The University of Sheffield
Department of Archaeology

Production and Circulation of the Late Neolithic Pottery from Makrygialos (Phase II), Macedonia, Northern Greece

Elissavet Hitsiou

Volume 1

Submitted for the Degree of Doctor of Philosophy

March 2003

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Αγγελική

ACKNOWLEDGMENTS

This PhD has been a long and interesting journey. During its course, I was transformed by many social, emotional and intellectual experiences thanks to the many people who accompanied me in one way or another. To all of them, even if their names do not appear here, I owe a great deal.

First of all I would like to thank my supervisor Dr P. M. Day and my advisor Dr P. Halstead, for helping me to shape coherent ideas out of what seemed like chaos. My teacher, Dr K. Kotsakis, supported me and encouraged me to start this adventure. I am indebted to M. Pappa and M. Besios, Directors of the Makrygialos project at the Thessaloniki Archaeological Museum in Greece, for granting me the invaluable opportunity to study this ceramic material; M. Pappa, in particular, has resolved many practical problems and facilitated my fieldwork periods in Makrygialos. I owe many thanks to Professor Hourmouziadis of the Aristotle University of Thessaloniki, V. Adrimi and V. Rondiri of the Volos Archaeological museum, Pan. Chrysostomou and P. Chrysostomou, of the Pella Archaeological Museum, and Dr I. Aslanis, of the National Research Institute in Athens, for giving me permission to take comparative samples for petrographic analysis from the sites of Dimini, Agrosykia A and Giannitsa B. The Greek Archaeological Service guards, P. Miaouras and N. Kalitsios, and the excavation team in Makrygialos, offered much valuable help during my fieldwork there.

I am grateful to Professor P. Buckland for reading my work and for practical help and support. I owe many thanks to Dr L. Joyner and Dr P. Quinn for checking earlier drafts of my petrographic descriptions, and Dr E. Kiriatzi for useful discussions on the material. Many thanks to Dr A. Krahtopoulou for offering me to use the geological map of Makrygialos of her unpublished PhD thesis. J. Russell, from the Computing Services Department, University of Sheffield, helped me to organise my macroscopic data and performed part of the basic statistical analysis. Rob Craigie, Martin Brocklesby and Marco Beggiora offered invaluable help by resolving computer related problems.

This research project was financially supported by the University of Sheffield, the Department of Archaeology, University of Sheffield, the Sheffield Centre for

Aegean Archaeology, the British Federation for Women Graduates, the Swann-Morton Foundation and the Gilchrist Educational Trust.

I owe many thanks to a number of people who have supported me during my years in Sheffield. The Cox family, Pia Nystrom, Delil, Claudia, Ana and Dulce have created a friendly and homely environment and tolerated my moods during difficult times.

The people who have shared my enthusiasm and hopes and kept me going during hard times are my friends. I would like to express my gratitude to them. Alice, Elena and Emma have offered me not only constant emotional support but also invaluable practical help. Also, Maria, Vangelio, Penelopi, Maria, Evi, Vicky, Eva and Despina were always there to listen and encourage me in times when I felt I was about to collapse.

Above all, I want to express my warmest and deepest gratitude to my family. My brother, Dimitris, has been a constant source of care and support; his free spirit and sense of humour were there to remind me the bigger picture whenever I was in danger of 'loosing the plot'. There are not enough words to thank my parents. Without their love, confidence in me and financial support, this PhD would not have been possible. I am indebted to them for making my dream come true.

ABSTRACT

This thesis investigates the production technology and inter-site circulation of a large and diverse Late Neolithic ceramic assemblage from the newly excavated, flat-extended settlement of Makrygialos, in Pieria, northern Greece. It argues for the use of macroscopic and petrographic analysis of a large number of samples from Makrygialos (Phase II) in a fully integrated project. Also incorporated are comparative samples from the contemporary settlements of Dimini, in Thessaly, and Agrosykia A and Giannitsa B, in western Macedonia.

A large body of new evidence is presented, which sheds light on the manipulation of raw materials by ancient potters through detailed study of the production technology of distinct categories of pottery, for a better understanding of the role of technological choice in production. Locally produced and imported ceramic categories are found to co-exist. These may signify manufacture by different groups or individuals with varying degrees of technological knowledge and skill, possibly produced in different places, or distinct ceramic traditions. More importantly, petrographic analysis provides positive evidence of the long-distance movement of pots, contradicting previously established ideas on the circulation of pottery for this period. Such evidence illustrates a high level of complexity in the societal organisation of the studied communities that has until recently been largely underestimated. The emerging picture strongly supports the idea of a dynamic Neolithic society characterised by mobility and interaction between people, as revealed through their material culture.

