	0.336	3.49	0.73	7.50	2.19
LAZ 12/03	1.08	12.81	13.7	460.0	3.74	19.4	85.1	70.4	88.3	6.5	415.9	20.8	41.9	4.05	0.89	0.45	1.85	0.243	3.59	0.69	6.25	1.90
LAZ 12/04	1.05	12.00	13.6	462.7	3.72	18.8	91.3	69.7	107.8	6.3	515.2	20.5	42.2	4.05	0.84	0.48	1.72	0.271	3.58	0.69	6.20	2.54
LAZ 12/07	1.02	12.52	14.1	477.6	3.81	18.7	83.8	71.1	110.8	6.5	739.7	21.5	42.8	4.18	0.92	0.47	1.87	0.251	3.75	0.70	6.50	2.45
LAZ 12/08	0.96	9.39	19.3	549.7	4.97	33.9	113.6	93.1	77.8	9.0	507.0	23.2	47.1	4.59	1.02	0.57	2.04	0.319	3.42	0.77	7.09	2.47
LAZ 12/10	1.01	12.03	13.8	464.6	3.84	21.6	96.8	68.4	95.9	6.2	790.8	20.9	42.6	4.10	0.90	0.51	1.98	0.294	3.79	0.70	6.34	1.97
LAZ 12/14	1.12	12.99	14.4	377.0	3.82	19.0	116.2	65.8	86.8	5.7	584.6	20.2	39.1	3.98	0.84	0.51	1.87	0.302	2.78	0.56	5.75	2.25
LAZ 12/15	0.96	13.13	16.6	436.6	4.40	24.8	120.1	79.4	120.2	7.5	569.4	23.8	47.1	4.64	1.00	0.59	2.09	0.328	3.28	0.75	7.15	2.05
LAZ 12/16	1.11	12.82	14.0	361.0	3.68	23.8	133.6	67.3	77.8	4.7	964.5	20.0	40.5	4.00	0.86	0.51	1.86	0.243	3.02	0.61	6.05	2.19
LAZ 12/17	1.01	13.59	15.9	413.5	4.30	22.2	112.5	75.8	93.9	6.8	461.4	21.6	42.4	4.30	0.95	0.56	2.13	0.315	3.13	0.65	6.44	2.20
LAZ 12/18	0.94	11.80	17.2	445.9	4.56	28.2	118.6	82.0	99.5	7.3	556.7	23.4	45.9	4.69	1.02	0.57	2.21	0.341	3.42	0.74	6.95	2.85
LAZ 12/19	1.00	13.86	15.6	430.3	4.19	21.1	119.8	79.2	87.0	7.1	498.4	21.9	42.7	4.34	0.91	0.59	1.97	0.309	3.24	0.73	6.64	2.31
LAZ 12/20	1.00	12.45	16.3	443.7	4.45	23.7	124.0	82.2	76.1	7.4	518.4	23.2	47.0	4.58	0.98	0.57	2.13	0.318	3.38	0.75	7.23	2.06
LAZ 12/21	1.11	15.28	14.0	373.6	3.74	21.6	114.3	65.0	95.6	5.5	670.6	19.6	38.3	3.97	0.86	0.49	1.89	0.278	2.88	0.57	5.76	2.22
LAZ 12/22	0.98	11.62	16.1	437.6	4.43	23.7	115.6	80.4	84.7	7.3	591.7	22.9	46.4	4.50	0.97	0.62	2.01	0.328	3.37	0.75	7.02	2.66
LAZ 12/23	0.98	10.41	18.4	493.1	4.55	29.8	133.6	90.3	97.9	8.8	500.8	22.4	45.6	4.55	1.00	0.52	2.01	0.338	3.04	0.67	6.57	3.43
LAZ 12/24	1.06	11.45	15.6	423.8	3.92	15.6	133.0	75.7	107.5	6.4	732.4	21.1	40.5	4.39	0.95	0.48	1.79	0.298	3.20	0.68	6.71	2.30
LAZ 12/25	1.01	13.19	15.4	426.7	4.19	22.7	122.0	73.8	104.7	6.6	586.8	21.8	43.2	4.25	0.92	0.50	1.92	0.309	3.10	0.71	6.63	2.40
LAZ 12/26	1.03	12.93	14.9	403.8	3.95	21.6	125.0	79.8	114.0	7.0	621.7	22.1	44.4	4.26	0.92	0.43	1.83	0.276	3.33	0.72	6.79	2.68
LAZ 12/27	1.01	11.34	13.9	450.8	3.88	21.1	107.0	73.3	118.0	6.3	532.5	21.9	42.9	4.25	0.89	0.54	1.98	0.291	3.72	0.72	6.67	2.19
LAZ 12/30	1.03	9.59	14.6	449.4	3.84	22.2	92.4	73.1	105.1	6.1	563.9	23.0	45.4	4.55	0.94	0.56	2.16	0.310	3.94	0.75	6.80	1.76
Mean		11.64	15.5	449.3	4.15	21.8	106.3	73.5	99.4	6.4	614.6	22.1	44.3	4.36	0.94	0.56	2.00	0.297	3.58	0.72	6.78	2.34
SD		1.9	1.5	44.4	0.4	4.0	17.4	9.9	14.2	1.2	171.4	1.3	3.2	0.2	0.1	0.1	0.1	0.0	0.5	0.1	0.6	0.3
SD (%)		16.0	9.5	9.9	8.8	18.4	16.4	13.5	14.3	18.0	27.9	5.9	7.3	5.5	6.1	13.3	6.8	9.3	13.8	9.9	9.0	14.6

Group 5	Fit	Ca (%)	Sc	Cr	Fe (%)	Co	Zn	Rb	Zr	Cs	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
COE01	1.11	14.09	11.3	425.5	3.65	34.3	104.2	51.6	74.4	4.7	156.7	18.6	37.1	3.45	0.78	0.39	1.51	0.229	2.42	0.55	5.76	1.89
COE10	0.94	14.02	12.4	437.1	3.96	37.6	151.4	58.8	92.8	3.7	240.1	21.8	44.7	4.14	0.82	0.62	1.99	0.267	3.00	0.66	6.80	1.32
COE11	1.08	7.63	14.8	480.1	4.56	36.0	167.5	60.5	64.8	3.5	163.0	17.5	37.4	3.52	0.77	0.57	1.42	0.236	2.69	0.63	5.66	1.32
COE12	0.92	13.48	12.6	466.2	4.05	37.5	141.7	60.6	102.5	3.9	272.3	22.3	46.3	4.26	0.86	0.63	1.74	0.255	2.93	0.66	6.84	1.69
ELF16	1.04	9.30	16.6	468.4	4.83	35.4	80.4	63.8	83.1	3.0	218.5	19.0	40.4	3.87	0.88	0.44	1.91	0.249	2.79	0.60	5.89	1.29
Mean		11.70	13.5	455.5	4.21	36.2	129.0	59.1	83.5	3.8	210.1	19.8	41.2	3.85	0.82	0.53	1.71	0.247	2.77	0.62	6.19	1.50
SD		3.0	2.2	23.0	0.5	1.4	35.8	4.5	14.8	0.6	49.8	2.1	4.2	0.4	0.0	0.1	0.2	0.0	0.2	0.0	0.6	0.3
SD (%)		25.8	16.0	5.1	11.3	4.0	27.7	7.7	17.8	17.0	23.7	10.6	10.2	9.4	6.0	20.7	14.4	6.1	8.3	7.8	9.4	18.2

Unknowns	Ca (%)	Sc	Cr	Fe (%)	Co	Zn	Rb	Zr	Cs	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Th	U
AK 12/20	5.61	17.4	158.1	4.66	18.4	99.8	96.4	117.8	6.9	457.9	27.8	58.2	5.13	1.14	0.62	2.59	0.364	4.60	0.86	9.98	2.23
AK 12/32	5.33	21.8	275.4	5.76	29.5	111.2	79.0	115.5	4.8	485.9	35.0	63.7	5.99	1.21	0.69	2.90	0.421	3.64	0.94	11.32	2.64
AK 12/39	5.14	17.5	332.8	4.63	23.5	78.1	110.7	86.2	6.0	572.6	27.7	57.2	5.00	1.02	0.68	2.08	0.308	3.08	0.84	9.35	2.08
AK 12/53	7.27	17.2	514.0	4.47	22.1	88.2	76.6	111.6	6.5	423.0	25.7	50.8	5.07	1.07	0.72	2.51	0.385	4.38	0.80	8.01	3.65
AK 12/64	0.86	19.8	254.3	5.23	29.3	121.2	138.9	171.3	7.4	455.5	39.0	80.4	7.12	1.50	0.90	3.15	0.470	6.44	1.21	12.95	2.64
ALM 12/10	11.56	18.6	372.7	4.98	29.5	95.4	97.6	96.0	9.0	443.9	25.5	53.0	5.09	1.05	0.51	2.27	0.316	3.50	0.70	8.41	2.46
ALM 12/11	10.67	23.3	823.2	6.80	38.9	109.9	59.7	80.2	15.0	432.5	24.3	55.5	5.26	1.05	1.12	2.70	0.361	4.09	1.05	10.32	2.06
ALM 12/17	9.01	23.8	842.3	7.19	45.4	115.7	98.0	98.2	11.2	590.4	24.7	59.0	5.38	1.04	0.97	2.47	0.364	4.26	1.11	11.29	2.03
ALM 12/26	5.33	20.7	1002.3	5.44	40.2	118.3	73.0	107.3	7.6	466.9	31.1	67.1	6.24	1.17	0.62	2.79	0.383	4.43	0.91	10.73	2.99
ALM 12/35	10.09	20.6	462.3	6.06	35.6	101.8	56.8	62.6	4.9	569.8	27.7	56.8	5.84	1.16	0.70	2.63	0.393	3.54	0.83	9.51	1.69
ALM 12/44	5.30	22.1	997.7	5.53	37.2	120.7	88.1	90.4	9.6	740.7	29.4	63.2	5.74	1.11	0.75	2.49	0.376	4.71	0.98	11.05	2.49
ALM 12/61	2.02	20.6	590.2	5.71	30.3	104.4	99.0	92.4	26.1	344.4	29.4	58.4	6.31	1.24	0.85	2.58	0.406	4.54	0.86	8.75	1.91
ALM 12/64	6.05	20.2	582.5	5.12	30.9	109.2	112.3	101.8	14.4	413.5	22.4	48.7	4.75	1.00	0.54	2.36	0.374	3.68	0.76	7.97	2.55
ALM 12/67	2.24	20.1	554.8	13.62	51.0	114.5	134.2	135.4	45.5	295.9	27.6	54.0	5.82	1.26	0.76	2.79	0.392	3.62	0.81	7.60	4.29
ALM 12/70	3.56	22.5	441.8	5.52	27.9	113.0	116.8	144.1	32.5	301.6	27.6	57.3	5.56	1.23	0.71	2.60	0.432	4.41	0.87	8.69	1.95

ALM 12/72	3.07	18.0	147.7	5.31	21.7	100.1	100.4	153.5	8.1	527.5	31.7	80.2	5.86	1.09	0.67	2.88	0.449	6.19	1.30	13.04	2.59
ALM 12/74	1.47	18.7	154.4	5.31	17.6	95.4	102.0	157.9	7.7	579.7	35.5	83.8	6.65	1.25	0.84	3.25	0.492	6.50	1.35	13.77	3.43
ALM 12/75	2.69	17.9	208.0	5.31	23.6	89.9	120.3	127.9	8.7	435.6	30.8	86.5	5.96	1.15	0.70	3.08	0.469	6.00	1.33	14.23	1.74
ALM 12/78	16.71	10.9	197.4	4.76	18.7	78.5	50.7	72.4	4.1	331.8	23.2	40.8	4.19	0.87	0.56	2.11	0.323	2.62	0.69	6.89	1.55
ALM 12/79	1.40	26.7	321.1	6.70	26.7	136.2	78.2	117.8	4.6	296.4	27.9	49.8	6.53	1.73	1.06	3.08	0.482	3.56	0.64	7.31	1.53
ALM 12/83	2.69	20.5	461.8	5.43	29.0	105.5	116.8	120.6	23.6	316.8	25.6	54.8	5.17	1.12	0.99	2.37	0.375	4.50	0.88	8.26	1.58
ALM 12/85	2.29	19.6	375.4	5.17	23.1	88.1	93.0	128.3	10.0	221.9	21.7	48.8	4.45	0.97	0.53	2.16	0.348	4.51	0.75	7.03	1.78
ALM 12/96	1.88	21.4	306.5	6.31	28.9	79.9	56.8	84.7	4.4	324.5	24.8	49.2	5.57	1.35	0.70	2.61	0.359	3.34	0.72	7.31	1.19
ALM 12/98	5.65	15.9	225.4	4.93	19.1	151.9	66.1	87.7	7.6	562.2	23.1	46.7	4.81	1.06	0.70	2.98	0.394	3.74	0.65	7.38	2.06
ALM 12/119	7.94	15.3	364.6	4.28	24.7	78.0	91.8	148.3	5.6	269.5	22.5	46.5	4.30	0.98	0.49	2.04	0.277	3.74	0.83	7.11	2.40
ALM 13/05	9.59	21.7	623.5	5.24	36.6	111.2	114.0	115.5	14.4	407.7	26.9	56.7	5.90	1.18	0.60	2.42	0.359	4.04	0.84	8.99	1.56
ALM 13/08	7.63	21.1	661.1	5.33	36.8	167.3	119.8	89.5	18.9	337.1	28.5	61.4	5.76	1.19	0.63	2.67	0.417	4.51	0.90	9.23	2.96
EC 12/15	14.77	12.9	486.6	4.43	48.3	108.8	49.6	61.9	3.0	199.6	17.4	37.2	3.47	0.71	0.37	1.48	0.223	2.32	0.58	5.63	1.14
EC 12/20	9.62	18.3	174.1	4.26	14.3	93.3	60.7	84.4	5.0	529.2	27.9	57.4	5.39	1.13	0.79	2.67	0.418	4.76	0.92	10.54	1.75
EC 12/21	10.74	19.0	274.6	4.75	28.3	137.0	118.0	90.7	6.0	329.7	25.9	54.7	4.91	1.01	0.61	2.16	0.325	3.59	0.90	10.09	2.59
DOK 12/05	0.56	15.0	116.7	4.70	16.9	99.3	90.8	207.0	4.7	300.4	58.6	113.6	10.39	2.06	1.47	4.37	0.625	7.92	2.24	14.77	3.28
DOK 12/07	7.22	20.7	210.0	5.52	23.5	74.5	92.6	127.8	4.0	569.7	33.2	72.9	6.64	1.44	0.94	2.85	0.452	4.58	1.08	11.59	2.36
ELF 12/04	3.35	19.8	196.0	4.99	18.6	73.1	143.3	154.1	8.9	554.6	36.3	77.0	6.50	1.32	0.75	2.97	0.404	4.78	1.13	12.79	2.80
ELF 12/08	12.63	21.3	716.8	5.71	38.1	120.8	112.8	93.9	13.3	495.9	24.2	51.6	4.95	1.03	0.57	2.26	0.315	3.32	0.87	9.13	2.01
KAL 12/06	5.89	24.4	271.2	6.22	33.4	163.5	68.8	108.4	3.8	275.0	39.3	76.2	7.10	1.45	0.96	3.15	0.454	4.07	1.10	12.88	2.64
KAL 12/29	17.34	13.2	181.4	3.52	21.4	96.1	85.2	63.2	5.2	278.5	22.7	44.6	4.10	0.87	0.52	1.72	0.283	2.47	0.57	7.00	1.82
KAL 12/41	16.20	14.0	175.0	3.50	20.1	94.9	97.5	64.2	7.2	214.0	22.5	43.9	4.04	0.86	0.57	1.79	0.290	2.69	0.64	7.17	2.20
KAL 12/56	7.30	26.0	303.4	6.97	34.1	145.4	141.2	138.6	7.9	294.6	40.7	79.7	6.63	1.39	0.92	3.08	0.447	3.89	1.09	13.36	2.73
KAL 12/125	17.60	14.6	173.3	3.55	21.4	107.4	96.8	52.6	6.3	204.4	22.5	42.9	3.89	0.82	0.54	1.65	0.262	2.09	0.54	6.86	1.40
KAL 12/126	16.37	15.0	185.7	3.78	22.6	132.5	107.9	105.3	7.0	252.2	23.4	45.1	4.04	0.85	0.42	2.07	0.263	2.16	0.59	7.16	1.79
KAN 07/35	0.56	17.9	101.9	6.35	17.1	56.2	86.8	152.3	4.6	542.9	47.1	109.2	7.32	1.35	0.79	3.05	0.447	6.75	2.01	16.54	3.29
KAN 07/36	11.08	25.2	262.7	6.54	27.9	97.6	98.3	108.4	5.9	883.3	25.3	56.0	4.57	1.03	0.60	2.62	0.375	3.87	1.09	12.48	2.98