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LIST OF ABBREVIATIONS

DMP: .....Domestic Mode of Production
EN: .....Early Neolithic
FN: ..... Final Neolithic
LN: ..... Late Neolithic
MN: .....Middle Neolithic
NAA: .....Neutron Activation Analysis
SEM: ..... Scanning Electron Microscopy
Tcfs: .....Textural Concentration Features
XRD: ..... X-ray Diffraction
XRF: ..... X-ray Fluorescence

CHAPTER 1

INTRODUCTION

In studies of the Greek Neolithic the analysis of pottery has occupied an important place. It is essentially based on this category of material culture that the period itself has been divided into distinct chronological phases and sub-phases. Initially, such divisions were made on grounds of stylistic and morphological similarities and differences, influenced by evolutionary schemes. They were used for the reconstruction of chrono-typological sequences in order to establish the cultural history and originality of the Greek Neolithic (Hauptmann 1981; Milojcic 1960; Theocharis 1973; Tsountas 1908; Wace & Thompson 1912). Gradually, however, and within the theoretical framework of 'ceramic ecology' and 'New Archaeology', the study of pottery became a search for social and economic processes and production relationships, even symbolic meanings, that were observed in the organisation of the society in question (Halstead 1981a, 1981b, 1989, 1992a, 1992b, 1994, 1995; Hourmouziadis 1978, 1979, 1980, 1981; Kotsakis 1983, 1992; Perlès 1992; Perlès and Vitelli 1994, 1999; Renfrew 1973; Torrence 1986; Vitelli 1989, 1993a, 1995).

In the Aegean, the search for socio-economic and cultural changes was until relatively recently primarily focused on studies of the Bronze Age, which was believed to display increasing social complexity and the emergence of well-defined, hierarchically-structured states (e.g. Renfrew 1972). These changes were traced through and explained by parameters such as population growth, craft specialisation in the production of certain categories of material culture, and long-distance 'exchange', which in the majority of cases were considered directly inter-related.

The Neolithic period in Greece, on the other hand, has traditionally been contemplated as 'egalitarian' and characterised by 'self-sufficiency', in contrast to the more sophisticated organisation of the later periods. The broad themes through which the study of this period has been undertaken are primarily agricultural and craft production and 'exchange'. These subjects have been approached through the concept of the 'Domestic Mode of Production' (DMP), where the idea of *under*production – production only to cover the consumption needs of a 'household' – has dominated (Sahlins 1972). Whilst the definition of the Neolithic 'household', as represented in the

archaeological record, remains open to debate, emphasis has been given to the investigation of craft production and 'exchange'. Two categories of material culture, in particular, have been employed: stone tools and pottery. These have been used as sensitive indices to measure craft specialisation and 'exchange', two processes that in the literature are associated with social complexity.

For perhaps the first time, recent debate has acknowledged the powerful dynamics and the complex nature of Greek Neolithic society, and these have been examined on different levels: the individual/'household', the community, and inter-community scale (Broodbank 1992; Demoule & Perlès 1993; Halstead 1999a, 1999b; Kotsakis 1994, 1996a, 1996b, 1996c; Perlès 1992; Perlès and Vitelli 1999; Vitelli 1993a, 1993b, 1995, 1999). The issues that have monopolised this discussion remain 'household' and craft production and 'exchange'.

In the debate on the Greek Neolithic, however, arguments and explanatory models have been built largely on assumptions that, to an extent, are compromised, due to the nature of the available evidence itself. For example, the basis of the archaeological information used has been the product:

a) of surface finds or small trial trenches, and
b) of small-scale excavations at *tell* sites that, until recently, have been considered the predominant type of spatial habitation during the Neolithic.

Further to this, the collected data have been retrieved predominantly from one particular geographical area, Thessaly, which functions as yardstick for other regions.

The discovery and excavation of the Late Neolithic settlement at Makrygialos, Macedonia, northern Greece, offers a unique opportunity to re-investigate some of the aforementioned central issues through examination of its diverse categories of material culture. This thesis is engaged in the study of the pottery from Phase II at Makrygialos. The importance of this material lies in several factors:

1) it comes from a large, extensively-excavated site, whose development can be traced horizontally, and offers very rich evidence of all categories of material culture;
2) it belongs to a flat-extended settlement, outside the norm of the Neolithic *tell* site, and is located in a geographical area other than Thessaly;

3) most importantly, it is the first time that such an extensive research project has been undertaken for this particular chronological period and geographical area in northern Greece. The strength of this thesis lies upon its integrated methodology which combines macroscopic examination with petrographic analysis of a very large number of pottery samples, covering the whole range of wares, fabrics and shapes present in the material rather than concentrating on a single ceramic category; the purpose of this is to study the intra-site production technology of the Makrygialos assemblage. At the same time, comparative petrographic analysis of sufficient samples from contemporary sites located in both Thessaly and western Macedonia is also undertaken for the investigation of inter-site circulation of the studied material.

Through examination of the organisation of production technology and study of the circulation of the later Late Neolithic pottery, this research sets out to explore the social complexity of the LN period in its own right, as reflected in this particular category of material culture. More specifically, the thesis is engaged in the investigation of socio-cultural aspects pertaining to the organisation of society in Late Neolithic Makrygialos, with two main points of reference:

a) intra-site production technology of the ceramic material, and
b) its inter-site circulation

These are investigated in order to establish, on the one hand, a better understanding of the potter's raw material choices, and on the other, to explore the possibility of the circulation of pottery, and the reasons why these may have occurred.

On the level of observation, the archaeological questions that this thesis aims to answer include the following: within this pottery assemblage, are there distinct fabric categories that are consistent and constitute quite different recipes and raw materials? Is all the ceramic assemblage locally made, or do local examples co-exist with imported wares? If so, which are these wares? Are there readily distinguishable functional categories, which are then associated with specific wares and fabrics? Furthermore, do different morphological and decorative classes of pottery reveal any meaningful associations with distinct fabric groups? On an intra-site level, how does the ceramic material circulate? Is the distribution restricted for some wares in specific contexts,

whilst being wider for others across the settlement? Ultimately, was pottery circulating over long distances during this period?

These questions are basic, but crucial, as they have serious implications for cultural, economic and ideological aspects of the societal organisation of the Makrygialos community. On an interpretative level, then, what are the clues that the Makrygialos pottery production technology offers regarding a better understanding of the intra-site organisation of this settlement? What was the role of ceramics within the community, and how were they manipulated during this period in relationships with other contemporary communities? Finally, could answers to the aforementioned questions shed some light on and inform previously established ideas concerning the Greek Neolithic in general?

To be able to address such questions and follow the main argument this thesis is organised into eight chapters (including the Introduction); their structure is briefly presented below:

Chapter 2 presents the chronological and theoretical framework of Greek Neolithic studies. This is done:

1) through a brief review of the body of archaeological evidence available for the Early (EN), Middle (MN), Late (LN) and Final Neolithic (FN) – the emphasis is on the Late Neolithic period to which the studied material belongs – and,
2) through assessment of the way researchers have interpreted the available material culture.

Chapter 3 explores approaches to the study of Greek Neolithic pottery, in the context of wider debates in ceramic studies. The focal points remain pottery production and circulation/'exchange', as they have been explored through theoretical constructs such as domestic production versus specialisation, and through discussion of manufacturing technology and its parameters, the organisation of production and the movement of pots over long distances. Emphasis will be given to the use of analytical techniques for the study of production technology and the circulation/provenance of ceramics.

Chapter 4 presents the newly-excavated Late Neolithic settlement of Makrygialos (Phase II), along with a brief account of all the categories of material culture remains from that site. The emphasis here is on the extensive presentation of the pottery from Phase II. A brief discussion of typological classification in general and of the typological models used since the turn of the century, particularly to describe Greek Neolithic pottery, is followed by an account of the typological model adopted in the present study. Finally, the detailed typology of the Makrygialos Phase II pottery, as developed during its macroscopic examination, is presented.

Chapter 5 presents the methodology employed in this study of the Makrygialos Phase II pottery, which was carried out on several different levels of analysis:

- macroscopic examination (a ware- and fabric-based analysis)
- study of the geological deposits from the area under investigation
- petrographic analysis of a large number of representative samples, selected on the basis of the detailed macroscopic examination
- petrographic examination of comparative material sampled from three other contemporary settlements (Dimini, Agrosykia and Giannitsa B) located in Thessaly and Western Macedonia.

Chapter 6 presents and discusses the results of the petrographic characterisation of the four ceramic assemblages under study (namely Makrygialos, Dimini, Agrosykia and Giannitsa B) along with an account of their production technology. Provenance ascription is attempted where possible.

First, the location and geological environment of each site is discussed separately, together with any previous analytical work done in that specific area. This is followed by a detailed presentation of all the fabric groups formed from the ceramics examined. These have been classified and analysed together, rather than split by site. The purpose is to examine the interplay between and across the same and different categories of pottery from the different sites, in order to investigate choices made by the ancient potters. Mineralogical/compositional and textural differences are the main criteria used in forming the fabric groups presented here in an attempt to ascribe provenance identification. Finally, a discussion of the 'imported' and 'local' fabrics is provided.

In **Chapter 7** the results of the macroscopic and petrographic analysis of this pottery are brought together and all the key elements that came about from the analysis along with their implications are discussed. The final step is to point out the essential concepts linked to pottery that help to incorporate it into the discussion on the Greek Neolithic in general and, ultimately, to explore how such concepts inform and to what extent confirm or question the previously established ideas.

Finally, in **Chapter 8** the conclusions and issues for further research are presented.

Following the aforementioned paths, the thesis provides a fresh perspective on Late Neolithic material culture, based on a fully integrated analytical methodology.

CHAPTER 2

THE NEOLITHIC PERIOD IN GREECE

2.1 Introduction

In this chapter the chronological framework of the period in question is defined and then a summary of the available published archaeological evidence is presented, divided into the conventional phases of the Greek Neolithic, i.e., Early (EN), Middle (MN), Late (LN) and Final (FN) Neolithic. It is not the aim of the writer here to undertake a detailed review of research carried out on the Greek Neolithic, as this has been done successfully elsewhere (Alram-Stern 1996; Andreou *et al.*, 1996; Cherry 1990; Demoule & Perlès 1993; Halstead 1999a; Papathanassopoulos 1996; Perlès 1992; Theocharis 1973). Instead, the emphasis is on the approaches that researchers have undertaken to interpret the remains of the surviving material culture. From this body of evidence the purpose is to identify the key elements that this thesis will examine. Throughout the study, the geographical focus will be northern Greece, where Makrygialos is located, although extensive reference is also made to important work undertaken on the Neolithic of southern Greece.

2.2 Chronological framework of the Greek Neolithic

During the course of early work both in Thessaly and Greek Macedonia, from the beginning of the 20th century until the 1970s, the efforts of researchers, with a few exceptions, were focused on resolving chronological problems. Tsountas (1908) and Wace and Thompson (1912) were the first pioneers to work towards the establishment of a chrono-typological framework that would be adequate to describe the cultural history of Thessaly. A further refinement was made possible by detailed stratigraphic evidence from the excavations of Milojcic and Theocharis, resulting in a chronology of the Thessalian Neolithic and its relationship to South Greece and the Balkans (for a detailed account, see Otto 1985: 42, fig. 11).