KAN 07/41	6.68	23.2	283.7	6.08	31.6	103.9	161.1	102.5	8.9	997.7	32.1	65.3	5.06	1.05	0.63	2.59	0.354	3.78	0.99	11.69	3.30
KAN 07/66	5.66	15.5	1067.8	4.98	55.3	83.6	24.7	123.7	1.4	597.1	20.6	46.5	3.94	0.82	0.51	2.00	0.266	3.91	0.72	7.11	1.74
KAN 07/69	9.99	14.6	347.0	4.25	32.1	83.7	45.4	99.0	2.5	483.5	20.3	44.3	4.04	0.84	0.62	1.96	0.245	4.12	0.69	8.06	2.08
KAN 07/70	5.01	14.0	303.3	3.99	30.1	81.5	74.3	160.1	7.4	640.8	47.6	70.1	11.06	1.56	1.52	5.01	0.667	6.05	0.93	13.42	4.51
KAN 07/80	3.54	21.1	259.9	5.18	24.3	96.8	100.5	77.7	25.2	885.4	31.7	63.4	4.93	1.01	0.67	2.54	0.380	3.60	0.92	11.24	3.69
KAN 07/81	1.06	15.1	314.9	4.52	26.9	84.9	89.9	143.3	4.8	640.0	22.8	53.4	4.73	0.82	0.73	2.80	0.376	5.47	0.89	11.03	2.47
KAN 07/82	2.03	15.1	458.0	4.46	35.0	79.7	70.6	109.7	4.1	858.1	24.0	52.8	4.52	0.81	0.65	2.07	0.301	4.49	0.80	8.64	2.24
KAN 07/84	10.90	12.7	261.0	3.78	17.7	79.5	75.3	97.0	6.9	708.3	26.1	55.5	4.85	0.98	0.69	2.27	0.300	4.70	0.94	8.96	2.04
KAN 07/85	2.17	15.8	335.1	4.86	23.3	97.1	98.1	136.6	8.1	1133.6	29.4	62.4	5.16	0.98	0.71	2.67	0.347	5.37	1.26	10.56	2.52
KAN 07/87	0.78	13.2	106.2	3.70	10.0	92.9	48.6	237.4	3.3	896.2	48.7	93.8	10.98	2.26	1.79	4.37	0.575	9.88	2.66	13.13	4.65
KAN 07/88	8.06	15.6	375.9	4.37	30.8	65.0	63.6	95.0	3.6	393.5	27.8	58.3	5.15	0.95	0.65	1.93	0.275	3.31	0.66	10.60	2.03
KAN 07/90	9.41	15.4	587.2	4.33	20.2	70.9	43.5	126.2	5.4	392.4	21.8	46.7	4.34	0.91	0.62	2.01	0.306	4.91	0.79	7.29	3.62
KAN 10/14	2.42	16.7	434.5	5.08	36.8	76.4	65.1	121.4	3.9	840.7	25.7	55.8	5.50	0.97	0.63	2.58	0.381	4.87	0.98	10.67	1.81
KAN 10/15	3.70	16.8	1512.3	5.57	54.7	94.6	49.6	103.2	5.1	679.8	21.2	53.2	4.24	0.81	0.63	1.79	0.272	4.22	0.74	7.34	1.71
KAN 10/04	6.39	16.3	412.6	4.73	31.9	103.7	64.0	96.5	2.8	1301.7	21.7	47.7	4.24	0.92	0.49	2.03	0.258	3.43	0.74	8.15	1.78
KAN 10/07	6.86	16.3	401.8	5.03	34.9	119.5	43.2	74.6	1.7	915.2	24.1	51.8	4.89	1.10	0.66	3.15	0.469	3.27	0.76	8.23	2.00
LAZ 12/01	9.64	15.3	593.2	4.33	21.4	104.0	65.6	140.5	5.3	407.3	21.8	42.6	4.41	0.97	0.58	2.32	0.295	4.10	0.71	6.30	1.88
LAZ 12/05	13.43	15.2	446.7	3.87	24.7	105.2	77.7	92.6	7.5	522.5	20.5	40.9	4.20	0.89	0.47	1.91	0.314	2.88	0.59	6.10	3.49
STIR 12/114	7.10	19.2	743.8	6.20	57.9	104.3	20.5	94.0	0.2	341.1	25.1	52.9	4.98	1.10	0.67	2.58	0.340	3.71	0.79	7.90	1.23

Saronic Gulf Complete Dataset

Saronic Gulf	As	Ba	Ca	Ce	Co	Cr	Cs	Dy	Eu	Fe	Hf	K	La	Lu	Mn	Na	Nd	Ni	Rb	Sb	Sc	Sm	Sr	Ta	Tb	Th	Ti	U	V	Yb	Zn	Zr
AK 12/01	4.6	853.0	3.3	63.0	15.7	70.4	4.6	4.5	1.2	4.5	4.8	1.4	28.8	0.4	908.4	1.5	22.5	0.0	61.4	0.4	15.1	5.3	315.8	0.9	0.7	10.5	5064.4	1.9	124.8	2.7	80.3	146.5
AK 12/02	7.3	466.0	2.5	85.8	21.9	116.3	6.3	4.2	1.3	5.2	6.0	1.4	36.8	0.4	1186.0	1.4	24.6	0.0	99.0	0.6	17.7	5.6	182.7	1.3	0.8	15.3	5555.0	1.4	121.7	2.9	72.3	162.0
AK 12/03	6.4	415.7	2.6	81.8	20.5	100.1	6.0	4.4	1.3	5.0	5.7	1.3	35.7	0.4	1157.1	1.4	25.3	39.5	88.0	0.6	17.4	5.6	242.2	1.2	0.7	14.6	4788.8	1.4	124.2	2.8	67.4	133.7
AK 12/04	4.3	821.1	2.8	56.5	18.0	94.1	4.1	3.6	1.1	4.4	4.9	1.1	25.7	0.3	1051.7	1.3	19.9	54.7	70.3	0.4	15.9	4.4	246.2	1.0	0.5	11.5	5249.2	1.2	122.6	2.3	66.5	101.4
AK 12/05	3.5	616.0	3.8	57.9	17.0	144.5	6.8	5.2	1.1	4.6	4.8	1.8	25.7	0.3	986.3	1.8	19.0	92.9	79.4	0.6	15.5	4.8	334.9	0.9	0.7	9.5	6459.5	1.8	154.1	2.7	82.2	131.4
AK 12/06	5.5	837.5	3.2	66.1	17.7	95.5	4.3	4.4	1.2	4.7	4.8	1.9	30.4	0.4	839.6	1.6	23.9	34.2	70.4	0.5	18.0	5.3	311.0	1.0	0.7	13.3	4769.5	1.9	120.0	2.8	63.7	136.7
AK 12/07	5.9	362.5	2.6	69.1	17.9	95.3	5.7	4.2	1.2	4.8	5.8	1.4	32.7	0.3	966.2	1.3	25.0	46.5	92.9	0.6	16.8	5.0	220.1	1.1	0.7	13.8	5816.6	1.6	141.6	2.5	66.8	163.2
AK 12/08	4.0	894.1	3.0	60.8	17.0	98.9	3.7	3.6	1.0	4.8	4.9	1.3	24.2	0.3	847.2	1.3	17.2	0.0	60.3	0.4	16.7	4.2	267.2	1.0	0.5	12.5	5055.9	1.1	102.7	2.3	64.4	133.0
AK 12/09	4.1	861.4	3.7	64.5	18.2	111.6	3.3	3.9	1.1	4.5	6.3	1.1	28.9	0.3	1000.2	1.2	20.9	43.8	62.5	0.4	15.5	4.8	264.8	1.0	0.7	11.7	5313.3	1.3	118.7	2.3	64.9	175.2
AK 12/10	6.0	380.9	2.7	65.6	18.4	90.0	5.2	4.0	1.1	4.7	5.1	1.2	29.1	0.3	1000.6	1.4	20.9	49.1	80.6	0.5	16.5	4.7	191.0	1.0	0.6	13.3	4996.5	1.4	130.6	2.5	66.6	113.7
AK 12/11	4.0	844.1	3.2	51.7	16.4	147.2	5.2	3.9	1.0	4.5	5.0	1.9	23.0	0.3	811.1	1.5	20.6	78.5	68.4	0.6	14.5	4.3	341.7	0.8	0.5	9.1	4537.5	2.0	129.8	2.3	87.9	148.7
AK 12/12	6.9	622.5	2.9	76.1	18.9	98.6	5.2	4.7	1.3	4.7	5.5	1.7	36.3	0.4	1150.5	1.5	26.1	63.3	80.4	0.5	16.2	5.5	232.7	1.2	0.7	14.2	6295.7	1.6	117.6	2.7	83.5	149.7
AK 12/13	8.0	464.8	2.4	74.7	20.3	110.2	5.3	4.7	1.3	4.8	6.0	1.5	34.8	0.4	1482.5	1.3	27.0	79.7	86.3	0.5	16.5	5.6	181.3	1.2	0.7	13.2	5118.5	1.4	132.8	2.8	88.6	134.4
AK 12/14	7.8	499.9	2.6	72.0	21.3	111.1	5.1	4.3	1.2	4.9	5.9	1.7	34.0	0.4	1517.5	1.3	25.1	41.3	90.7	0.6	15.9	5.3	187.5	1.1	0.7	12.7	7060.4	1.6	139.6	2.7	77.7	137.0
AK 12/15	6.4	849.0	2.2	64.4	17.7	103.4	3.9	4.1	1.1	4.8	4.9	1.8	28.6	0.4	1125.3	1.2	22.7	0.0	81.0	0.5	17.2	4.8	241.2	1.0	0.6	11.9	4816.0	1.7	98.3	2.3	76.2	145.5
AK 12/16	5.5	627.4	2.5	63.1	16.9	61.9	5.7	3.8	1.0	5.4	5.5	1.7	28.0	0.4	789.0	1.4	20.5	0.0	84.1	0.4	15.9	4.5	288.8	1.0	0.5	12.0	4993.4	1.6	142.3	2.7	83.6	148.9
AK 12/17	4.7	522.3	3.3	65.9	22.2	97.9	5.8	4.5	1.2	5.8	5.5	1.7	30.6	0.4	1227.7	1.6	23.0	50.7	88.4	0.4	18.1	5.3	261.0	1.0	0.7	11.5	5553.2	1.8	177.7	2.8	95.6	147.5
AK 12/18	4.6	776.5	2.3	55.1	12.5	72.5	4.2	3.3	1.1	3.9	4.8	1.2	25.5	0.4	548.4	1.3	23.3	40.3	69.9	0.4	13.9	5.0	294.6	0.8	0.7	9.6	4463.4	2.0	86.5	2.4	60.8	134.8
AK 12/20	4.5	457.9	5.6	58.2	18.4	158.1	6.9	4.1	1.1	4.7	4.6	1.8	27.8	0.4	1300.9	1.3	21.1	86.1	96.4	0.5	17.4	5.1	346.6	0.9	0.6	10.0	4581.3	2.2	156.2	2.6	99.8	117.8
AK 12/21	4.8	533.9	1.8	66.0	21.1	160.8	6.5	4.2	1.0	4.4	5.3	2.4	31.2	0.4	959.3	1.2	25.1	59.0	115.7	0.7	17.2	4.9	161.6	1.1	0.6	12.5	5196.7	2.7	121.6	2.5	92.4	147.2
AK 12/22	18.1	383.4	3.8	58.9	34.1	724.3	23.8	4.9	1.2	5.7	4.6	2.3	28.3	0.4	775.2	0.5	27.1	341.7	115.6	1.0	23.2	6.0	104.6	1.0	0.7	9.6	6116.0	2.9	133.8	2.7	120.6	105.3
AK 12/23	18.5	620.1	3.9	67.8	38.0	623.1	17.6	4.4	1.1	4.8	4.6	2.6	31.0	0.4	849.9	0.5	25.2	247.2	129.2	0.9	20.4	5.8	134.8	0.9	0.6	10.4	5490.2	2.3	121.1	2.4	121.8	132.0
AK 12/24	4.8	581.8	3.1	65.1	12.2	59.8	5.3	4.1	1.1	4.2	5.0	1.8	27.5	0.3	709.5	1.6	22.4	0.0	78.4	0.4	13.6	5.0	335.8	0.9	0.7	10.5	6683.5	2.4	104.3	2.4	77.1	171.4
AK 12/25	5.6	585.5	2.7	69.7	20.8	112.6	4.2	4.5	1.2	4.7	5.8	1.4	30.5	0.4	1536.7	1.5	23.0	57.3	75.7	0.5	15.6	5.0	202.3	1.1	0.7	11.7	5722.4	1.1	135.7	2.5	76.9	151.2
AK 12/26	6.9	600.3	2.9	63.4	17.3	105.0	3.4	4.3	1.2	4.7	5.5	1.2	31.1	0.3	906.9	1.4	25.1	54.0	52.0	0.4	18.1	5.1	242.3	1.0	0.6	13.3	5462.7	1.3	137.9	2.6	71.2	129.5

AK 12/28	3.1	403.3	6.5	61.8	27.0	254.2	8.3	4.3	1.2	5.7	3.7	2.3	32.4	0.4	882.1	0.3	27.2	144.3	141.3	0.6	21.8	5.7	198.3	1.0	0.7	10.9	5371.7	2.3	158.8	2.7	94.3	83.1
AK 12/30	3.6	777.6	7.6	62.7	28.1	242.9	9.5	4.3	1.1	5.1	3.2	3.1	32.4	0.4	933.9	0.3	24.5	144.3	155.2	0.4	21.0	5.3	264.8	0.9	0.7	10.8	5607.5	2.3	183.6	2.3	118.6	100.8
AK 12/32	4.5	485.9	5.3	63.7	29.5	275.4	4.8	4.9	1.2	5.8	3.6	1.8	35.0	0.4	961.0	0.3	26.1	192.4	79.0	0.4	21.8	6.0	129.0	0.9	0.7	11.3	5660.8	2.6	140.0	2.9	111.2	115.5
AK 12/33	4.3	494.5	8.9	59.7	25.7	246.4	8.7	4.6	1.3	5.3	3.8	1.5	35.6	0.4	1062.8	0.9	29.2	151.2	107.3	0.6	20.0	6.5	310.9	1.0	0.9	10.7	5566.6	1.9	150.3	2.9	74.6	94.0
AK 12/34	4.3	385.0	5.6	64.5	25.6	236.7	7.7	4.1	1.2	5.4	4.0	2.5	32.6	0.4	950.6	0.5	27.4	108.8	129.7	0.6	20.5	5.9	176.5	0.9	0.7	10.9	5315.9	2.3	121.9	2.7	87.0	119.0
AK 12/35	5.8	315.5	8.6	67.2	30.8	236.1	9.8	4.2	1.2	5.5	3.6	2.5	34.8	0.5	1176.0	0.7	27.3	166.8	146.7	0.6	22.4	5.9	235.8	1.0	0.7	11.6	6143.7	2.7	168.0	2.7	125.7	74.1
AK 12/36	16.8	463.0	5.0	62.1	38.4	893.7	18.2	3.6	1.2	5.9	4.2	2.1	28.7	0.3	873.4	0.6	26.0	340.6	125.2	1.1	22.9	5.8	100.0	0.9	0.6	10.4	8097.4	2.0	139.0	2.4	123.8	119.5
AK 12/37	3.3	429.4	11.5	64.7	28.4	222.8	8.1	4.7	1.2	5.4	3.5	2.3	33.0	0.4	1079.1	0.7	29.5	133.6	125.0	0.5	20.6	5.8	426.8	0.9	0.7	10.7	5342.2	2.7	161.5	2.8	108.3	98.6
AK 12/38	2.5	481.2	9.2	61.2	27.5	222.2	9.4	3.6	1.0	5.1	3.7	2.0	29.4	0.3	938.0	0.5	26.0	106.4	130.3	0.5	18.7	5.3	331.6	0.9	0.7	10.1	6452.0	2.8	106.5	2.3	79.0	119.6
AK 12/39	10.1	572.6	5.1	57.2	23.5	332.8	6.0	4.1	1.0	4.6	3.1	2.8	27.7	0.3	599.3	0.7	23.8	180.1	110.7	0.7	17.5	5.0	227.9	0.8	0.7	9.3	4957.0	2.1	128.0	2.1	78.1	86.2
AK 12/41	8.2	392.4	10.9	66.6	28.0	214.9	9.2	4.2	1.2	5.6	3.1	2.5	34.7	0.4	1153.8	0.4	27.7	143.3	149.9	0.6	21.2	6.0	340.4	1.0	0.7	10.9	5794.9	2.6	156.5	2.6	93.0	101.8
AK 12/42	83.7	481.2	5.0	65.0	31.3	504.8	23.2	4.6	1.2	5.6	4.3	2.4	30.4	0.4	828.4	0.7	28.4	271.8	146.2	1.2	20.8	6.0	133.8	0.9	0.7	9.8	5571.4	1.8	114.2	2.5	142.8	95.1
AK 12/43	7.6	493.8	6.6	63.7	23.7	181.0	4.7	4.2	1.2	5.0	4.1	1.9	29.1	0.3	1086.1	1.1	26.4	93.3	96.0	0.6	18.3	5.8	166.9	1.0	0.8	10.2	5394.9	1.6	113.2	2.4	79.0	103.5
AK 12/44	3.8	569.9	2.7	64.1	22.1	231.2	5.6	4.3	1.1	4.3	5.9	2.0	30.7	0.4	890.8	1.1	24.9	108.7	111.1	0.5	15.6	5.5	203.8	1.1	0.6	10.8	5391.7	2.3	115.9	2.7	84.2	147.5
AK 12/45	27.3	580.4	6.1	54.8	35.0	560.6	15.3	4.3	1.1	5.0	4.3	1.9	25.9	0.4	662.7	0.5	22.9	289.5	119.1	0.9	20.2	5.4	221.1	0.8	0.6	8.7	4832.7	1.9	108.6	2.3	98.0	125.1
AK 12/46	3.9	399.4	8.8	67.4	31.1	247.6	9.7	4.2	1.2	5.6	3.4	3.2	35.4	0.4	1087.4	0.3	29.0	191.1	161.9	0.5	22.9	5.9	305.8	1.0	0.7	11.3	5295.2	2.0	165.8	2.6	95.6	113.3
AK 12/47	20.3	536.9	5.4	54.1	37.8	628.0	13.5	3.6	1.0	5.0	4.1	2.1	23.1	0.3	923.7	0.6	21.3	308.9	108.8	1.1	20.1	4.8	149.1	0.9	0.6	8.6	5238.7	2.2	113.2	2.1	104.6	108.3
AK 12/48	3.5	512.7	2.0	74.0	26.7	231.9	7.1	4.4	1.1	4.9	5.9	2.3	34.0	0.4	1158.6	0.9	28.9	97.6	133.7	0.6	18.1	5.8	146.1	1.2	0.7	12.3	5202.8	2.5	131.5	3.0	96.3	157.3
AK 12/53	7.6	423.0	7.3	50.8	22.1	514.0	6.5	4.1	1.1	4.5	4.4	2.0	25.7	0.4	581.7	1.1	21.7	263.3	76.6	0.8	17.2	5.1	286.7	0.8	0.7	8.0	4802.7	3.7	95.7	2.5	88.2	111.6
AK 12/54	3.5	646.6	8.6	60.0	25.4	202.6	8.6	4.2	1.0	4.7	3.4	2.5	28.9	0.3	931.6	0.7	30.0	106.9	127.4	0.6	18.3	5.2	425.4	0.9	0.7	10.2	5926.4	2.1	140.9	2.3	109.9	71.3
AK 12/55	7.8	619.5	6.4	56.2	21.1	424.8	5.2	4.1	1.1	4.6	4.9	1.5	28.4	0.4	871.9	1.1	23.3	160.9	76.7	0.8	16.7	5.3	356.0	0.9	0.7	8.6	6855.9	2.2	103.8	2.4	74.6	110.2
AK 12/56	2.1	642.4	3.5	60.2	12.4	50.4	4.5	4.4	1.2	3.7	5.2	1.4	29.5	0.4	850.3	1.7	23.8	23.7	75.2	0.3	13.7	5.3	362.2	0.8	0.7	9.9	4173.1	1.6	103.2	2.9	73.5	117.3
AK 12/57	20.9	588.7	4.1	51.0	32.8	704.1	18.0	3.4	0.8	5.0	4.3	2.1	21.8	0.3	697.5	0.6	17.5	355.1	111.6	0.9	20.4	4.2	153.7	0.8	0.4	8.0	5072.9	2.0	107.3	2.1	116.0	120.5
AK 12/58	50.7	447.5	6.1	67.7	41.0	724.0	32.2	4.1	1.2	7.0	3.8	2.8	31.7	0.3	755.2	0.5	25.7	396.5	174.3	1.7	23.8	5.9	138.0	1.1	0.7	10.9	5567.7	2.8	156.2	2.4	156.6	100.1
AK 12/59	47.3	460.0	6.9	67.2	40.1	659.8	27.5	4.5	1.2	6.5	3.7	2.8	32.5	0.3	806.0	0.4	29.3	402.4	163.5	1.7	23.3	6.1	101.4	1.0	0.7	10.9	5698.1	2.6	161.9	2.7	133.7	93.7
AK 12/60	3.7	482.1	2.4	67.1	23.5	282.3	5.9	5.0	1.1	4.6	6.8	1.9	31.8	0.4	1007.3	1.0	26.4	125.6	112.5	0.6	16.5	5.8	145.7	1.1	0.8	11.4	5481.9	2.4	122.2	2.9	89.2	190.0
AK 12/61	3.1	464.2	1.6	54.7	17.7	210.5	5.3	3.7	0.9	3.8	5.4	2.1	26.2	0.3	543.9	1.0	21.0	97.4	108.6	0.4	14.1	4.3	112.9	1.0	0.5	9.5	6573.6	2.5	106.2	2.4	82.2	162.6