More recently, Demoule and Perlès, in their review of the Greek Neolithic, offer a more synthetic and simple chronological framework, which is related to chronologies for other parts of Greece during the Neolithic, excluding Crete, but briefly including the Balkans. This is presented in both uncalibrated and calibrated years (Demoule and Perlès 1993: 366, Figure 2). A more detailed account of comparative chronologies between northern Greece and the Balkans is given by Whittle (1996: 42, Table 3.4). Finally, Andreou, Fotiadis and Kotsakis, in their review of the Neolithic and Bronze Age of northern Greece have suggested a new chronological framework, based on calendrical rather than radiocarbon dates (Andreou *et al.*, 1996: 538). This chronology, presented below, although very broad, is yet simple, easy to follow and, now, widely accepted by researchers, who carry out archaeological work on northern Greek material. For these reasons it is adopted in the present study:

Archaeological Phases	Years BC Calendrical
Early Neolithic	6700/6500 - 5800/5600
Middle Neolithic	5800/5600 - 5400/5300
Late Neolithic	5400/5300 - 4700/4500
Final Neolithic	4700/4500 - 3300/3100

Table 2.1 Archaeological Phases and Chronology for northern Greece: Neolithic period (after Andreou *et al.*, 1996: 538)

2.3 Archaeological evidence

This brief account of the available body of information on mainly northern Greek Neolithic material culture is presented as reflected in: settlement patterns (spatial distribution and site types), settlement architecture, and agricultural and craft production.

2.3.1 The Early and Middle Neolithic

During these earlier phases, the evidence from Thessaly suggests a busy social environment, with a densely inhabited landscape, especially in its eastern basin (*fig.*

2.1). Opinions on settlement sizes differ, since they have been variously estimated as covering an area of either *c.* 0.5-1.0 ha (Halstead 1984, 1994: 200), with populations ranging from 50 to 300 inhabitants per Neolithic village (Halstead 1984, 1994; Theocharis 1973), or 2 to 5.5 ha (Demoule & Perlès 1993: 370). The sites were located in diverse environments, e.g., by a river bank (Argissa), in the foothills of mountains (Gediki), on low coastal hills (Sesklo), or in low-lying areas of the eastern or western Thessalian basin (Achilleion, Prodromos).

The archaeological evidence for the same period in Greek Macedonia is restricted and results from a different scale and intensity of research. This was primarily due to geopolitical and historical factors, and affected essentially the way prehistorians 'placed' and interpreted Macedonia's relations with the rest of Europe and the Aegean, as Kotsakis has discussed extensively in two recent papers (Kotsakis 1991, 1998: 47). Archaeological understanding is essentially based on information from the Early Neolithic settlement of Nea Nikomedeia, located in the southern alluvial plain of western Macedonia (Rodden 1965), and the Middle Neolithic settlement of Servia, in the mid-Aliakmon valley (Ridley & Wardle 1979). Their general characteristics match those of their Thessalian contemporaries. The fact that the majority of known Early and Middle Neolithic sites were continuously occupied throughout the two phases has been read as an element of stability (Demoule & Perlès 1993: 368; Halstead 1984; Theocharis 1973).

In the literature, until relatively recently, *tell* sites were assumed to have been the dominant type site of the Neolithic landscape. *Tells* are characterised by an accumulation of successive, continuous habitation layers, as a result of persistent occupation of the same location over a long time. Thus, the settlements expanded vertically rather than horizontally, covering a relatively restricted area and thereby maintaining a clearly visible height (Kotsakis 1999: 66-69). The present understanding of settlement patterns, however, including type sites, has been almost entirely based on evidence from Thessaly, especially the extensively excavated ones at Sesklo, Dimini and Achilleion (Gimbutas *et al.* 1989; Hourmouziadis 1979; Kotsakis 1994; Milojcic 1960; Theocharis 1973; Tsountas 1908; Wace & Thompson 1912) but also including surface surveys and small trial trenches. The *tell*-type of site was assumed to be the norm, despite evidence to the contrary. Sesklo, for instance, exhibits a dual habitation pattern, as it consists of two contemporary components, of which one is a *tell* and the

other an extended site (*acropolis* = *tell* and *polis* = *extended site*). This is the main reason for being treated as an isolated oddity, outside the *tell* site norm (Kotsakis 1999: 66). Theocharis, after having reinvestigated the site, clearly stated that "[it] was an extensive settlement from the beginning of the period....the settlement had spread out onto a flat, gently sloping ridge, which was a Pliocene 'terrace', and did not therefore have the appearance of a 'magula' or *tell*" (1973: 40). As examples of similar extended settlements, he cited Achilleion, in Thessaly, and Nea Makri and Corinth in southern Greece.

It is believed that most of these settlements were open, with closely spaced, free-standing houses and open courtyards. The exceptions, however, of Soufli, Achilleion, Nea Nikomedeia and Servia, where a wall or a pair of walls or a ditch enclosed the inhabited areas, may suggest that such constructions were probably universal, if not always discovered. Enclosure ditches may have served a practical purpose (such as drainage), they may have carried symbolic meaning (providing territorial demarcation), or they may have been for defence. There is still much dispute regarding the issue (Andreou *et al.* 1996; Aslanis 1990; Hourmouziadis 1979; Kokkinidou & Nikolaidou 1999; Pappa & Besios 1999a, 1999b).

In Neolithic *tell* architecture, rectangular, free-standing 'houses', with floor areas of 20 to 70 m^2 and/or much smaller clusters of adjoined 'rooms', dominated, and these have been interpreted as 'family houses' (Theocharis 1973). Nea Nikomedeia, Sesklo, Servia and Achilleion comprise good examples of house architecture (Gimbutas *et al.* 1989; Ridley & Wardle 1979; Rodden 1965; Theocharis 1973). A variety of construction forms and materials have been identified, not only on different sites, but also within the same site, for example, at Sesklo. Mudbrick appears to have been in general use, often combined with stone foundations, where this material was available, alongside wattle-and-daub. Variation is observed in structures for the preparation and cooking of food, which were placed both inside houses and in open courtyards. There is, however, very little evidence for pottery kilns, as will be discussed extensively in Chapter 3.

Reconstruction of the EN and MN subsistence economy is based on the assumption that communities maintained a sedentary character. The definition of the concept of sedentism, as opposed to mobility, is still disputed, as there is disagreement

on its forms, levels and its interpretation in cultural terms. Archaeological and ethnohistoric data, which seriously challenge the link between agriculture, house buildings and the 'settling down' process, have also been overlooked (cf. Kaiser & Voytek 1983: 324; Kelly 1992: 44-45, 49; Whittle 1997: 15-16, 21).

Most of the debate on subsistence economy relies on palaeoeconomic evidence from Thessaly, and stresses changes in subsistence strategies in the transition from the Early and Middle to the Late and Final Neolithic (Halstead 1981a, 1984, 1989, 1992b, 1994, 1995). It is thought that during the earlier phases, small, nucleated settlements relied on a small-scale, diversified, mixed agricultural economy. Subsistence mainly consisted of a wide range of domesticates, essentially cereal crops and pulses, einkorn, emmer, bread wheat, lentils and peas. In terms of arable land use, due to the small size of Neolithic settlements, it has been suggested that early inhabitants adopted an intensive horticultural regime, where cereals and pulses were cultivated in rotation in small plots/ 'gardens' in close proximity to the settlement. According to Halstead, such a strategy could produce more food than an alternative with bare fallow, would improve the soil composition and, after harvesting, allow animal fodder and consequently field manuring (1981a: 320). Hunting-gathering, on the other hand, is assumed to have taken place in areas where the presence of EN and MN settlements was very rare or absent, due to environmental constraints in agriculturally marginal areas (Halstead 1994: 200). In addition, the breeding of livestock, e.g., sheep, goat, cow and pig, is thought to have been a supplementary strategy (Andreou *et al.* 1996: 558; Hastead 1981a, 1984, 1994: 200-201). Evidence of high slaughter rates for young animals suggests that a meat production strategy was also employed. According to Halstead, however, this did not necessarily exclude the exploitation of secondary products, e.g., milk and wool, although clear evidence primarily comes from EBA and later contexts. Moreover, drawing on ethnographic evidence, Halstead suggested that even if meat exploitation was not intensive, the importance of maintaining domestic stock is seen in many small-scale, non-industrial societies as a symbol of prestige and wealth and as a coping mechanism against food emergencies (Halstead 1981a: 320).

In the production of craft goods, significant technological developments took place as new materials and techniques were explored. The firing of clay and the beginning of pottery making were amongst the most important ones. The body of evidence for this from the EN and MN, however, is more or less restricted to sites such

as Achilleion (Björk 1995; Gardner 1978; Winn & Shimabuku 1989), Nea Nikomedeia (Pyke & Youni 1996; Washburn 1984), Sesklo (Kotsakis 1983; Wijnen 1981, 1994) and Franchthi (Cullen 1985; Vitelli 1989, 1993a, 1993b, 1995, 1999; Washburn 1983). Pottery is considered as predominantly locally produced, and the output of domestic production (Vitelli 1989: 19; Wijnen 1994: 152; Yiouni 1996: 77), although more recent research on EN ceramic material strongly points to a different reality as will be outlined in more detail in Chapter 3 (Tomkins and Day 2001). The choice of raw materials and techniques, however, is taken to indicate well-informed potters. During the EN, the range of wares and fabrics is restricted, vessels are fired at low temperatures and produced to a more or less similar size and shape in very small quantities, e.g., estimated annual production at Franchthi is 12-13 pots. At the same time, the presence of 'local styles' at each site has been detected (Vitelli 1989: 19, 21, 1995: 60). Stylistic similarities in pottery decoration between distant geographical areas are taken to suggest close cultural links and ties. For example, the occurrence of white or red painted and finger-impressed wares found in EN Nea Nikomedeia are compared to similar pottery styles in central Bulgaria, eastern Yugoslavia and central Greece (Rodden 1965: 87; Yiouni 1996).

On a parallel line of argument, stylistic similarities in the design elements of painted Urfirnis pottery from five contemporary MN sites in southern Greece were tested to explore the nature of inter-community contact through interaction amongst potters (Cullen 1985). Here again, pottery is considered the output of household production or production "by a few talented individuals from each community rather than, for example, central production and subsequent distribution" (Cullen 1985: 82). During this phase (MN), the picture in Thessaly and South Greece changes slightly and a greater variation in surface treatment/decoration is observed, along with a sharp increase, compared to the preceding phase, in production output, i.e., 150-170 pots per year at Franchthi. Pottery was now fired at higher temperatures and the symmetry and regularity in the vessels' form, with elegant, sharp profiles and added, often pedestal, bases, is taken to suggest much more experienced and skilled potters with higher technological knowledge, willing to take risks. The first coarse cooking and storage vessels appear during this phase in relatively small quantities, although it has been cautiously suggested that cooking pots, along with storage vessels, may have been in use since the EN at Nea Nikomedeia (Yiouni 1996: 187-191) and at other southern

European EN settlements such as Anza, Achilleion, and Sitagroi (Gardner 1978; Yiouni 1996).