AK 12/62	2.8	403.3	8.2	66.9	28.6	225.9	8.9	4.1	1.2	5.2	3.7	2.9	32.1	0.4	1135.3	0.5	26.6	112.8	151.4	0.5	20.8	5.5	272.8	0.9	0.6	11.1	5679.5	2.1	145.2	2.7	94.9	127.1
AK 12/63	3.3	320.9	9.9	66.3	29.1	231.2	8.8	3.8	1.2	5.5	3.8	1.4	32.9	0.4	1058.9	1.1	28.9	124.7	97.8	0.7	20.3	5.7	371.9	1.0	0.6	10.9	4906.8	2.1	139.7	2.4	96.3	88.6
AK 12/64	6.9	455.5	0.9	80.4	29.3	254.3	7.4	5.5	1.5	5.2	6.4	2.6	39.0	0.5	1152.3	0.8	32.7	129.3	138.9	0.6	19.8	7.1	62.3	1.2	0.9	13.0	5874.9	2.6	147.3	3.2	121.2	171.3
AK 12/65	4.0	412.3	3.6	47.7	21.3	580.9	6.4	5.3	1.0	4.4	4.4	3.2	23.1	0.3	812.1	1.2	21.3	272.8	69.9	0.8	15.5	4.6	455.5	0.8	0.6	6.4	5202.5	2.2	122.9	2.1	105.0	113.4
ALM 12/01	30.4	491.6	5.4	62.5	39.5	820.9	11.2		1.2	6.2	4.6		29.5	0.4		0.5	26.8		92.4	1.1	23.1	6.1		0.9	0.9	10.1		2.0		3.1	130.0	143.6
ALM 12/02	27.5	533.1	4.9	63.5	47.2	710.9	11.0		1.2	6.2	4.6		29.4	0.4		0.5	27.3		89.5	1.1	23.5	6.1		1.0	0.7	10.3		1.8		2.8	129.4	135.1
ALM 12/03	36.9	658.1	2.9	61.2	33.0	615.2	12.9		1.1	5.7	4.8		27.4	0.4		0.6	27.3		106.2	0.9	21.5	5.6		1.0	0.6	9.8		1.3		2.6	129.1	138.7
ALM 12/04	17.8	750.6	5.1	67.4	35.5	646.1	6.4		1.2	6.0	5.9		31.1	0.5		0.7	29.9		64.8	1.1	22.3	6.4		1.1	0.8	13.2		2.5		3.2	127.4	163.4
ALM 12/05	50.4	411.2	6.2	60.5	42.2	732.6	15.7		1.3	6.6	4.5		28.1	0.5		0.4	27.9		59.7	1.3	21.8	5.9		1.0	0.8	9.7		2.4		2.8	195.6	131.3
ALM 12/06	31.1	403.7	6.5	56.6	34.7	617.4	17.4		1.2	5.2	4.1		27.0	0.4		0.7	26.1		121.5	0.9	22.3	5.5		0.9	0.7	9.0		1.5		2.5	114.5	98.2
ALM 12/07	40.7	443.3	4.9	58.4	31.7	565.6	19.9		1.1	5.3	4.5		27.8	0.3		0.7	22.4		118.4	0.9	21.7	5.6		0.8	0.8	8.8		2.5		2.3	106.6	105.7
ALM 12/08	31.6	469.5	6.0	57.9	37.1	621.7	18.4		1.1	5.9	4.0		27.2	0.4		0.7	30.2		126.5	1.1	21.4	5.5		0.9	0.6	9.1		2.7		2.5	111.4	132.3
ALM 12/09	26.8	463.6	5.0	54.6	39.1	709.8	16.5		1.1	5.9	3.9		25.8	0.4		0.6	25.4		123.1	0.9	22.2	5.5		0.8	0.7	9.0		2.1		2.4	120.9	97.2
ALM 12/10	47.4	443.9	11.6	53.0	29.5	372.7	9.0		1.1	5.0	3.5		25.5	0.3		0.6	22.4		97.6	0.8	18.6	5.1		0.7	0.5	8.4		2.5		2.3	95.4	96.0
ALM 12/11	36.4	432.5	10.7	55.5	38.9	823.2	15.0		1.0	6.8	4.1		24.3	0.4		1.1	21.5		59.7	2.6	23.3	5.3		1.0	1.1	10.3		2.1		2.7	109.9	80.2
ALM 12/12	11.3	384.2	7.5	63.9	28.3	276.0	4.6		1.2	6.1	4.1		31.5	0.4		0.4	25.0		78.3	0.6	20.8	5.9		1.0	0.5	11.5		2.6		2.4	84.2	106.1
ALM 12/13	28.3	507.4	4.9	60.4	35.6	625.3	14.4		1.1	5.6	4.4		28.8	0.4		0.5	24.6		111.7	1.0	22.5	5.7		0.9	0.8	10.0		2.0		2.7	118.2	77.8
ALM 12/14	24.1	410.6	6.2	63.7	34.6	740.8	13.6		1.1	5.9	4.0		29.4	0.4		0.8	20.7		137.6	1.3	21.2	5.8		0.9	0.6	10.4		2.0		2.5	115.4	87.9
ALM 12/15	33.8	443.9	6.0	63.2	29.7	576.6	15.9		1.1	5.4	4.4		28.9	0.4		0.7	23.0		129.3	1.2	18.7	5.9		0.9	0.6	10.0		2.0		2.4	114.1	96.8
ALM 12/16	27.4	420.7	4.1	68.0	31.8	403.2	9.0		1.3	5.8	4.3		31.7	0.4		0.6	25.2		125.9	1.1	21.4	6.4		0.9	0.9	10.3		2.6		3.0	113.3	109.6
ALM 12/17	36.9	590.4	9.0	59.0	45.4	842.3	11.2		1.0	7.2	4.3		24.7	0.4		0.2	21.0		98.0	2.2	23.8	5.4		1.1	1.0	11.3		2.0		2.5	115.7	98.2
ALM 12/18	30.7	475.0	4.6	61.5	30.9	640.9	14.2		1.1	5.6	4.5		27.9	0.4		0.9	28.1		141.5	1.4	20.1	5.6		0.9	0.6	10.1		2.4		2.4	112.7	134.4
ALM 12/19	20.6	421.3	4.0	71.3	45.0	752.5	12.4		1.2	5.6	4.8		32.1	0.4		0.5	25.7		120.8	1.2	21.3	6.3		1.1	0.6	11.3		2.4		2.5	126.7	112.0
ALM 12/20	35.3	578.7	5.0	56.0	40.9	667.1	11.4		1.1	5.5	4.2		25.0	0.4		0.6	22.4		100.6	0.7	20.8	5.5		0.8	0.6	9.0		1.8		2.5	105.5	133.9
ALM 12/21	20.1	514.4	4.0	64.6	34.5	883.5	14.1		1.1	4.9	5.0		31.1	0.4		0.6	30.6		131.8	1.1	20.5	5.9		1.0	0.8	10.4		2.7		2.7	112.1	105.2
ALM 12/22	39.6	425.0	4.6	60.1	34.1	486.3	12.6		1.1	5.2	4.5		26.5	0.4		0.6	21.1		125.6	1.1	22.9	5.7		0.9	0.8	10.1		1.8		2.5	117.1	105.0
ALM 12/23	20.0	495.8	4.7	67.4	33.6	650.9	7.6		1.2	5.3	4.9		32.5	0.4		0.5	26.5		78.6	1.0	20.7	6.5		1.0	0.8	10.8		2.6		2.7	116.9	124.6

ALM 12/24	40.1	481.8	3.8	72.0	35.6	579.3	8.7	1.3	5.7	5.4	33.2	0.4	0.4	29.5	89.2	1.1	19.2	6.6	1.1	1.1	11.1	2.5	2.7	194.4	131.2
ALM 12/25	55.2	388.7	4.5	58.6	41.6	593.2	9.5	1.1	5.7	4.1	26.3	0.4	0.5	22.5	104.4	1.1	22.1	5.6	1.0	0.6	10.2	2.4	2.4	127.5	119.1
ALM 12/26	32.5	466.9	5.3	67.1	40.2	1002.3	7.6	1.2	5.4	4.4	31.1	0.4	0.4	25.7	73.0	1.0	20.7	6.2	0.9	0.6	10.7	3.0	2.8	118.3	107.3
ALM 12/27	22.7	466.5	5.2	64.0	39.3	847.0	9.0	1.1	5.7	5.0	29.0	0.4	0.5	21.4	85.8	1.0	19.8	5.9	1.0	0.6	10.7	2.2	2.5	136.6	129.9
ALM 12/28	53.7	329.2	3.4	69.8	29.3	571.8	34.2	1.2	5.2	4.7	32.7	0.4	0.5	28.6	144.2	0.9	19.1	6.4	1.1	0.9	10.4	2.5	2.5	114.0	80.9
ALM 12/29	15.0	478.3	5.1	61.0	35.4	884.4	16.3	1.1	5.3	4.5	28.6	0.3	0.6	23.8	144.8	0.8	19.7	5.7	0.9	0.8	9.5	2.0	2.5	111.5	111.7
ALM 12/30	26.8	428.2	3.6	69.6	40.6	723.7	24.0	1.2	5.2	4.5	32.4	0.4	0.6	24.1	141.8	0.8	21.3	6.3	0.9	0.6	10.6	3.3	2.7	113.1	95.0
ALM 12/31	36.5	461.7	6.5	58.9	34.7	605.0	15.9	1.0	5.6	4.4	27.0	0.4	0.8	21.7	126.0	1.1	20.0	5.4	0.8	0.5	9.5	3.0	2.4	109.3	77.3
ALM 12/32	39.3	692.3	6.5	59.1	41.4	733.6	13.3	1.2	6.1	4.1	28.0	0.4	0.5	21.3	97.7	1.1	21.8	6.0	0.8	0.6	9.3	2.1	2.9	112.6	92.4
ALM 12/33	44.0	390.2	4.9	49.0	46.0	788.4	16.9	0.9	6.4	3.7	21.8	0.3	0.6	20.7	133.4	1.2	22.2	4.7	0.8	0.4	8.6	1.5	2.2	119.4	113.7
ALM 12/34	29.6	448.3	5.4	55.0	37.2	619.6	15.2	1.1	5.7	4.4	25.7	0.4	0.9	22.2	112.1	1.0	20.9	5.3	0.8	0.7	8.6	2.2	2.3	106.9	90.9
ALM 12/35	73.8	569.8	10.1	56.8	35.6	462.3	4.9	1.2	6.1	3.5	27.7	0.4	0.2	25.0	56.8	0.9	20.6	5.8	0.8	0.7	9.5	1.7	2.6	101.8	62.6
ALM 12/36	23.7	472.3	7.1	57.1	34.6	546.7	12.9	1.1	5.5	4.3	27.3	0.4	0.7	26.8	113.8	1.0	20.4	5.8	0.8	0.6	9.0	2.2	2.3	107.5	111.7
ALM 12/37	24.8	432.7	5.8	55.8	34.8	588.2	16.2	1.1	5.2	4.1	26.6	0.4	0.7	24.3	120.2	1.0	21.7	5.4	0.8	0.6	8.8	2.4	2.4	109.9	121.8
ALM 12/38	16.7	441.0	4.9	60.2	38.2	616.7	11.2	1.0	6.2	4.6	26.3	0.4	0.5	22.0	99.5	0.9	21.7	5.4	1.0	0.5	10.8	2.5	2.6	111.1	98.0
ALM 12/39	26.5	399.6	3.9	56.0	40.0	707.6	17.9	1.0	6.7	4.5	23.8	0.4	0.7	24.0	127.9	2.2	22.6	5.0	0.8	0.6	9.6	3.0	2.4	131.1	105.0
ALM 12/40	27.8	415.1	4.6	58.9	36.5	675.1	17.7	1.1	5.8	4.6	26.1	0.4	0.8	25.2	123.9	1.1	21.9	5.5	0.9	0.6	9.4	2.9	2.4	110.0	115.8
ALM 12/41	25.3	589.4	3.8	74.7	39.6	683.7	7.6	1.3	6.3	5.5	33.8	0.4	0.4	28.1	85.3	1.1	20.6	6.7	1.1	0.6	12.4	2.7	3.3	135.4	107.6
ALM 12/42	20.4	565.8	6.1	61.2	38.7	566.5	5.8	1.2	5.7	4.6	28.8	0.4	0.4	30.0	70.5	0.8	23.0	6.1	1.0	0.8	11.4	2.1	2.7	133.3	122.2
ALM 12/43	11.2	344.8	5.6	55.6	36.7	675.2	16.5	1.1	5.7	4.3	26.0	0.4	0.7	22.9	123.7	1.0	21.0	5.6	0.8	0.5	9.0	2.7	2.5	117.5	103.7
ALM 12/44	19.0	740.7	5.3	63.2	37.2	997.7	9.6	1.1	5.5	4.7	29.4	0.4	0.5	23.9	88.1	0.8	22.1	5.7	1.0	0.7	11.1	2.5	2.5	120.7	90.4
ALM 12/45	37.5	489.1	3.1	68.4	38.6	673.9	14.7	1.1	5.7	5.2	29.9	0.4	0.4	29.9	107.8	1.1	20.1	6.0	1.1	0.8	11.3	2.9	2.7	215.8	108.8
ALM 12/46	40.7	404.3	5.3	60.6	32.6	509.8	13.8	1.1	5.6	4.2	28.0	0.4	0.8	28.3	117.4	1.1	20.7	6.0	0.9	0.8	9.3	2.5	2.3	165.7	106.8
ALM 12/47	27.6	506.4	5.5	61.3	32.6	562.4	12.6	1.2	5.6	4.6	28.8	0.4	0.5	24.3	110.2	1.0	20.5	6.1	0.9	0.7	10.1	2.3	2.7	113.1	81.0
ALM 12/48	36.6	475.9	5.8	57.6	33.9	559.6	16.5	1.1	5.5	4.4	26.0	0.4	0.9	21.9	124.1	0.9	21.6	5.6	0.8	0.6	9.3	2.9	2.8	112.5	126.9
ALM 12/49	27.2	389.8	5.0	73.4	38.6	556.3	15.6	1.3	5.5	5.0	34.9	0.4	0.6	36.5	131.5	1.1	20.4	6.8	1.0	1.1	10.7	2.4	3.2	200.3	106.5
ALM 12/50	24.6	654.1	5.9	67.0	28.2	556.3	6.7	1.3	4.9	4.8	31.9	0.4	0.5	25.9	61.7	0.8	19.8	6.4	1.0	0.7	10.8	1.8	2.8	119.2	105.8