Stone tool production, however, suggests a notably different pattern. Exploitation and long-distance exchange of 'exotic' materials is favoured, whilst local resources are neglected to a large extent, and if used, are associated with low-quality products and much simpler techniques (Perlès 1992: 125, 136; Renfrew 1973: 180; Theocharis 1973: 45; Torrence 1986). Although typological simplicity characterises this period, it is combined with a rather sophisticated exploitation of raw materials, acquired from long-distance sources. Obsidian from the island of Melos and fine-grained chert, honey flint and jasper, probably obtained from the west and north-western part of Greece, represent the most typical examples of non-local production. They usually occur in pressure-flaked, fine and large blades and bladelets, imported into the sites as preformed or partially flaked cores and distributed in small quantities. The above pattern, along with the absence of local variability in intra-site tool production, has been explained as the result of groups of specialists acquiring and distributing raw materials and specialist itinerant knappers operating throughout Greece (Perlès 1993: 382-383).

2.3.2 The Late and Final Neolithic

Research suggests that changes in habitation and land use patterns took place during the transition from the Early and Middle to the Late and Final Neolithic phases (Demoule & Perlès 1993; Halstead 1984, 1989, 1994). In Thessaly, the number of new sites, thought to be of a small size and short duration, significantly increased during the LN, followed by concentration of the population in much fewer sites in the FN. There also seems to have been a shift in the favoured locations of new settlements, now distributed more regularly but at greater distances apart, from the foothills to the alluvial plains (Demoule & Perlès 1993: 388; Halstead 1984, 1989, 1994: 200). *Tell* sites are thought to have dominated during this period again. It should be acknowledged, however, that all these assumptions have been established on evidence that is largely derived from surface surveys or small trial trenches. In Greek Macedonia, for the Late to Final Neolithic period, it is evident from excavations that new settlements were established in previously uninhabited areas such as central and eastern Macedonia and Thrace, for example at Sitagroi and Dikili Tash (Renfrew *et al.* 1986; Seferiades 1983).

In addition, horizontally shifting, flat-extended sites have been discovered, either through surface surveys or through small- and large-scale rescue excavations (Andreou & Kotsakis 1986; Andreou *et al.* 1996; Besios & Pappa 1994, 1998; Grammenos 1992, 1996; Grammenos *et al.* 1992; Pappa 1997; Pappa & Besios 1999a, 1999b). Such settlements occupied discontinuously very large areas and covered what apparently had previously been uninhabited landscape. Vasilika C, Thermi B, Arethousa and Makrygialos, all in central Macedonia, are typical examples of this new habitation pattern. Simultaneous changes were also observed in the South, where cave habitation was increasingly favoured, and the apparent first occupation in some of the Aegean islands took place, a development, which is not firmly defined chronologically (Cherry 1990; Davis 1992; Demoule & Perlès 1993).

The discovery of large, *flat-extended* sites in Greek Macedonia, primarily related to the Late Neolithic period, required that all assumptions about the predominance of the *tell* site during this period be rethought. This new pattern of habitation and land use suggests settlements that extended horizontally and discontinuously, over areas ranging from 12 ha (Thermi B) or 25 ha (Vasilika C) to 50 ha (Makrygialos), or even 100 ha (Andreou & Kotsakis 1986; Andreou *et al.* 1996). A distinctive feature is the presence of enclosures/ditches around some of these non-*tell* sites, but as noted above, similar constructions also appear at some *tell* sites. Moreover, their purpose cannot be generalised for all settlements, as each case may maintain a unique character (Kotsakis 1999: 72). Excavation at most of the *flat-extended* sites, with the exception of Makrygialos, where the extensive study of architecture and material remains is still in progress, was on a small scale. The available evidence from all excavations suggests a non-intensive use of space, as sometimes unused areas have been detected between structures, or parts of the settlement appear to have been abandoned. Interpretation of the character of these sites is not yet conclusive.

Also fragmentary is the evidence for architectural remains for the LN and FN. In Thessaly, this is predominantly restricted to sites such as Dimini, Sesklo (its late phase), Agia Sophia, and perhaps Magoula Visviki. These settlements are associated with long, rectangular and free-standing buildings (so-called 'Megara'), usually comprising two to three rooms and facing a central courtyard, around which clusters of smaller domestic units, 'households', were organised, expanding on a lower level. Dimini (*fig.* 2.2), the best-preserved example of this period, is characterised by a set of

concentric perimeter walls, whose function was in the first place interpreted as defensive (Theocharis 1973; Tsountas 1908). During its latest re-investigation, however, careful evaluation of the architectural features suggested a rather different picture, according to which the purpose of the walls was to demarcate the four main domestic wards into which the settlement was thought to be segmented. Each of these wards, or 'courtyard groups', was organised around a main, large domestic/production unit with smaller rooms/areas for food preparation/cooking and storage attached to it (Hourmouziadis 1979). Hourmouziadis also argues that the building of the enclosures took place gradually, as a response to population growth and the settlement's need for expansion, and in order to secure the maximum possible space for use by the community. In addition, however, he stresses the Neolithic inhabitants' tendency to demarcate their space, resulting in the isolation of domestic units. This interpretation has been closely associated with the observation that during the Late Neolithic the placement of cooking facilities (hearths and ovens) is no longer both inside and between houses, in open yards, but is restricted to indoors. Such a 'reading' of the material evidence, i.e., architectural segmentation that is taken to imply social isolation of the 'households', becomes a new element that is particularly assigned to this final phase of the Late Neolithic.

With the transition from the earlier to the later Neolithic phases, it has been suggested that early farming settlements in fertile areas were eventually abandoned and that herding started to emerge as a new subsistence strategy (Halstead 1981a). The employment of new strategies appears to emerge around the same period as available evidence of cave habitation, especially in southern Greece, in combination with the colonisation of agriculturally marginal areas, which is explained to be a result of population growth (Halstead 1981a: 326).

In the domain of craft production, a new picture is suggested to have emerged during this period, which has been interpreted in rather divergent ways (Perlès 1992; Schneider *et al.* 1991, 1994; Vitelli 1993a, 1995). Archaeologists agree that pottery production became more diversified and increased dramatically. Large, coarse vessels predominated. A wide range of functional categories and shapes appeared, e.g., storage, cooking, eating and drinking vessels found in different use contexts. What strikes one as a new element, however, beside the technological developments, is the sophisticated and dense decoration of restricted categories of containers to which a social and

symbolic character has been assigned. The differences in ceramic styles throughout Greece are significant, associated with different patterns of production and distribution. During the earlier phases of the Late Neolithic (the so-called pre-Dimini phases), there is a clear geographical division between western Macedonia, Thessaly and the southern Greece, on the one hand, and eastern Macedonia and Thrace on the other, where stylistic parallels with the Balkans are detected. Matt-painted, black-topped and impressed wares occur widely distributed in most parts of northern and southern Greece, following local manufacturing traditions, whilst the first specialised production centres are identified in Thessaly, referring to Grey-on-Grey ware (Schneider *et al.* 1991, 1994). Chemical and limited petrographic analysis on a number of samples from the transitional late Middle and early Late Neolithic phases show that Grey-on-Grey painted pottery was most likely manufactured in one production centre, located in the western Thessalian plain, and was exchanged between neighbouring communities over a radius of no more than *c.* 70 km. This fine ware is thought to have had high social value, as repair holes on sherds testify. At the same time, the distribution of Grey monochrome ware is restricted to the eastern Thessalian plain. Along with the Polychrome, White-on-Red, and Black-on-Red mainly occurring during the earlier Arapi, Agia Sophia and Otzaki sub-phases respectively, new, very distinct decorative styles, such as Brown-on-Cream and Incised ware appear during the latest sub-phase, known as 'Classical Dimini'. These 'chronological' sub-divisions of LN are made primarily on stylistic rather than stratigraphic grounds. In eastern Macedonia and Thrace, on the other hand, different styles predominate including Graphite-painted, Incised and local Black-on-Red. A few sherds of Graphite-painted and Black-on-Red have been found at the Late Neolithic coastal settlement of Pefkakia, near Dimini, and were assumed to have originated in the plain of Drama, in eastern Macedonia (Keighley 1986: 369). As for the highly-decorated painted wares of 'Classical Dimini', until recently it had been assumed that their distribution was restricted to the eastern plain of Thessaly and nowhere else in Neolithic Greece. This particular type of pottery will be extensively discussed in Chapters 4, 6 and 7 of this thesis.

Geographical differences are also marked between northern and southern Greece regarding another category of material culture: stone tools. As noted earlier, raw materials such as obsidian, flint and jasper are known to have circulated over long distances since the beginning of the Early Neolithic, in contrast with pottery, which is thought to have been locally produced and consumed. During the later phases of the

Neolithic, the quantities of imported obsidian in the South increase dramatically and this is followed by technological developments in its procurement and manufacturing techniques. It has been suggested that, as a result, local materials are almost abandoned, but the general variability in manufacture is taken to suggest that both specialists and non-specialist groups of producers were operating simultaneously. The large quantities of obsidian, combined with the fact that it is now imported in variable condition to each site, has been associated with the parallel development of the colonisation of the Cycladic islands, and has been interpreted as evidence for direct procurement and unlimited access to the sources (Demoule & Perlès 1993; Cherry 1990; Torrence 1986). In Thessaly, on the other hand, an area more distant from possible sources, the use of materials and techniques appears unchanged in comparison to the earlier periods. It has been suggested that these different choices of tools and materials, which occurred between northern and southern Greece, should be associated with divergent economic strategies, rather than cultural differences (Demoule & Perlès 1993: 394).

In addition to stone tools that were exchanged over long distances and used to cover everyday needs (with very few exceptions), and pottery that was predominantly locally produced and very rarely exchanged, there was a third category of material 'goods'. These are considered rare/'exotic' and mainly comprise *Spondylus* shell ornaments, stone vessels and rare metal objects. It is possible that archaeologically largely invisible items, such as textiles, were also involved. All these are viewed as components of long-distance exchange networks and are thought to have been used in ritual and ceremonial occasions (Demoule and Perlès 1993; Perlès 1992). *Spondylus gaederopus* is found in relatively large quantities in settlements of northern Greece, e.g., Dimini and Sitagroi. It is believed that shell ornaments were manufactured in coastal areas by specialists and exchanged inland, as far as central Europe, as finished products, although recently this view has been disputed by Halstead (1993: 604, 608). The picture, however, appears different in the South, where the virtual absence of *Spondylus* shell ornaments in settlements is taken to suggest a lack of demand, due to the fact that they were near to the sources, and therefore the raw material was not highly valued (Hourmouziadis 1979; Renfrew 1973; Shackleton 1988).