ALM 12/51	24.1	633.4	5.3	52.9	33.8	625.1	13.7	1.0	4.9	4.0	25.2	0.4	0.7	25.1	102.5	0.8	19.6	5.3	0.7	0.7	8.3	2.2	2.4	107.5	110.9
ALM 12/52	28.8	512.0	3.9	54.2	40.5	868.1	15.7	1.0	5.9	4.3	24.3	0.4	0.9	21.8	111.8	0.8	20.9	5.2	0.8	0.7	8.4	2.8	2.5	101.7	111.5
ALM 12/53	41.0	480.0	6.1	62.6	39.8	642.3	14.0	1.2	6.3	4.5	29.7	0.4	0.6	23.6	102.9	1.4	23.0	6.3	0.9	0.8	10.2	1.7	2.9	122.7	118.2
ALM 12/54	34.3	603.5	3.0	59.0	34.2	727.3	6.2	1.2	5.8	4.8	27.7	0.4	0.5	22.8	53.2	0.7	21.2	5.8	0.9	0.9	8.9	2.0	2.7	115.8	106.2
ALM 12/55	39.4	460.5	6.2	67.8	39.5	561.0	11.0	1.3	6.3	3.9	30.6	0.4	0.5	29.2	112.8	1.4	21.1	6.4	0.9	0.6	10.5	2.4	2.7	123.2	105.1
ALM 12/56	49.8	625.6	5.3	69.4	46.7	584.4	8.5	1.3	6.6	4.0	31.2	0.4	0.4	24.0	90.0	1.3	21.5	6.5	1.0	0.6	10.8	2.5	2.6	135.7	114.1
ALM 12/57	16.8	433.6	5.7	52.5	38.6	714.1	12.0	1.1	6.1	4.1	25.1	0.4	0.6	22.3	108.0	0.8	21.9	5.1	0.8	0.6	8.7	2.2	2.5	125.7	82.1
ALM 12/58	50.8	345.5	4.6	51.8	29.6	434.7	21.1	1.1	5.3	3.7	25.0	0.4	0.6	22.8	114.6	0.9	19.8	5.2	0.8	0.7	8.1	2.0	2.7	162.4	59.4
ALM 12/59	28.0	362.9	2.1	70.1	19.1	289.2	14.6	1.1	4.5	6.2	33.3	0.4	0.8	32.2	94.0	0.8	14.6	5.7	1.3	0.8	11.0	3.3	2.7	73.3	146.0
ALM 12/60	68.4	389.4	1.1	46.8	26.0	329.6	9.6	1.0	5.4	4.1	21.2	0.4	0.4	20.7	52.5	0.6	19.3	4.7	0.7	1.1	6.8	1.2	2.7	152.3	85.8
ALM 12/61	35.8	344.4	2.0	58.4	30.3	590.2	26.1	1.2	5.7	4.5	29.4	0.4	0.5	24.4	99.0	0.8	20.6	6.3	0.9	0.8	8.8	1.9	2.6	104.4	92.4
ALM 12/62	16.7	163.6	1.0	50.7	32.0	323.6	8.1	1.1	6.3	4.6	23.6	0.5	0.6	21.8	102.6	1.4	22.8	4.9	0.7	0.7	7.1	2.3	2.8	126.5	138.2
ALM 12/63	55.3	267.3	1.1	52.6	24.3	306.2	20.7	1.2	5.3	4.9	24.1	0.5	0.5	24.7	111.5	0.7	20.3	5.4	0.7	0.7	7.3	1.8	2.7	89.5	123.7
ALM 12/64	34.5	413.5	6.0	48.7	30.9	582.5	14.4	1.0	5.1	3.7	22.4	0.4	0.6	20.4	112.3	0.7	20.2	4.7	0.8	0.5	8.0	2.6	2.4	109.2	101.8
ALM 12/65	71.4	443.7	3.5	59.2	30.5	515.6	14.5	1.1	5.3	4.4	27.6	0.4	0.6	25.7	104.7	0.9	19.8	5.5	0.9	0.7	9.2	2.2	2.5	107.3	132.9
ALM 12/66	31.9	299.0	1.2	52.2	24.0	381.0	21.6	1.1	5.2	4.5	23.5	0.4	0.6	22.3	109.9	0.8	20.5	4.9	0.7	0.6	7.5	2.3	2.6	92.0	129.9
ALM 12/67	268.3	295.9	2.2	54.0	51.0	554.8	45.5	1.3	13.6	3.6	27.6	0.4	0.9	23.7	134.2	3.4	20.1	5.8	0.8	0.8	7.6	4.3	2.8	114.5	135.4
ALM 12/68	72.7	204.6	1.1	48.8	24.1	320.8	20.8	1.2	5.2	4.5	22.1	0.4	0.6	21.3	111.2	0.7	20.0	5.1	0.7	0.7	7.0	1.7	2.6	88.8	133.3
ALM 12/69	38.6	264.5	1.3	50.7	20.6	309.5	22.2	1.2	5.1	4.8	24.3	0.4	0.5	21.2	99.1	0.7	19.6	5.2	0.7	0.7	7.2	1.6	2.7	87.3	124.9
ALM 12/70	35.9	301.6	3.6	57.3	27.9	441.8	32.5	1.2	5.5	4.4	27.6	0.4	0.6	23.5	116.8	0.9	22.5	5.6	0.9	0.7	8.7	2.0	2.6	113.0	144.1
ALM 12/71	31.4	592.9	6.2	75.0	26.0	162.9	6.6	1.5	5.6	5.5	34.5	0.6	0.3	27.5	100.6	1.1	22.3	6.8	1.1	0.8	11.8	2.9	3.3	123.7	139.6
ALM 12/72	25.8	527.5	3.1	80.2	21.7	147.7	8.1	1.1	5.3	6.2	31.7	0.4	0.4	27.8	100.4	1.4	18.0	5.9	1.3	0.7	13.0	2.6	2.9	100.1	153.5
ALM 12/73	22.6	500.8	2.5	85.2	23.7	264.7	7.6	1.3	5.7	6.4	30.1	0.4	0.5	26.8	105.5	0.9	18.4	6.3	1.4	0.7	14.6	2.2	2.9	87.9	178.7
ALM 12/74	34.9	579.7	1.5	83.8	17.6	154.4	7.7	1.2	5.3	6.5	35.5	0.5	0.5	28.9	102.0	1.5	18.7	6.6	1.3	0.8	13.8	3.4	3.2	95.4	157.9
ALM 12/75	29.3	435.6	2.7	86.5	23.6	208.0	8.7	1.1	5.3	6.0	30.8	0.5	0.6	26.2	120.3	0.8	17.9	6.0	1.3	0.7	14.2	1.7	3.1	89.9	127.9
ALM 12/76	27.2	546.8	6.5	73.5	17.8	124.6	6.5	1.1	4.4	5.0	30.3	0.4	0.5	28.1	105.5	2.5	15.7	5.6	1.4	0.7	12.3	1.7	2.3	171.8	134.8
ALM 12/77	24.4	508.3	6.6	73.7	18.3	137.6	7.1	1.1	4.8	4.6	31.5	0.4	0.5	26.2	111.0	1.2	17.1	5.7	1.4	0.7	12.4	1.9	2.6	104.6	126.5

ALM 12/78	46.7	331.8	16.7	40.8	18.7	197.4	4.1	0.9	4.8	2.6	23.2	0.3	0.2	18.2	50.7	1.4	10.9	4.2	0.7	0.6	6.9	1.6	2.1	78.5	72.4
ALM 12/79	18.6	296.4	1.4	49.8	26.7	321.1	4.6	1.7	6.7	3.6	27.9	0.5	1.4	27.7	78.2	1.4	26.7	6.5	0.6	1.1	7.3	1.5	3.1	136.2	117.8
ALM 12/80	66.9	373.8	5.8	55.1	24.7	415.7	14.0	1.2	4.4	4.6	26.6	0.4	0.7	24.6	76.3	1.0	18.7	5.5	0.8	0.7	8.5	1.9	2.6	104.4	108.4
ALM 12/81	39.7	566.8	2.9	66.7	32.4	565.9	13.3	1.1	5.4	4.9	29.8	0.4	0.7	31.9	119.5	1.1	19.0	5.6	1.1	0.8	11.2	2.4	2.5	100.0	178.0
ALM 12/82	32.7	612.6	2.8	64.7	33.0	518.9	12.6	1.1	5.1	4.8	29.5	0.4	0.7	25.7	108.2	1.0	18.2	5.6	1.0	0.6	10.6	1.8	2.7	101.8	141.6
ALM 12/83	34.5	316.8	2.7	54.8	29.0	461.8	23.6	1.1	5.4	4.5	25.6	0.4	0.7	22.7	116.8	0.9	20.5	5.2	0.9	1.0	8.3	1.6	2.4	105.5	120.6
ALM 12/84	41.2	341.1	0.5	60.9	21.8	357.3	19.7	1.3	5.7	4.9	30.2	0.4	0.6	29.6	137.0	0.8	21.3	6.0	1.0	1.0	9.4	2.1	2.9	93.2	110.8
ALM 12/85	18.8	221.9	2.3	48.8	23.1	375.4	10.0	1.0	5.2	4.5	21.7	0.3	0.5	21.6	93.0	0.9	19.6	4.4	0.8	0.5	7.0	1.8	2.2	88.1	128.3
ALM 12/86	55.3	302.4	1.3	54.0	24.7	341.3	54.8	1.2	5.0	4.9	24.8	0.4	0.7	20.9	150.5	0.8	20.1	5.1	0.8	0.7	7.9	1.8	2.6	99.0	125.7
ALM 12/87	16.2	157.2	1.6	48.2	23.6	288.2	8.3	1.0	5.2	4.5	21.3	0.3	0.5	20.0	88.8	0.7	18.7	4.5	0.7	0.6	6.6	1.6	2.1	91.5	103.7
ALM 12/88	51.5	262.6	0.5	67.9	26.5	411.3	33.7	1.4	5.5	5.1	30.7	0.5	0.5	27.9	152.6	0.9	21.2	6.4	0.9	0.8	9.3	2.4	3.0	104.4	144.9
ALM 12/89	29.2	359.0	2.7	50.2	22.5	293.2	7.9	1.0	5.1	4.6	22.2	0.3	0.4	20.7	85.1	0.8	18.1	4.6	0.7	0.5	6.9	1.9	2.2	84.9	125.8
ALM 12/90	25.5	382.6	1.0	57.7	27.3	341.9	10.4	1.1	5.1	5.2	27.9	0.4	0.4	25.6	82.7	0.7	18.7	5.3	0.9	0.7	7.7	1.7	2.7	107.8	144.1
ALM 12/91	54.7	362.9	0.4	58.0	19.3	353.5	45.4	1.3	5.7	4.7	29.2	0.4	0.5	25.5	118.1	0.8	20.0	6.1	0.8	0.8	8.2	2.3	2.9	96.4	122.4
ALM 12/92	19.8	345.2	1.8	50.8	25.1	312.4	10.2	1.2	6.3	5.4	25.6	0.4	0.4	22.7	85.7	1.4	20.2	5.3	0.7	0.9	7.4	1.5	2.7	101.9	127.7
ALM 12/93	123.3	333.5	0.6	49.6	26.3	339.8	36.4	1.2	5.3	4.6	25.0	0.4	0.7	24.3	123.1	0.8	19.0	5.5	0.8	0.7	7.5	1.7	2.7	91.3	92.0
ALM 12/94	41.3	218.6	0.7	51.5	24.1	332.9	21.6	1.0	5.3	4.5	21.8	0.4	0.5	22.9	111.2	0.8	20.3	4.6	0.7	0.6	7.3	1.4	2.6	98.8	108.5
ALM 12/95	40.4	641.9	1.3	63.2	28.1	326.8	11.6	1.4	6.0	5.4	31.3	0.5	0.4	27.5	97.7	0.7	21.8	6.5	1.0	1.1	9.4	2.1	3.2	107.3	123.3
ALM 12/96	36.4	324.5	1.9	49.2	28.9	306.5	4.4	1.4	6.3	3.3	24.8	0.4	1.5	22.7	56.8	2.7	21.4	5.6	0.7	0.7	7.3	1.2	2.6	79.9	84.7
ALM 12/97	44.3	310.2	0.7	54.9	31.3	361.0	20.6	1.0	6.0	4.9	22.6	0.4	0.4	22.1	115.0	1.4	20.5	4.8	0.7	0.5	7.6	2.3	2.5	99.2	143.4
ALM 12/98	7.8	562.2	5.7	46.7	19.1	225.4	7.6	1.1	4.9	3.7	23.1	0.4	1.4	19.5	66.1	0.5	15.9	4.8	0.7	0.7	7.4	2.1	3.0	151.9	87.7
ALM 12/99	20.0	606.7	4.1	56.5	12.1	87.2	3.9	1.1	4.0	4.9	24.8	0.4	1.6	22.3	64.5	0.4	13.1	4.8	0.8	0.7	9.7	1.4	2.5	78.5	142.5
ALM 12/100	6.1	864.9	3.5	62.1	15.0	72.8	5.8	1.1	4.7	5.0	26.8	0.4	1.7	22.4	78.4	0.3	15.5	4.9	1.0	0.6	11.7	1.8	2.6	86.4	117.2
ALM 12/101	9.0	625.4	3.7	62.6	13.7	108.0	5.1	1.2	4.3	5.1	27.8	0.4	1.5	23.0	78.8	0.4	15.0	5.2	0.9	0.6	11.0	1.6	2.6	78.9	122.4
ALM 12/102	7.7	654.5	3.3	56.0	15.3	66.2	7.1	1.1	4.6	4.5	26.0	0.4	1.6	22.6	79.1	0.4	17.9	4.8	0.9	0.6	9.7	1.9	2.4	81.6	135.0
ALM 12/103	4.7	486.7	3.4	59.5	14.8	58.4	6.7	1.0	4.3	4.6	25.3	0.4	1.8	19.3	92.6	0.4	15.1	4.4	1.0	0.6	11.3	2.3	2.5	81.6	114.5
ALM 12/104	6.3	613.6	3.4	58.6	12.9	63.1	4.8	1.1	4.1	4.5	26.9	0.4	1.7	21.4	76.6	0.3	14.1	4.7	0.8	0.6	10.3	2.4	2.6	77.1	120.5

ALM 12/105	11.1	655.5	3.8	59.0	16.8	78.5	4.5	1.0	4.2	4.6	22.0	0.4	1.6	19.4	57.2	0.3	14.2	4.2	0.8	0.5	9.8	1.6	2.4	69.6	139.3
ALM 12/106	10.3	556.0	5.1	57.7	12.6	62.4	4.7	1.2	4.1	4.7	27.5	0.5	2.0	22.4	71.1	0.3	14.0	5.1	0.8	0.6	9.3	1.7	3.0	73.7	129.2
ALM 12/107	18.9	251.2	1.8	53.1	23.0	328.7	14.0	1.2	5.3	4.4	25.9	0.4	0.5	24.7	115.8	0.9	20.0	5.3	0.7	0.9	7.6	1.7	2.5	95.5	140.7
ALM 12/108	15.6	266.7	1.3	51.2	23.8	343.5	13.0	1.1	5.6	4.6	24.6	0.4	0.5	23.4	106.8	1.0	19.9	5.1	0.8	0.9	7.7	1.9	2.7	97.1	97.4
ALM 12/109	55.3	445.0	1.0	47.1	31.7	358.2	10.4	1.0	6.3	5.3	20.8	0.4	0.7	21.1	58.2	1.3	18.1	4.6	0.7	0.6	6.8	1.3	2.4	97.6	109.9
ALM 12/110	20.6	510.7	3.2	61.1	35.7	709.5	9.0	1.2	5.8	5.0	28.3	0.4	0.5	24.8	84.9	0.9	21.3	5.8	0.9	0.7	9.8	2.4	2.7	135.1	110.1
ALM 12/111	39.5	472.3	5.2	58.2	36.7	645.4	17.1	1.1	5.6	4.2	27.1	0.4	0.8	25.4	119.8	1.1	22.0	5.6	0.9	0.6	9.1	3.1	2.4	112.4	139.8
ALM 12/112	95.1	423.0	4.9	58.2	34.7	513.6	27.8	1.2	5.7	4.0	28.1	0.4	0.6	23.7	130.6	0.8	23.4	5.9	0.9	0.9	9.1	1.5	2.8	108.2	110.4
ALM 12/113	12.3	509.6	13.7	53.8	26.6	184.1	9.5	1.0	4.7	3.2	26.4	0.3	0.7	22.6	100.4	0.6	16.3	5.0	0.8	0.6	9.2	1.9	2.0	85.7	77.2
ALM 12/114	9.3	484.9	7.7	66.0	30.7	275.0	6.5	1.2	6.0	4.3	31.3	0.4	0.4	28.0	101.4	0.6	21.6	5.9	1.1	0.5	12.1	2.4	2.6	160.1	113.3
ALM 12/115	21.8	381.4	7.4	66.0	27.8	267.6	4.1	1.2	5.3	4.3	31.7	0.4	0.5	25.0	74.1	0.5	18.8	6.1	1.0	0.6	11.1	2.0	2.6	91.4	130.1
ALM 12/116	30.5	482.0	5.8	51.5	40.8	909.0	11.9	1.0	6.3	4.5	23.7	0.4	0.6	21.5	81.5	1.2	20.7	4.7	0.9	0.5	9.5	1.9	2.3	112.8	96.6
ALM 12/117	25.8	412.3	7.4	60.0	45.2	786.0	18.0	1.2	5.9	4.0	28.2	0.4	0.5	22.4	128.8	1.1	22.9	5.8	0.9	0.6	9.5	2.6	2.7	123.6	97.2
ALM 12/118	15.6	493.0	5.2	71.0	37.8	563.9	13.3	1.2	6.0	4.5	31.1	0.4	0.5	29.0	129.1	1.5	22.5	6.4	1.0	0.6	11.5	1.7	2.6	127.8	132.4
ALM 12/119	7.9	269.5	7.9	46.5	24.7	364.6	5.6	1.0	4.3	3.7	22.5	0.3	1.2	18.5	91.8	0.7	15.3	4.3	0.8	0.5	7.1	2.4	2.0	78.0	148.3
ALM 13/01	9.5	334.6	5.9	71.9	30.6	588.7	16.9	1.4	5.2	4.8	35.0	0.4	0.4	33.2	136.5	0.9	20.6	6.7	1.1	0.9	10.8	2.9	2.5	111.2	110.8
ALM 13/02	32.8	369.8	7.1	61.1	36.9	631.4	16.3	1.2	5.0	4.4	28.7	0.4	0.6	27.0	121.2	1.0	22.0	5.7	0.9	0.8	9.4	1.8	2.5	109.7	119.5
ALM 13/03	22.7	254.8	6.1	53.7	32.5	505.1	12.9	1.1	4.9	4.3	26.7	0.4	1.2	23.7	99.1	0.9	19.8	5.5	0.9	0.9	8.2	1.8	2.5	162.8	105.0
ALM 13/04	31.7	353.1	7.7	55.6	37.6	826.8	18.3	1.1	5.3	4.4	26.6	0.4	0.6	21.4	128.2	0.9	21.7	5.7	0.8	0.6	9.1	2.0	2.6	112.7	101.6
ALM 13/05	6.2	407.7	9.6	56.7	36.6	623.5	14.4	1.2	5.2	4.0	26.9	0.4	0.6	26.4	114.0	0.7	21.7	5.9	0.8	0.6	9.0	1.6	2.4	111.2	115.5
ALM 13/06	36.7	366.4	8.0	69.8	33.0	549.6	13.5	1.2	5.0	4.3	32.9	0.4	0.4	28.4	125.5	1.0	21.2	6.5	0.9	0.9	10.6	2.6	2.6	119.8	109.9
ALM 13/07	25.7	421.9	7.7	52.0	33.9	641.4	18.6	1.1	5.1	3.9	26.1	0.4	1.1	26.9	101.2	0.7	20.1	5.4	0.8	0.6	8.0	2.6	2.6	95.1	113.7
ALM 13/08	4.1	337.1	7.6	61.4	36.8	661.1	18.9	1.2	5.3	4.5	28.5	0.4	0.7	24.5	119.8	0.8	21.1	5.8	0.9	0.6	9.2	3.0	2.7	167.3	89.5
ALM 13/09	21.0	244.9	2.8	53.8	26.3	527.1	34.4	1.1	4.6	4.5	24.9	0.3	1.4	23.4	123.2	0.7	20.4	5.2	0.8	0.8	8.0	1.6	2.3	122.7	107.3
ALM 13/10	17.3	609.4	0.6	83.3	23.2	267.1	6.2	1.4	5.2	6.4	34.3	0.4	0.8	32.7	97.8	0.8	18.1	6.5	1.3	1.0	13.0	1.7	3.1	93.7	167.9
COE 12/01	6.0	156.7	14.1	37.1	34.3	425.5	4.7	0.8	3.6	2.4	18.6	0.2	0.5	16.9	51.6	0.3	11.3	3.4	0.5	0.4	5.8	1.9	1.5	104.2	74.4
COE 12/02	24.4	354.7	7.6	50.7	30.2	480.2	12.9	1.0	4.6	4.3	23.7	0.4	0.7	22.1	103.5	0.9	18.9	5.1	0.8	0.5	8.5	2.3	2.4	123.7	109.8

COE 12/03	21.3	374.5	7.2	51.9	29.5	473.6	12.9	1.0	4.5	4.2	24.0	0.4	0.7	22.7	104.4	0.8	18.4	4.9	0.8	0.5	8.2	1.8	2.0	119.5	123.1
COE 12/04	23.8	334.9	7.7	51.5	34.1	587.9	14.4	1.0	5.2	3.7	24.1	0.3	0.7	22.0	102.9	0.8	20.0	5.1	0.8	0.6	8.7	2.0	2.3	215.9	114.4
COE 12/05	26.7	274.8	7.2	54.2	30.0	483.3	12.6	1.0	4.6	4.3	25.8	0.4	0.7	23.4	102.6	0.9	18.7	5.3	0.8	0.5	8.5	1.9	2.4	131.1	113.9
COE 12/06	34.7	365.4	6.5	55.5	35.0	633.5	13.4	1.1	5.1	4.0	26.3	0.3	0.8	25.6	116.6	1.1	19.8	5.4	0.8	0.5	8.8	2.3	2.2	135.5	113.0
COE 12/07	20.1	330.9	5.4	54.1	35.4	639.8	16.8	1.0	5.5	3.9	23.9	0.4	0.5	25.3	124.9	0.8	21.9	5.1	0.8	0.6	9.0	2.2	2.3	296.4	99.8
COE 12/08	12.5	442.5	7.7	66.2	31.1	539.4	17.5	1.2	4.7	4.2	31.2	0.4	0.6	28.3	110.6	1.4	19.6	6.2	1.0	0.6	10.0	3.3	2.4	140.3	102.4
COE 12/09	5.8	262.0	11.3	55.2	30.3	249.5	8.1	1.1	4.2	3.3	29.1	0.3	0.7	26.7	113.4	0.5	17.0	5.4	0.8	0.8	9.0	1.9	2.4	121.7	80.8
COE 12/10	7.3	240.1	14.0	44.7	37.6	437.1	3.7	0.8	4.0	3.0	21.8	0.3	0.5	25.4	58.8	0.6	12.4	4.1	0.7	0.6	6.8	1.3	2.0	151.4	92.8
COE 12/11	4.7	163.0	7.6	37.4	36.0	480.1	3.5	0.8	4.6	2.7	17.5	0.2	0.7	15.2	60.5	0.5	14.8	3.5	0.6	0.6	5.7	1.3	1.4	167.5	64.8
COE 12/12	6.8	272.3	13.5	46.3	37.5	466.2	3.9	0.9	4.0	2.9	22.3	0.3	0.5	19.8	60.6	0.6	12.6	4.3	0.7	0.6	6.8	1.7	1.7	141.7	102.5
COE 12/13	2.3	521.6	4.7	54.8	10.7	58.3	3.2	1.0	3.9	5.7	25.0	0.4	1.8	23.4	51.1	0.3	12.9	4.3	0.7	0.5	8.6	1.2	2.5	79.2	149.4
COE 12/14	27.9	469.7	7.0	54.3	34.4	579.4	14.8	1.0	5.1	3.8	25.3	0.4	0.7	21.0	120.3	1.0	20.1	5.4	0.8	0.5	8.7	1.7	2.1	179.1	106.8
COE 12/15	2.9	199.6	14.8	37.2	48.3	486.6	3.0	0.7	4.4	2.3	17.4	0.2	0.4	14.8	49.6	0.4	12.9	3.5	0.6	0.4	5.6	1.1	1.5	108.8	61.9
COE 12/16	4.9	326.2	8.3	61.5	24.1	189.2	6.8	1.2	5.2	3.4	30.0	0.4	0.8	28.0	123.3	0.5	18.3	5.8	0.9	0.8	9.9	2.5	2.6	116.5	83.6
COE 12/17	5.3	236.8	13.8	35.9	46.7	467.3	2.8	0.7	4.3	2.3	17.2	0.2	0.5	18.2	49.3	0.4	12.5	3.5	0.6	0.4	5.5	1.4	1.4	105.1	98.1
COE 12/18	25.6	402.9	6.4	63.2	31.1	531.5	13.8	1.2	4.5	4.0	29.2	0.4	0.6	27.7	126.5	1.2	20.4	6.1	0.9	0.8	9.7	2.4	2.8	248.2	104.0
COE 12/19	5.6	202.8	10.3	62.7	29.0	225.7	9.0	1.1	5.0	3.4	32.0	0.4	1.2	26.8	81.6	0.6	20.8	5.5	0.9	0.7	10.5	2.4	2.5	136.2	96.9
COE 12/20	10.9	529.2	9.6	57.4	14.3	174.1	5.0	1.1	4.3	4.8	27.9	0.4	1.3	27.3	60.7	1.4	18.3	5.4	0.9	0.8	10.5	1.7	2.7	93.3	84.4
COE 12/21	3.0	329.7	10.7	54.7	28.3	274.6	6.0	1.0	4.7	3.6	25.9	0.3	0.7	24.0	118.0	0.6	19.0	4.9	0.9	0.6	10.1	2.6	2.2	137.0	90.7
DOK 12/01	4.8	324.2	3.3	64.4	17.0	127.2	5.9	1.2	4.7	5.9	33.2	0.4	1.7	25.8	76.9	0.5	19.1	5.2	1.0	0.6	13.2	2.0	2.5	74.4	142.7
DOK 12/02	3.6	223.9	4.3	100.9	19.3	103.7	6.0	1.2	4.5	7.0	48.3	0.4	2.0	35.3	74.3	0.5	20.8	6.1	1.0	0.7	20.4	2.6	2.5	84.6	141.0
DOK 12/03	4.5	390.8	2.8	67.8	19.2	108.0	5.2	1.3	4.9	5.8	33.7	0.4	1.4	25.2	89.3	0.5	18.0	5.3	1.1	0.7	13.4	1.8	2.7	82.3	137.9
DOK 12/04	3.8	294.1	3.5	67.1	20.3	124.6	4.4	1.1	4.8	7.7	27.7	0.4	1.9	24.1	59.1	0.4	19.7	4.6	1.0	0.6	13.7	2.4	2.4	80.3	192.8
DOK 12/05	5.2	300.4	0.6	113.6	16.9	116.7	4.7	2.1	4.7	7.9	58.6	0.6	0.4	52.7	90.8	0.8	15.0	10.4	2.2	1.5	14.8	3.3	4.4	99.3	207.0
DOK 12/06	9.1	223.3	11.0	65.0	36.3	261.5	8.6	1.3	5.3	3.6	35.6	0.4	0.9	32.0	82.4	0.7	22.3	6.2	1.0	0.8	11.5	2.4	2.6	124.5	102.6
DOK 12/07	8.0	569.7	7.2	72.9	23.5	210.0	4.0	1.4	5.5	4.6	33.2	0.5	1.1	30.5	92.6	0.7	20.7	6.6	1.1	0.9	11.6	2.4	2.8	74.5	127.8
DOK 12/08	7.0	453.7	6.7	69.6	33.3	254.6	7.2	1.2	6.2	4.0	32.4	0.5	0.7	28.9	124.0	0.6	22.7	5.9	1.0	0.8	12.4	2.8	2.7	91.9	108.1

DOK 12/09	4.4	306.1	3.5	65.9	20.2	119.1	5.4		1.1	4.7	6.5		29.9	0.4		1.8	24.8		74.6	0.5	20.1	5.0		1.0	0.6	12.9		2.6		2.4	82.8	155.4
DOK 12/10	4.0	456.9	9.1	69.2	27.3	246.7	5.5		1.3	5.6	4.1		34.8	0.5		0.5	30.2		98.7	0.5	21.8	6.0		1.0	1.1	11.8		2.5		3.0	91.4	98.5
ELF 12/01	140.8	558.9	6.4	78.0	19.7	207.4	8.7	3.3	1.4	5.0	4.8	1.2	37.7	0.4	546.1	0.8	32.1	102.4	142.7	2.7	19.8	6.8	81.9	1.1	0.8	13.0	3995.6	2.2	74.5	2.9	64.4	140.3
ELF 12/02	66.0	486.7	5.3	53.8	37.3	808.7	16.9	4.0	1.1	5.7	3.9	2.6	25.3	0.3	866.5	0.7	20.6	314.3	123.2	1.1	21.9	5.2	120.5	0.8	0.6	8.7	5076.9	2.1	134.6	2.2	131.0	114.9
ELF 12/03	5.0	338.7	9.3	61.8	27.5	221.5	8.8	4.0	1.1	5.3	3.6	3.0	30.4	0.3	1081.1	0.5	26.2	86.1	140.7	0.6	20.1	5.3	367.8	0.9	0.6	10.8	5701.9	2.4	124.8	2.3	104.4	102.9
ELF 12/04	126.2	554.6	3.3	77.0	18.6	196.0	8.9	5.4	1.3	5.0	4.8	3.4	36.3	0.4	844.2	1.3	28.0	68.2	143.3	2.7	19.8	6.5	68.2	1.1	0.7	12.8	5672.7	2.8	125.5	3.0	73.1	154.1
ELF 12/05	18.1	291.8	6.4	50.5	17.8	443.4	6.3	3.3	1.0	4.5	4.6	1.8	23.5	0.3	499.6	1.0	21.1	197.0	78.7	0.8	16.7	4.6	359.8	0.9	0.5	8.1	5545.3	2.7	74.1	2.2	75.9	138.2
ELF 12/06	41.4	523.9	5.0	76.3	37.5	575.2	17.2	4.8	1.3	5.4	3.8	3.2	34.6	0.3	677.7	0.5	33.9	301.0	154.7	1.4	22.3	6.6	144.1	1.0	0.7	11.8	6158.2	2.6	144.3	2.2	126.2	98.8
ELF 12/07	29.7	359.8	7.2	58.5	34.0	744.8	12.0	4.6	1.1	5.2	4.0	3.1	27.1	0.3	842.0	0.5	23.0	290.9	111.5	2.8	20.8	5.5	103.6	0.9	0.6	9.3	7130.0	2.6	129.9	2.4	136.6	128.8
ELF 12/08	54.4	495.9	12.6	51.6	38.1	716.8	13.3	4.1	1.0	5.7	3.3	2.2	24.2	0.3	1035.3	0.4	21.2	326.0	112.8	2.5	21.3	5.0	188.2	0.9	0.6	9.1	5615.6	2.0	122.3	2.3	120.8	93.9
ELF 12/09	30.8	456.9	9.5	47.9	34.1	546.9	35.2	4.2	1.0	5.0	3.4	1.9	23.9	0.3	895.9	0.7	18.7	279.6	114.5	1.8	18.3	4.7	162.3	0.7	0.6	7.2	5644.8	2.3	106.3	2.1	79.3	87.9
ELF 12/10	46.7	371.9	4.3	63.4	40.4	694.8	17.6	4.4	1.1	5.5	4.0	2.7	27.9	0.3	914.3	0.7	26.4	391.5	135.0	1.4	21.5	5.4	91.5	0.9	0.6	9.9	6569.0	2.0	117.4	2.4	109.7	104.1
ELF 12/11	24.2	401.1	3.7	69.6	34.0	509.0	12.5	4.8	1.2	5.2	4.7	3.2	30.5	0.4	711.6	0.6	29.7	235.2	120.1	1.2	20.9	6.1	147.6	0.9	0.7	10.1	5957.0	2.6	115.4	2.6	119.4	150.9
ELF 12/12	7.5	356.4	8.4	48.9	17.9	422.7	6.2	4.0	1.0	4.4	4.0	1.9	23.3	0.3	602.6	1.1	19.1	195.3	77.9	0.7	16.7	4.4	386.0	0.8	0.5	7.9	5081.6	1.8	95.4	2.1	90.8	104.4
ELF 12/13	20.7	322.3	9.5	50.0	30.7	527.3	21.0	4.1	1.1	4.3	3.3	1.8	25.0	0.3	836.0	0.7	19.7	260.1	96.3	0.8	18.4	5.0	160.5	0.8	0.6	7.6	4839.8	1.2	118.6	2.3	71.3	86.7
ELF 12/14	11.1	401.5	10.0	53.5	22.8	219.8	10.2	3.8	1.0	4.4	3.1	2.9	27.5	0.3	844.7	0.6	23.6	141.8	127.7	0.5	17.9	4.8	357.5	0.8	0.6	9.3	5442.3	2.8	131.6	2.2	79.5	63.6
ELF 12/15	28.1	414.9	4.8	73.9	38.4	543.4	15.3	4.5	1.2	5.1	4.0	3.2	33.0	0.3	795.4	0.6	27.0	276.4	141.8	1.5	21.3	6.3	102.8	1.0	0.7	11.4	5920.5	2.5	129.0	2.4	107.3	134.4
ELF 12/16	7.1	218.5	9.3	40.4	35.4	468.4	3.0	3.7	0.9	4.8	2.8	2.0	19.0	0.2	1190.4	0.5	18.6	333.2	63.8	0.4	16.6	3.9	114.4	0.6	0.4	5.9	5276.1	1.3	118.5	1.9	80.4	83.1
ELF 12/17	28.6	462.5	6.4	57.4	32.6	521.9	15.6	4.6	1.2	5.3	4.1	2.3	27.6	0.4	790.9	0.6	24.4	220.7	113.2	0.8	21.2	5.6	152.4	0.8	0.7	8.6	5948.8	2.1	133.7	2.7	117.8	101.0
LAZ 12/01	7.1	407.3	9.6	42.6	21.4	593.2	5.3	3.7	1.0	4.3	4.1	1.4	21.8	0.3	424.6	0.9	18.9	264.3	65.6	0.8	15.3	4.4	359.9	0.7	0.6	6.3	4040.8	1.9	82.0	2.3	104.0	140.5
LAZ 12/02	6.6	589.3	12.1	48.5	23.0	466.1	7.6	4.0	1.0	4.7	3.5	1.7	24.2	0.3	544.7	0.5	21.4	252.3	81.8	0.7	17.0	4.7	523.4	0.7	0.6	7.5	4398.8	2.2	89.1	2.0	95.9	111.2
LAZ 12/03	14.0	415.9	12.8	41.9	19.4	460.0	6.5	3.3	0.9	3.7	3.6	1.6	20.8	0.2	485.2	0.6	19.8	211.6	70.4	0.9	13.7	4.1	383.4	0.7	0.4	6.3	4565.2	1.9	88.6	1.8	85.1	88.3
LAZ 12/04	12.5	515.2	12.0	42.2	18.8	462.7	6.3	3.5	0.8	3.7	3.6	1.5	20.5	0.3	477.7	0.6	19.5	233.7	69.7	1.0	13.6	4.1	408.8	0.7	0.5	6.2	4442.1	2.5	85.5	1.7	91.3	107.8
LAZ 12/05	5.4	522.5	13.4	40.9	24.7	446.7	7.5	3.6	0.9	3.9	2.9	1.6	20.5	0.3	561.5	0.6	18.0	226.8	77.7	0.8	15.2	4.2	537.1	0.6	0.5	6.1	4168.0	3.5	87.1	1.9	105.2	92.6
LAZ 12/06	4.5	575.9	12.1	57.2	24.3	182.0	7.2	4.3	1.1	4.7	3.1	2.2	29.3	0.4	951.9	0.5	24.2	102.9	119.9	0.5	17.9	5.2	366.6	0.8	0.6	9.4	5077.0	2.1	146.0	2.4	101.1	80.6
LAZ 12/07	11.2	739.7	12.5	42.8	18.7	477.6	6.5	4.0	0.9	3.8	3.8	1.9	21.5	0.3	510.4	0.7	17.7	247.3	71.1	0.9	14.1	4.2	396.6	0.7	0.5	6.5	5952.6	2.4	83.5	1.9	83.8	110.8
LAZ 12/08	6.7	507.0	9.4	47.1	33.9	549.7	9.0	3.5	1.0	5.0	3.4	1.9	23.2	0.3	650.6	0.5	19.9	339.2	93.1	1.1	19.3	4.6	407.4	0.8	0.6	7.1	4522.4	2.5	96.0	2.0	113.6	77.8

LAZ 12/09	5.0	505.3	10.0	64.2	24.7	205.2	8.6	4.2	1.2	5.0	3.6	2.6	32.6	0.4	935.5	0.7	26.9	120.0	127.8	0.5	19.1	5.7	286.2	0.9	0.7	10.4	6192.5	2.3	141.3	2.5	103.6	109.4
LAZ 12/10	13.0	790.8	12.0	42.6	21.6	464.6	6.2	3.7	0.9	3.8	3.8	1.8	20.9	0.3	593.5	0.6	18.7	273.8	68.4	1.0	13.8	4.1	416.3	0.7	0.5	6.3	4662.5	2.0	78.6	2.0	96.8	95.9
LAZ 12/11	2.9	485.2	9.5	60.8	29.3	229.1	10.3	4.0	1.1	5.1	3.4	2.9	30.5	0.3	873.5	0.6	24.0	93.8	148.0	0.6	20.7	5.1	453.3	0.8	0.7	10.3	4927.0	2.4	146.7	2.3	122.3	96.1
LAZ 12/12	23.1	513.4	5.0	74.4	27.9	503.9	11.1	5.2	1.3	4.1	5.3	2.7	33.3	0.4	651.2	0.6	28.7	264.9	119.7	1.2	18.9	6.3	99.1	1.0	0.7	10.9	5516.1	2.4	104.8	2.7	125.6	129.7
LAZ 12/14	7.6	584.6	13.0	39.1	19.0	377.0	5.7	3.5	0.8	3.8	2.8	1.6	20.2	0.3	433.7	0.5	19.3	251.7	65.8	0.6	14.4	4.0	380.5	0.6	0.5	5.8	4027.3	2.3	84.8	1.9	116.2	86.8
LAZ 12/15	9.0	569.4	13.1	47.1	24.8	436.6	7.5	3.5	1.0	4.4	3.3	2.0	23.8	0.3	588.1	0.6	20.3	279.0	79.4	0.8	16.6	4.6	481.7	0.8	0.6	7.1	4859.8	2.1	90.0	2.1	120.1	120.2
LAZ 12/16	6.9	964.5	12.8	40.5	23.8	361.0	4.7	3.5	0.9	3.7	3.0	1.5	20.0	0.2	479.9	0.5	17.1	228.3	67.3	0.6	14.0	4.0	383.7	0.6	0.5	6.0	3374.1	2.2	83.5	1.9	133.6	77.8
LAZ 12/17	13.1	461.4	13.6	42.4	22.2	413.5	6.8	3.8	1.0	4.3	3.1	1.6	21.6	0.3	522.0	0.5	17.8	260.0	75.8	0.7	15.9	4.3	479.6	0.6	0.6	6.4	4273.2	2.2	91.1	2.1	112.5	93.9
LAZ 12/18	11.4	556.7	11.8	45.9	28.2	445.9	7.3	3.7	1.0	4.6	3.4	1.7	23.4	0.3	632.9	0.5	20.4	281.2	82.0	0.8	17.2	4.7	508.2	0.7	0.6	7.0	5210.1	2.9	104.2	2.2	118.6	99.5
LAZ 12/19	11.9	498.4	13.9	42.7	21.1	430.3	7.1	3.8	0.9	4.2	3.2	1.8	21.9	0.3	560.4	0.5	19.4	273.0	79.2	0.7	15.6	4.3	523.9	0.7	0.6	6.6	4525.0	2.3	101.3	2.0	119.8	87.0
LAZ 12/20	7.8	518.4	12.4	47.0	23.7	443.7	7.4	3.6	1.0	4.4	3.4	1.7	23.2	0.3	551.2	0.5	20.6	285.0	82.2	0.7	16.3	4.6	517.7	0.7	0.6	7.2	3926.5	2.1	86.7	2.1	124.0	76.1
LAZ 12/21	6.8	670.6	15.3	38.3	21.6	373.6	5.5	3.7	0.9	3.7	2.9	1.9	19.6	0.3	519.3	0.5	16.0	258.3	65.0	0.6	14.0	4.0	445.3	0.6	0.5	5.8	5091.4	2.2	95.3	1.9	114.3	95.6
LAZ 12/22	8.1	591.7	11.6	46.4	23.7	437.6	7.3	3.2	1.0	4.4	3.4	1.7	22.9	0.3	532.9	0.5	18.9	293.8	80.4	0.7	16.1	4.5	493.1	0.7	0.6	7.0	4420.0	2.7	87.4	2.0	115.6	84.7
LAZ 12/23	6.2	500.8	10.4	45.6	29.8	493.1	8.8	3.5	1.0	4.5	3.0	1.7	22.4	0.3	591.1	0.4	21.4	276.9	90.3	0.8	18.4	4.6	425.3	0.7	0.5	6.6	4181.7	3.4	101.9	2.0	133.6	97.9
LAZ 12/24	6.7	732.4	11.4	40.5	15.6	423.8	6.4	3.4	0.9	3.9	3.2	1.6	21.1	0.3	391.4	0.4	21.5	282.1	75.7	0.7	15.6	4.4	432.7	0.7	0.5	6.7	4899.9	2.3	97.5	1.8	133.0	107.5
LAZ 12/25	10.6	586.8	13.2	43.2	22.7	426.7	6.6	3.5	0.9	4.2	3.1	1.7	21.8	0.3	618.1	0.5	17.2	314.8	73.8	0.7	15.4	4.2	444.8	0.7	0.5	6.6	4781.5	2.4	115.5	1.9	122.0	104.7
LAZ 12/26	7.9	621.7	12.9	44.4	21.6	403.8	7.0	2.9	0.9	3.9	3.3	1.6	22.1	0.3	499.4	0.5	18.9	233.7	79.8	0.6	14.9	4.3	498.1	0.7	0.4	6.8	4816.2	2.7	92.5	1.8	125.0	114.0
LAZ 12/27	13.8	532.5	11.3	42.9	21.1	450.8	6.3	3.8	0.9	3.9	3.7	1.8	21.9	0.3	542.7	0.7	17.3	278.0	73.3	0.9	13.9	4.3	321.4	0.7	0.5	6.7	4678.3	2.2	105.6	2.0	107.0	118.0
LAZ 12/28	7.0	415.9	10.4	57.1	27.4	233.8	9.0	3.5	1.0	5.5	3.3	2.5	25.9	0.4	1083.2	0.4	22.7	130.0	134.4	0.6	21.2	4.6	401.9	0.9	0.6	10.6	5257.2	2.7	149.5	2.4	103.3	83.6
LAZ 12/29	5.2	632.3	6.6	57.1	26.6	242.6	8.1	3.9	1.0	5.0	3.9	2.6	28.0	0.4	900.4	0.5	21.7	169.6	138.2	0.5	19.7	4.9	191.2	0.9	0.5	10.3	6488.2	1.9	144.3	2.3	95.5	98.7
LAZ 12/30	9.8	563.9	9.6	45.4	22.2	449.4	6.1	3.9	0.9	3.8	3.9	1.6	23.0	0.3	606.1	0.7	20.4	257.2	73.1	0.7	14.6	4.5	309.7	0.8	0.6	6.8	6180.5	1.8	78.1	2.2	92.4	105.1
KAN 07/01	20.9	478.9	2.9	73.4	30.5	599.6	16.1		1.2	5.2	5.4		34.5	0.4		0.4		311.9	135.1	1.0	21.8	6.5		1.1	1.1	11.9		3.1		2.8	116.9	134.5
KAN 07/02	48.9	670.2	3.9	68.4	33.5	559.7	14.5		1.2	5.2	4.7		32.4	0.4		0.4		312.6	139.0	1.3	21.5	6.0	112.3	1.0	0.8	11.0		2.5		2.6	124.7	102.0
KAN 07/03	24.5	444.6	4.3	62.8	41.6	714.4	18.1		1.1	5.4	4.6		28.3	0.3		0.7		370.9	134.1	1.4	21.6	5.2	108.3	0.9	0.7	9.8		2.6		2.3	116.5	87.9
KAN 07/04	47.5	692.7	5.2	69.2	33.2	510.2	8.7		1.2	4.9	5.2		32.2	0.4		0.4		278.6	87.5	1.2	19.1	5.9	119.1	1.0	0.9	10.5		2.3		2.7	116.1	111.3
KAN 07/05	33.6	743.9	4.6	64.4	40.0	653.4	16.3		1.1	5.3	5.0		29.0	0.4		0.6		360.8	118.8	1.4	20.1	5.6	161.9	1.0	0.7	10.2		2.6		2.4	108.4	112.4
KAN 07/06	16.3	602.2	3.6	69.5	34.3	610.8	11.2		1.3	4.5	5.1		33.7	0.4		0.4		302.8	123.9	0.9	20.9	6.3	76.2	1.0	0.8	11.0		2.4		2.6	118.4	104.6

KAN 07/07	34.7	556.0	2.9	74.6	38.8	721.9	11.2	1.3	5.7	5.2	33.6	0.4	0.4	281.4	99.8	1.1	22.4	6.2	47.7	1.1	0.8	12.2	2.9	2.7	140.0	92.1
KAN 07/08	27.6	1066.7	3.3	68.4	32.9	687.1	15.7	1.1	5.3	4.8	32.1	0.4	0.5	270.6	131.8	0.9	20.8	5.8	48.4	1.0	0.8	10.9	2.2	2.4	121.4	92.3
KAN 07/09	41.9	668.5	4.8	65.6	41.8	819.4	16.0	1.2	5.0	4.9	31.5	0.4	0.5	349.7	131.2	1.2	20.8	6.1	77.3	0.9	0.9	10.2	3.0	2.5	130.4	101.4
KAN 07/10	9.8	773.6	4.6	53.9	34.8	781.8	10.4	1.0	5.5	5.0	23.8	0.3	0.7	315.6	105.4	0.9	21.9	4.7	135.1	0.9	0.7	9.0	2.2	2.4	108.6	115.6
KAN 07/11	21.1	645.3	4.3	65.1	34.6	826.5	10.6	1.2	5.0	4.9	31.2	0.4	0.5	353.4	112.4	0.9	21.2	6.0	97.7	1.0	0.7	10.6	2.3	2.5	128.9	117.8
KAN 07/12	23.0	667.7	4.4	53.4	35.7	725.4	12.6	1.0	5.2	4.7	25.1	0.3	0.6	317.4	128.1	0.9	21.9	5.0	123.8	0.9	0.8	9.1	2.2	2.5	111.7	124.6
KAN 07/13	28.3	571.1	4.1	66.5	36.3	810.2	10.0	1.2	5.1	5.1	31.7	0.4	0.5	372.5	94.1	1.1	20.3	6.1	159.9	1.0	0.9	10.4	2.8	2.6	124.3	104.4
KAN 07/14	26.6	630.6	3.3	68.6	33.6	733.7	15.1	1.2	5.0	5.1	33.0	0.4	0.5	300.4	113.1	1.0	21.0	6.1	73.8	1.0	0.7	10.6	2.7	2.4	126.7	123.0
KAN 07/15	30.0	708.2	3.3	70.7	31.0	625.3	8.4	1.2	4.9	5.2	33.3	0.4	0.4	315.5	89.4	0.9	19.9	6.3	56.6	1.0	0.9	11.3	2.4	2.9	120.3	107.3
KAN 07/16	62.1	585.1	4.2	65.3	41.2	786.1	11.6	1.2	5.0	4.8	31.2	0.4	0.4	365.4	98.0	1.1	20.5	6.1	73.4	0.9	0.9	10.1	2.8	2.6	123.3	101.8
KAN 07/17	13.0	693.0	4.4	62.6	33.8	802.7	11.4	1.1	4.9	4.8	29.9	0.3	0.6	298.7	120.5	0.9	20.6	5.5	79.6	1.0	0.6	10.0	3.0	2.5	122.2	118.1
KAN 07/18	36.7	481.0	4.6	53.4	32.9	801.1	16.3	1.0	4.9	4.7	24.9	0.3	0.7	325.5	115.7	0.7	20.6	4.9	133.5	0.8	0.7	8.6	2.2	2.3	102.5	96.0
KAN 07/19	21.0	592.5	4.5	63.6	34.3	802.0	10.9	1.1	5.0	4.8	30.1	0.3	0.6	324.5	117.3	1.0	20.7	5.6	91.1	1.0	0.8	10.3	2.4	2.4	126.0	104.9
KAN 07/20	19.0	842.3	4.0	65.9	29.4	578.6	15.9	1.2	4.7	4.9	32.1	0.4	0.5	256.3	133.8	0.9	20.3	6.0	83.9	1.0	0.8	10.5	2.4	2.4	110.5	115.3
KAN 07/21	20.8	711.3	3.8	71.8	30.7	567.7	7.3	1.3	4.7	5.3	34.5	0.4	0.4	330.8	94.5	1.0	20.7	6.4	71.2	1.1	0.8	11.5	2.3	2.8	122.9	104.6
KAN 07/22	20.6	757.2	5.4	53.1	34.7	831.2	12.7	1.0	5.7	4.3	24.3	0.3	0.5	347.8	109.6	1.0	22.8	4.9	92.2	0.9	0.6	8.8	2.2	2.2	113.2	73.1
KAN 07/23	23.8	785.5	4.0	70.5	32.5	570.7	7.8	1.3	5.0	5.6	33.5	0.4	0.4	271.8	99.6	1.1	21.0	6.4	91.8	1.1	0.9	11.5	2.9	2.8	124.5	110.2
KAN 07/24	35.8	860.9	5.2	57.4	39.4	689.1	17.8	1.1	6.0	4.4	26.3	0.3	0.6	323.5	133.4	1.2	23.0	5.3	112.9	0.8	0.9	9.1	2.6	2.4	119.4	97.8
KAN 07/25	25.5	662.2	3.7	71.9	35.7	610.1	14.5	1.2	5.2	5.5	33.8	0.4	0.5	272.6	125.2	1.3	21.0	6.3	66.0	1.1	0.8	11.5	2.6	2.6	122.2	121.2
KAN 07/26	32.7	604.2	4.3	59.3	34.2	682.0	12.8	1.2	6.0	4.7	27.7	0.3	0.5	332.3	100.4	1.1	21.6	5.6	108.4	1.0	0.8	10.0	2.2	2.5	119.2	95.3
KAN 07/27	26.9	651.4	5.0	59.4	39.8	676.4	14.3	1.1	5.6	4.6	28.0	0.4	0.6	351.7	123.4	1.0	22.7	5.5	117.9	0.9	0.8	9.6	2.1	2.5	114.9	86.4
KAN 07/28	23.6	536.1	3.7	71.0	34.0	549.5	8.2	1.3	4.8	5.3	33.6	0.4	0.4	285.1	108.4	1.0	20.9	6.4	45.8	1.0	0.8	11.2	2.7	2.6	120.2	108.3
KAN 07/29	27.3	742.7	5.5	61.1	42.8	693.8	13.2	1.2	5.8	4.6	28.0	0.3	0.6	346.0	118.5	1.2	23.0	5.7	170.8	0.9	0.7	9.8	1.9	2.8	118.8	98.9
KAN 07/30	23.4	863.0	5.0	69.8	31.5	657.4	13.5	1.2	4.5	5.4	33.2	0.3	0.6	284.1	116.6	1.0	20.5	6.4	122.5	1.0	0.9	10.9	2.5	2.7	109.7	125.1
KAN 07/31	7.5	874.6	11.5	47.1	17.3	505.9	4.7	1.0	4.2	4.3	23.0	0.3	0.9	252.0	48.4	0.8	16.3	4.6	380.2	0.8	0.7	7.0	2.6	2.3	83.3	84.7
KAN 07/32	5.8	813.3	4.7	58.4	28.9	397.4	3.2	1.1	5.0	4.4	26.8	0.3	0.7	210.6	77.4	0.4	17.4	5.0	132.8	0.9	0.7	9.6	2.0	2.6	95.4	93.9
KAN 07/33	12.3	579.5	10.5	45.6	21.9	472.3	5.6	1.0	4.3	4.1	23.3	0.3	0.8	268.8	67.6	0.7	15.5	4.5	309.2	0.8	0.7	7.2	2.3	2.1	101.5	99.5

KAN 07/34	28.0	862.9	1.8	65.3	36.8	987.5	11.6	1.1	5.6	4.9	28.3	0.4	0.5	349.2	107.5	0.9	22.0	5.5	44.1	1.0	0.7	10.7	2.9	2.4	127.7	87.3
KAN 07/35	12.4	542.9	0.6	109.2	17.1	101.9	4.6	1.4	6.4	6.8	47.1	0.4	0.4		86.8	0.9	17.9	7.3	54.2	2.0	0.8	16.5	3.3	3.0	56.2	152.3
KAN 07/36	5.9	883.3	11.1	56.0	27.9	262.7	5.9	1.0	6.5	3.9	25.3	0.4	0.3	179.1	98.3	3.4	25.2	4.6	366.3	1.1	0.6	12.5	3.0	2.6	97.6	108.4
KAN 07/37	7.0	1031.8	6.4	59.6	27.2	252.7	7.1	1.1	5.3	4.1	28.6	0.3	0.5	162.6	125.2	0.5	19.8	5.0	266.4	0.9	0.7	10.6	2.8	2.5	84.9	80.0
KAN 07/38	4.1	538.9	9.6	66.2	29.2	228.7	10.7	1.2	6.0	3.6	33.9	0.4	1.3	143.6	85.9	0.5	22.5	5.8	543.0	1.0	0.8	11.3	3.1	2.4	125.1	103.0
KAN 07/39	13.9	648.8	7.7	64.2	28.2	231.1	8.1	1.1	5.3	3.9	31.9	0.3	0.5	117.6	145.7	0.5	20.5	5.4	293.9	1.0	0.6	11.2	2.4	2.9	106.4	70.0
KAN 07/40	11.9	708.9	8.8	49.7	24.2	546.1	5.0	1.0	4.6	4.7	23.2	0.3	0.6	308.5	64.3	1.0	16.1	4.7	223.9	0.9	0.7	8.1	2.4	2.1	98.5	100.4
KAN 07/41	5.0	997.7	6.7	65.3	31.6	283.7	8.9	1.1	6.1	3.8	32.1	0.4	0.2	192.4	161.1	0.6	23.2	5.1	167.7	1.0	0.6	11.7	3.3	2.6	103.9	102.5
KAN 07/42	15.3	716.2	6.5	61.4	26.5	246.9	4.6	1.1	5.5	4.4	30.2	0.4	0.4	123.0	84.4	0.4	20.1	5.2	222.8	1.0	0.6	11.1	2.8	2.7	98.5	88.9
KAN 07/43	8.3	858.2	8.0	61.2	24.8	261.5	6.5	1.1	5.4	4.2	30.2	0.3	0.4	149.7	109.5	0.5	19.2	5.4	296.9	1.0	0.7	10.8	2.1	2.5	89.2	110.9
KAN 07/44	11.0	896.3	11.2	41.4	17.0	449.9	6.0	0.9	3.7	3.9	20.9	0.3	0.8	236.8	72.9	0.8	13.9	4.2	393.0	0.7	0.6	6.4	2.4	2.0	89.8	100.7
KAN 07/45	6.1	753.2	3.5	69.9	26.7	247.6	4.8	1.2	4.8	6.0	33.7	0.4	0.8	130.9	105.1	0.5	17.3	6.0	191.7	1.1	0.9	11.4	2.4	2.8	100.3	144.8
KAN 07/46	2.7	829.3	4.2	55.3	10.6	60.7	3.1	1.1	3.8	4.4	26.5	0.3	1.7	43.3	55.9	0.2	13.3	4.7	382.5	0.7	0.7	9.1	1.6	2.7	75.4	85.5
KAN 07/47	5.8	807.4	3.4	52.8	14.4	60.2	5.2	1.1	4.5	4.6	22.4	0.3	1.5	49.6	66.8	0.3	17.2	4.5	323.9	0.8	0.7	9.6	1.4	2.3	83.8	97.2
KAN 07/48	2.9	807.0	5.4	58.0	12.8	70.3	2.6	1.2	4.1	5.0	26.6	0.4	1.3	41.6	51.5	0.2	14.3	5.1	351.9	0.8	0.8	9.2	2.0	3.0	85.7	107.2
KAN 07/49	7.5	976.2	3.5	56.8	15.8	71.8	4.4	1.0	4.4	5.0	23.1	0.3	1.5		59.8	0.2	17.0	4.3	303.0	0.8	0.5	9.9	1.7	2.2	81.9	98.5
KAN 07/50	7.9	1118.9	3.4	52.6	14.5	59.3	5.1	1.0	4.4	4.9	23.6	0.3	1.5	35.2	65.5	0.3	15.1	4.3	334.9	0.9	0.7	9.9	2.0	2.4	70.0	100.1
KAN 07/51	3.7	1041.8	3.3	60.3	16.9	68.9	4.1	1.0	4.3	5.3	28.1	0.3	1.7		75.1	0.3	15.5	4.5	329.0	0.9	0.6	12.2	2.8	2.2	68.1	126.0
KAN 07/52	3.3	894.3	3.6	49.1	19.0	71.5	5.1	0.8	4.5	3.7	18.4	0.3	1.7	60.2	80.7	0.3	17.0	3.1	357.0	0.8	0.4	11.3	2.7	1.6	83.3	94.6
KAN 07/53	5.3	1697.1	3.7	61.4	12.8	64.5	3.8	1.1	4.0	5.0	24.3	0.3	1.6	43.3	60.9	0.3	13.7	4.7	376.7	0.8	0.8	10.1	2.1	2.6	67.1	161.6
KAN 07/54	5.2	809.8	3.3	54.8	24.4	53.5	4.5	0.9	4.7	5.4	18.4	0.3	1.7		57.0	0.3	14.6	3.5	382.0	0.8	0.5	9.7	1.8	1.9	69.9	119.0
KAN 07/55	5.5	1151.1	3.8	57.3	21.2	149.4	4.3	1.0	5.2	4.6	20.3	0.3	1.5	61.3	63.6	0.3	20.9	4.2	300.8	0.9	0.6	11.4	1.7	2.1	70.4	97.1
KAN 07/56	4.9	640.4	4.2	52.7	14.6	59.3	3.5	1.0	4.2	5.0	20.8	0.4	1.6	62.9	45.1	0.2	13.9	4.2	334.6	0.7	0.6	9.0	1.8	2.5	77.7	112.6
KAN 07/57	4.8	1096.8	4.0	52.2	20.0	94.2	3.6	0.9	4.9	5.8	19.8	0.3	1.7	57.6	54.5	0.3	19.8	3.7	425.3	0.9	0.5	12.3	2.2	1.9	65.0	148.9
KAN 07/58	6.7	1316.3	3.7	55.2	14.0	48.4	4.3	1.0	4.4	4.9	22.8	0.3	1.6	53.1	53.4	0.3	14.3	4.3	394.4	0.9	0.6	10.1	2.2	2.2	66.0	114.2
KAN 07/59	5.8	1238.3	2.3	53.5	19.6	109.6	5.1	0.8	4.8	4.8	20.3	0.3	1.3	62.4	78.6	0.4	16.4	3.4	245.1	0.9	0.5	10.9	2.7	1.9	61.1	115.9
KAN 07/60	4.9	761.8	2.9	55.4	15.7	59.6	5.4	1.0	4.3	4.8	24.1	0.3	1.6		77.3	0.4	16.7	4.2	335.9	0.8	0.6	10.0	2.3	2.4	65.2	111.4

KAN 07/61	3.5	1163.3	3.8	54.5	13.7	65.4	3.2		1.1	4.3	5.5		23.9	0.3		1.7		40.3	47.8	0.3	15.1	4.4	373.7	0.7	0.7	9.3		2.0		2.8	71.3	133.2
KAN 07/62	5.5	953.3	2.6	53.6	15.9	119.9	4.1		1.0	4.8	5.6		24.2	0.3		1.2		30.6	67.1	0.4	16.7	3.9	178.0	1.0	0.6	11.0		1.6		2.1	74.9	112.7
KAN 07/63	4.6	1218.8	2.4	56.9	17.8	118.6	3.9		1.1	5.0	4.8		26.6	0.4		1.1		71.6	69.5	0.4	19.0	4.6	195.0	0.9	0.7	11.2		2.3		2.4	70.1	96.0
KAN 07/64	4.0	625.3	3.4	56.2	15.8	79.1	4.9		1.1	4.7	5.2		23.1	0.3		1.6		53.9	68.7	0.3	16.5	4.4	269.1	0.9	0.7	10.7		1.8		2.3	73.9	129.7
KAN 07/65	5.9	1012.2	4.0	64.9	16.3	91.4	4.9		1.1	4.3	5.4		27.0	0.3		1.5		57.7	67.6	0.4	14.6	4.9	353.2	1.0	0.7	10.9		1.8		2.3	75.5	130.8
KAN 07/66	16.3	597.1	5.7	46.5	55.3	1067.8	1.4		0.8	5.0	3.9		20.6	0.3		0.6		752.1	24.7	0.8	15.5	3.9	208.3	0.7	0.5	7.1		1.7		2.0	83.6	123.7
KAN 07/67	28.4	821.1	6.3	67.7	31.9	600.4	13.0		1.2	5.2	4.6		31.5	0.4		0.4		339.3	98.3	1.4	20.9	6.1	166.4	1.0	1.1	10.6		3.0		3.0	110.1	104.8
KAN 07/68	80.3	942.3	6.4	66.4	32.3	565.0	12.3		1.3	5.7	4.5		31.6	0.4		0.4		376.6	102.4	1.8	20.3	6.2	230.8	1.0	0.9	10.4		3.0		2.7	120.1	92.8
KAN 07/69	12.0	483.5	10.0	44.3	32.1	347.0	2.5		0.8	4.3	4.1		20.3	0.2		0.4		365.0	45.4	0.9	14.6	4.0	96.6	0.7	0.6	8.1		2.1		2.0	83.7	99.0
KAN 07/70	5.0	640.8	5.0	70.1	30.1	303.3	7.4		1.6	4.0	6.0		47.6	0.7		0.2		326.7	74.3	0.9	14.0	11.1	61.1	0.9	1.5	13.4		4.5		5.0	81.5	160.1
KAN 07/71	18.1	726.0	4.3	63.6	37.6	890.9	12.6		1.2	5.2	4.9		30.7	0.3		0.6		460.5	106.5	0.9	21.2	5.7	76.1	0.9	0.8	10.6		2.0		2.5	122.8	92.5
KAN 07/72	5.3	523.8	3.5	71.2	30.5	237.2	3.8		1.3	5.7	5.3		32.5	0.3		1.3		183.3	70.1	0.6	23.1	5.4	225.1	1.0	0.8	11.5		1.8		3.3	89.3	140.8
KAN 07/73	9.5	797.1	3.3	57.8	15.4	100.4	6.0		1.0	4.8	6.6		24.5	0.3		1.6		44.0	73.0	0.5	16.4	4.2	351.4	1.3	0.7	12.9		2.1		2.1	78.2	147.7
KAN 07/74	6.6	926.6	3.6	67.7	14.5	65.8	3.1		1.0	4.1	5.0		32.3	0.3		1.8		41.3	48.8	0.3	13.8	4.3	342.8	0.8	0.6	11.1		1.8		2.3	68.1	107.9
KAN 07/75	8.4	624.2	3.3	41.7	15.9	100.3	4.6		0.9	4.9	5.4		19.6	0.3		1.5			56.2	0.4	16.7	3.3	192.8	1.1	0.4	11.2		1.5		1.8	64.2	107.8
KAN 07/76	6.6	721.4	3.4	57.7	14.9	92.3	5.2		1.1	4.2	4.9		28.0	0.3		1.7		53.1	77.6	0.4	14.8	4.9	342.6	0.8	0.8	10.0		1.8		2.4	73.6	107.0
KAN 07/77	7.1	1027.4	3.5	60.3	20.4	196.9	5.2		1.2	4.8	5.1		27.0	0.4		1.6		146.9	64.7	0.4	18.2	5.0	299.9	0.8	0.8	9.8		2.6		2.6	79.8	111.4
KAN 07/78	6.6	1188.5	3.6	52.6	15.1	64.3	4.1		1.1	5.1	5.0		23.7	0.3		1.7			58.9	0.4	15.5	4.3	350.1	0.9	0.6	10.1		1.4		2.3	72.8	135.2
KAN 07/79	10.4	1279.7	3.6	73.3	14.1	83.3	3.6		1.2	4.2	5.1		35.7	0.3		1.6			59.0	0.4	14.7	5.5	336.1	0.8	0.9	11.8		1.6		2.7	65.1	129.1
KAN 07/80	12.4	885.4	3.5	63.4	24.3	259.9	25.2		1.0	5.2	3.6		31.7	0.4		0.4		145.0	100.5	0.7	21.1	4.9	226.8	0.9	0.7	11.2		3.7		2.5	96.8	77.7
KAN 07/81	11.2	640.0	1.1	53.4	26.9	314.9	4.8		0.8	4.5	5.5		22.8	0.4		1.1		292.8	89.9	0.8	15.1	4.7	64.2	0.9	0.7	11.0		2.5		2.8	84.9	143.3
KAN 07/82	6.8	858.1	2.0	52.8	35.0	458.0	4.1		0.8	4.5	4.5		24.0	0.3		1.0		413.8	70.6	0.6	15.1	4.5	56.1	0.8	0.6	8.6		2.2		2.1	79.7	109.7
KAN 07/83	10.0	990.1	11.9	41.1	19.1	491.7	3.7		0.9	3.9	4.1		20.5	0.3		0.7		254.7	49.7	0.8	15.0	4.2	316.3	0.7	0.7	6.2		2.3		2.1	82.2	93.5
KAN 07/84	17.7	708.3	10.9	55.5	17.7	261.0	6.9		1.0	3.8	4.7		26.1	0.3		0.4		146.6	75.3	1.4	12.7	4.9	109.5	0.9	0.7	9.0		2.0		2.3	79.5	97.0
KAN 07/85	20.3	1133.6	2.2	62.4	23.3	335.1	8.1		1.0	4.9	5.4		29.4	0.3		0.4		264.7	98.1	1.0	15.8	5.2	114.0	1.3	0.7	10.6		2.5		2.7	97.1	136.6
KAN 07/86	10.3	959.5	5.4	62.3	33.8	395.3	6.2		1.3	5.2	4.8		29.8	0.3		0.7		354.4	85.2	1.1	16.5	5.7	152.2	1.0	0.8	10.0		2.2		2.4	85.2	98.8
KAN 07/87	7.3	896.2	0.8	93.8	10.0	106.2	3.3		2.3	3.7	9.9		48.7	0.6		0.2		62.5	48.6	0.3	13.2	11.0	70.1	2.7	1.8	13.1		4.6		4.4	92.9	237.4

KAN 07/88	6.5	393.5	8.1	58.3	30.8	375.9	3.6	0.9	4.4	3.3	27.8	0.3	0.6		320.4	63.6	0.7	15.6	5.1	229.8	0.7	0.6	10.6	2.0	1.9	65.0	95.0
KAN 07/89	22.6	1073.8	2.8	69.2	21.0	165.0	8.5	1.2	5.4	4.1	33.5	0.4	0.8		123.3	151.0	2.4	20.1	5.8	130.2	1.1	0.8	13.1	2.5	2.5	72.5	90.8
KAN 07/90	7.4	392.4	9.4	46.7	20.2	587.2	5.4	0.9	4.3	4.9	21.8	0.3	1.1		263.4	43.5	0.8	15.4	4.3	429.6	0.8	0.6	7.3	3.6	2.0	70.9	126.2
KAN 10/01	40.2	1205.2	3.0	66.0	42.0	698.2	10.6	1.1	5.7	5.1	29.0	0.4	0.6	26.8		98.8	1.1	20.6	6.0		1.0	0.7	10.2	2.4	2.6	177.7	136.7
KAN 10/02	33.5	1060.4	4.7	67.2	33.6	625.8	6.4	1.1	4.9	5.0	30.6	0.4	0.4	24.7		72.0	1.0	18.3	6.0		1.0	0.6	10.8	2.3	2.6	116.9	150.9
KAN 10/04	6.0	1301.7	6.4	47.7	31.9	412.6	2.8	0.9	4.7	3.4	21.7	0.3	0.3	21.0		64.0	0.6	16.3	4.2		0.7	0.5	8.1	1.8	2.0	103.7	96.5
KAN 10/05	12.4	547.1	4.2	53.8	37.6	798.9	14.8	1.0	6.0	4.8	23.9	0.4	0.5	21.8		114.3	1.0	23.0	5.1		0.9	0.4	10.0	2.8	2.5	199.4	92.6
KAN 10/06	12.8	331.1	2.7	68.4	43.3	831.9	4.4	1.3	6.6	5.3	31.2	0.4	0.4	31.3		49.1	1.0	25.1	6.7		1.1	0.9	11.9	2.0	3.0	190.0	120.8
KAN 10/07	6.2	915.2	6.9	51.8	34.9	401.8	1.7	1.1	5.0	3.3	24.1	0.5	0.5	25.3		43.2	0.6	16.3	4.9		0.8	0.7	8.2	2.0	3.1	119.5	74.6
KAN 10/08	3.8	810.0	3.4	57.1	17.7	91.4	5.2	1.0	4.8	4.9	19.8	0.3	1.6	17.6		53.4	0.3	18.0	4.2		0.9	0.6	10.4	1.7	2.4	114.9	89.4
KAN 10/09	4.3	1331.0	3.7	62.7	22.5	159.8	4.1	1.2	5.1	4.9	27.0	0.4	1.6	20.4		65.2	0.4	19.0	5.3		1.0	0.8	11.9	1.6	2.4	141.1	119.6
KAN 10/10	4.0	921.8	4.0	53.1	11.6	56.1	2.6	1.1	3.9	4.5	20.5	0.4	1.7	17.8		37.8	0.1	13.8	4.1		0.7	0.7	8.4	1.2	2.5	125.7	114.9
KAN 10/11	4.4	1106.8	4.4	57.4	13.0	67.8	3.7	1.1	4.5	4.5	23.4	0.4	1.4	21.1		45.3	0.4	13.8	4.7		0.8	0.5	9.1	1.6	2.9	139.4	143.4
KAN 10/12	4.1	892.9	3.2	57.4	19.3	125.7	3.8	1.0	4.8	4.7	20.8	0.3	1.7	15.2		65.6	0.4	16.3	4.2		1.0	0.7	11.5	1.7	2.2	67.7	99.5
KAN 10/13	3.0	595.9	3.9	61.1	13.6	68.8	4.3	1.1	4.2	4.8	27.4	0.4	1.7	24.0		71.5	0.4	13.9	5.0		0.8	0.6	10.3	1.5	2.5	78.4	107.3
KAN 10/14	9.1	840.7	2.4	55.8	36.8	434.5	3.9	1.0	5.1	4.9	25.7	0.4	0.9	26.0		65.1	0.8	16.7	5.5		1.0	0.6	10.7	1.8	2.6	76.4	121.4
KAN 10/15	21.3	679.8	3.7	53.2	54.7	1512.3	5.1	0.8	5.6	4.2	21.2	0.3	0.5	22.1		49.6	1.0	16.8	4.2		0.7	0.6	7.3	1.7	1.8	94.6	103.2
KAL 12/06	5.4	275.0	5.9	76.2	33.4	271.2	3.8	1.4	6.2	4.1	39.3	0.5	0.3		186.9	68.8	0.6	24.4	7.1	95.9	1.1	1.0	12.9	2.6	3.2	163.5	108.4
KAL 12/14	8.5	365.7	15.5	47.7	24.9	173.8	8.1	0.9	4.0	2.6	25.0	0.3	0.5		122.8	105.1	0.5	15.0	4.5	399.3	0.6	0.4	7.7	2.2	2.1	111.7	75.5
KAL 12/16	3.3	306.9	13.2	59.8	25.1	206.1	8.7	1.1	4.9	3.2	30.5	0.4	0.6		137.2	123.9	0.5	18.7	5.6	474.2	0.8	0.8	9.6	2.1	2.5	130.9	114.5
KAL 12/18	4.8	300.2	12.9	54.1	23.8	222.3	7.0	1.0	4.4	3.4	27.4	0.3	0.7		135.0	109.0	0.5	16.7	5.1	311.3	0.8	0.5	8.8	1.6	2.2	99.4	93.4
KAL 12/20	36.8	373.5	5.1	52.9	25.4	244.5	6.4	1.3	5.5	3.3	26.1	0.5	0.8		130.0	85.9	10.9	20.3	5.8		0.8	0.8	9.0	1.2	3.5	108.1	72.4
KAL 12/21	5.2	405.3	13.6	57.6	23.1	196.3	8.6	1.0	4.8	2.9	29.5	0.3	0.4		93.4	130.6	0.6	18.2	5.0	313.5	0.8	0.6	9.3	2.4	2.3	120.7	73.2
KAL 12/22	3.4	349.2	14.2	52.6	21.6	180.3	6.6	1.0	4.1	3.0	26.2	0.3	0.5		117.7	109.2	0.5	15.6	4.7	207.1	0.7	0.5	8.4	1.8	2.1	126.9	86.1
KAL 12/24	8.1	252.3	19.4	56.3	21.1	186.5	4.0	1.1	4.4	2.8	29.9	0.4	0.2		125.9	63.3	0.6	16.8	5.3	254.3	0.7	0.8	8.8	1.5	2.2	110.2	54.4
KAL 12/25	3.7	301.4	12.4	55.5	22.9	204.1	6.8	1.1	4.5	3.5	28.1	0.4	0.5		124.7	110.3	0.5	16.9	4.9	264.9	0.8	0.7	9.0	2.2	2.3	105.4	100.8
KAL 12/27	4.1	358.1	9.9	59.6	27.3	223.2	7.7	1.1	5.0	3.6	30.3	0.4	0.5		137.5	129.9	0.5	19.0	5.2	309.3	0.8	0.7	9.9	2.1	2.3	127.8	102.0

KAL 12/29	6.6	278.5	17.3	44.6	21.4	181.4	5.2	0.9	3.5	2.5	22.7	0.3	0.6	145.6	85.2	0.4	13.2	4.1	352.3	0.6	0.5	7.0	1.8	1.7	96.1	63.2
KAL 12/31	3.5	340.1	9.6	67.9	27.3	241.6	8.9	1.2	5.4	3.9	34.3	0.4	1.0	171.3	124.6	0.5	21.0	5.9	289.9	1.0	0.7	11.3	2.5	2.5	120.8	95.3
KAL 12/32	8.7	515.0	13.9	54.9	24.1	200.2	6.6	1.1	4.3	3.1	28.3	0.3	0.6	114.1	106.3	0.6	16.7	5.1	408.9	0.7	0.7	8.8	2.1	2.5	118.0	74.3
KAL 12/33	7.0	397.2	16.4	48.6	22.0	172.7	5.8	1.0	3.8	2.7	24.9	0.3	0.5	105.7	93.3	0.5	14.8	4.5	362.8	0.6	0.6	7.8	2.1	2.1	101.0	60.9
KAL 12/34	3.0	309.8	11.3	52.0	39.4	447.4	5.8	1.0	5.1	3.2	25.8	0.3	1.0	402.4	95.8	0.4	18.3	4.7	253.8	0.7	0.6	8.2	1.6	2.2	110.0	77.2
KAL 12/35	6.0	500.0	14.3	53.2	23.8	185.2	6.7	1.1	4.2	3.0	27.7	0.3	0.5	142.2	105.7	0.6	16.2	5.0	386.3	0.8	0.7	8.5	2.2	2.4	108.3	73.5
KAL 12/36	9.8	243.2	11.7	52.7	23.0	174.7	7.3	1.0	4.3	2.7	26.7	0.4	0.4	107.2	117.0	0.6	16.8	4.6	384.0	0.7	0.6	8.6	2.3	1.9	106.9	73.0
KAL 12/37	9.1	197.2	13.3	53.0	24.9	193.2	6.7	1.1	4.2	3.1	27.9	0.4	0.5	123.2	110.4	0.5	16.1	5.0	332.0	0.7	0.6	8.6	2.2	2.2	113.1	86.0
KAL 12/39	5.8	329.7	9.6	62.9	28.6	238.4	8.6	1.1	5.2	3.4	32.6	0.4	0.4	115.2	145.1	0.5	21.2	5.4	916.0	0.9	0.7	10.6	2.1	2.7	120.2	96.5
KAL 12/41	3.3	214.0	16.2	43.9	20.1	175.0	7.2	0.9	3.5	2.7	22.5	0.3	0.4	107.5	97.5	0.4	14.0	4.0	356.3	0.6	0.6	7.2	2.2	1.8	94.9	64.2
KAL 12/42	6.4	448.3	11.1	58.2	22.9	200.1	7.6	1.1	4.4	3.4	29.8	0.4	0.6	124.0	116.6	0.4	17.5	5.4	319.3	0.8	0.8	9.3	2.5	2.3	115.4	101.6
KAL 12/43	3.9	343.4	11.5	58.8	26.1	209.4	8.0	1.1	5.0	3.1	30.1	0.4	0.9	143.5	134.4	0.5	19.5	5.1	388.2	0.8	0.8	9.9	2.9	2.3	130.5	90.1
KAL 12/44	7.4	463.1	8.6	67.7	29.3	241.3	8.0	1.2	5.4	4.0	34.2	0.5	0.5	152.1	132.8	0.6	20.7	6.0	365.8	1.0	0.8	11.2	3.0	2.6	112.6	97.4
KAL 12/45	24.6	318.8	8.9	60.7	28.1	521.7	11.3	1.1	4.4	4.1	28.9	0.4	0.4	256.8	109.9	0.9	17.7	5.4	90.6	0.8	0.7	9.0	2.7	2.2	108.3	113.7
KAL 12/47	6.9	301.7	17.0	45.8	21.4	175.5	6.3	0.9	3.9	2.8	23.6	0.3	0.4	134.0	98.5	0.5	14.5	4.3	295.8	0.7	0.5	7.5	1.7	2.0	104.4	82.1
KAL 12/52	11.0	237.0	12.8	62.1	26.4	208.2	6.2	1.1	4.6	3.3	31.6	0.4	0.4	118.0	108.2	0.5	19.3	5.4	206.1	0.9	0.7	10.3	1.9	2.6	126.5	81.4
KAL 12/56	5.2	294.6	7.3	79.7	34.1	303.4	7.9	1.4	7.0	3.9	40.7	0.4	0.3	179.0	141.2	0.7	26.0	6.6	210.8	1.1	0.9	13.4	2.7	3.1	145.4	138.6
KAL 12/59	5.7	370.4	13.6	60.1	25.5	200.6	8.7	1.2	4.9	3.0	30.9	0.3	0.5	133.1	131.0	0.5	19.2	5.4	400.2	0.8	0.8	9.9	2.2	2.6	118.4	102.3
KAL 12/61	4.6	275.6	15.5	49.5	23.5	183.1	6.7	1.0	4.0	2.9	25.5	0.3	0.4	112.5	105.1	0.5	15.7	4.5	281.5	0.7	0.5	8.1	2.2	2.0	97.7	74.3
KAL 12/62	5.2	297.4	11.8	59.6	26.0	210.1	7.1	1.1	4.8	3.5	30.4	0.4	0.5	139.7	117.4	0.5	18.4	5.3	285.2	0.8	0.7	9.7	2.3	2.6	125.8	62.2
KAL 12/64	5.5	324.5	14.1	45.0	22.5	187.8	5.6	0.9	3.6	3.1	23.5	0.3	0.5	117.2	92.4	0.5	13.9	4.3	320.6	0.6	0.6	7.4	1.3	1.9	87.0	87.3
KAL 12/73	5.1	295.0	11.2	56.0	25.0	207.8	7.3	1.0	4.5	3.3	28.6	0.3	0.5	124.8	125.7	0.6	18.0	5.0	359.0	0.8	0.6	9.2	1.9	2.2	107.6	105.9
KAL 12/74	6.2	267.3	13.7	53.6	23.0	187.2	6.2	1.0	4.3	3.2	27.5	0.3	0.5	116.9	99.1	0.5	16.3	4.8	313.4	0.8	0.7	8.8	2.2	2.2	105.1	62.6
KAL 12/75	4.8	263.1	12.1	66.2	31.0	235.8	10.0	1.2	5.4	3.4	33.8	0.4	1.2	169.5	120.4	0.6	21.8	5.7	386.3	0.9	0.7	11.0	1.6	2.4	128.6	119.8
KAL 12/125	7.8	204.4	17.6	42.9	21.4	173.3	6.3	0.8	3.6	2.1	22.5	0.3	0.3	156.8	96.8	0.4	14.6	3.9	338.6	0.5	0.5	6.9	1.4	1.7	107.4	52.6
KAL 12/126	6.5	252.2	16.4	45.1	22.6	185.7	7.0	0.8	3.8	2.2	23.4	0.3	0.3	160.9	107.9	0.4	15.0	4.0	305.1	0.6	0.4	7.2	1.8	2.1	132.5	105.3
KAL 12/127	5.5	330.0	14.0	48.5	21.0	176.5	5.8	0.9	4.0	2.9	24.7	0.3	0.4	142.4	95.6	0.5	15.1	4.4	256.8	0.7	0.5	8.0	1.7	2.0	105.1	58.0

KAL 12/137	5.1	290.2	14.5	48.4	24.1	194.8	7.2	0.9	4.2	2.7	25.5	0.3	0.4	100.2	107.1	0.4	15.9	4.5	287.8	0.7	0.5	8.0	1.8	2.0	102.0	74.9
Stiri 12/97	5.4	609.4	19.5	41.8	19.3	144.6	5.4	0.8	3.4	2.2	21.5	0.3	0.9	87.4	76.4	0.5	13.1	3.8	307.5	0.6	0.5	6.8	1.4	1.7	87.3	50.7
Stiri 12/100	4.7	349.1	10.8	56.1	21.1	175.8	6.5	1.1	4.2	3.5	28.4	0.4	0.6	163.5	104.0	0.5	15.8	5.3	381.4	0.8	0.6	8.8	1.9	2.4	122.5	88.6
Stiri 12/101	6.6	381.6	12.1	61.4	24.7	208.0	7.1	1.2	5.1	3.1	32.0	0.4	0.5	115.1	115.5	0.6	19.4	5.6	843.7	0.8	0.7	10.1	2.7	2.6	112.3	108.5
Stiri 12/102	4.4	444.4	12.9	62.2	27.0	216.1	8.7	1.2	4.9	3.4	31.5	0.4	0.5	167.8	132.5	0.5	19.4	5.7	277.7	0.8	0.7	10.3	2.4	2.7	171.4	105.8
Stiri 12/105	3.7	460.7	16.3	54.6	28.7	227.2	8.7	1.1	4.6	2.8	29.3	0.3	0.7	211.5	120.5	0.5	18.4	5.2	273.3	0.7	0.8	8.9	1.7	2.1	147.5	95.9
Stiri 12/108	5.9	298.0	13.4	55.2	23.1	202.9	8.0	1.0	4.4	2.9	28.1	0.3	0.3	146.6	123.2	0.4	17.8	4.9	236.4	0.7	0.5	9.1	1.9	2.5	144.2	50.5
Stiri 12/109	3.4	327.7	10.1	63.7	28.1	224.2	8.8	1.2	5.3	3.6	32.2	0.3	0.5	195.1	140.9	0.6	20.8	5.7	274.3	0.9	0.8	10.7	1.9	2.8	164.8	66.5
Stiri 12/114	4.2	341.1	7.1	52.9	57.9	743.8	0.2	1.1	6.2	3.7	25.1	0.3	0.4	624.3	20.5	0.4	19.2	5.0	62.2	0.8	0.7	7.9	1.2	2.6	104.3	94.0