2.4 Models of interpretation

2.4.1 Introduction

The hotly-debated issue of the organisation of Greek Neolithic society has been understood and explored mainly through two major themes: those of production and exchange. Both concepts originally derived from the theoretical tradition of economic anthropology (Sahlins 1972). Under this influence, two prevalent explanatory models have been developed over the years in an effort to reconstruct socio-economic aspects of Greek Neolithic culture. Halstead (1981a, 1989, 1992a, 1992b, 1995, 1999b), on the one hand, and Perlès and Vitelli (Demoule and Perlès 1993; Perlès 1992; Perlès and Vitelli 1999; Vitelli 1993a, 1995) on the other, put forward their views incorporated into a more general model: that of the 'Domestic Mode of Production'. The archaeological problem, therefore, is approached from the same theoretical perspective, but investigated through different categories of material evidence. Halstead develops a theoretical framework for the study of agricultural production, organised around the ideas of the 'DMP' and 'social storage', whilst Perlès and Vitelli have focused on craft production with emphasis on specialisation and exchange of stone tools and pottery respectively.

2.4.2 Agricultural Production and Exchange

The assumption of a 'family household' as the basic unit of production resulted in the direct association between household production and what is known in the literature as the 'Domestic Mode of Production' (Halstead 1989, 1992b: 20; Sahlins 1972). Its primary components, with reference to the Greek Neolithic, have been, a) crop and animal husbandry for food production, and b) craft production. The main idea around which the debate on household production has developed is that of *under*production, where each household is assumed to have produced as much as was necessary to cover its needs for survival (Sahlins 1972: 86). This self-sufficiency has always been seen as an element of a simple egalitarian society, mainly assigned to the Neolithic period, as opposed to the more 'complex' social structures of later periods.

According to Halstead's ideas, Neolithic inhabitants had to develop 'buffering mechanisms' to cope with the risks and uncertainties of temporal (seasonal, interannual or long-term) production flactuations. Storage was arguably the main mechanism for coping with seasonal shortages, as these would to some extent have been predictable. Thus, reciprocal sharing of food between domestic units, hospitality and small-scale exchange with more distant neighbours were possible strategies employed against long-term seasonal food scarcity. Storage of normal surplus in good years for consumption during the bad years would also have been a major response to these circumstances.

The changing of surplus through time has been examined in the context of the Neolithic farming communities of Thessaly (Halstead 1989: 68-9, 1992b: 23-4; Halstead & O'Shea 1982). Here once more, significant differences have been observed in the transition from the Early and Middle to the Late and Final Neolithic.

2.4.2.1 The Early and Middle Neolithic

During the earlier phases (EN and MN), the close spacing of the farming communities (mean distance <5 km) is regarded as an important element in the struggle against any kind of environmental hazard that affected production. This would have meant an immediate response from neighbours in times of crises. The very same element, however, could have been negative in the case of a prolonged, unpredicted failure. Under such circumstances, a diversified strategy of crop and animal husbandry to reduce the risk, along with the limited exploitation of wild resources, would not have been enough. Not even the physical, direct storage of surplus from good years for use in bad years would have been sufficient, as the storage life of grain is too short (Halstead 1989: 73-74; Halstead & O'Shea 1982: 93, 1989: 4).

Hence, it has been proposed that indirect storage was used in such circumstances to cope with long-term crop failures. This would have involved the transformation of food into a more stable, alternative form from which food could be retrieved later. For example, surplus grain could be used to fatten up livestock, which in turn could be slaughtered in times of need. Further to this, the balancing of foodstuffs against non-food valuable 'tokens' or labour through exchange has been suggested. In this case it is implicitly expected that such tokens could have been reconverted to food when needed.

This coping mechanism has been termed 'social storage' (Halstead 1989: 73-74; Halstead & O'Shea 1982: 93; O'Shea 1981: 169).

An apparent objection to this concept is Sahlins' idea that foodstuffs cannot be exchanged because they have too much social value due to their use value. In addition, craft goods purchased through food exchange would not have been reconverted into food value (Sahlins 1974: 217-218). Halstead and O'Shea (1982), nevertheless, point out that there are ethnographic observations, which demonstrate such cases. Also, as social distance between households increases, the idea that food cannot be exchanged loses its weight (Halstead 1989: 75; Sahlins 1974: 219). These authors also stress that such exchange of food for other craft products must have taken place not only during lean years but also in good, with the difference that a smaller amount of food was exchanged, whilst the quantity of 'prestige goods' increased. Such 'diplomacy' would maintain and reinforce the social obligations between more distant communities, so that these obligations would be remembered in times of shortage. The importance of this mechanism as a safeguard against scarcity has thus been stressed (Halstead and O'Shea 1982: 93).

In addition, it has been suggested that from this exchange mechanism another one developed: marriage partnerships. Although the Thessalian landscape was densely occupied and marriage partners could easily have been secured amongst neighbouring settlements, the archaeological evidence has been interpreted as showing the opposite, that marriage alliances were sought further afield. Thus, the presence of exotic raw materials (such as obsidian from southern Greece) in certain Neolithic villages, where local products were also available for use, has been interpreted as a sign of some kind of contact between distant villages, perhaps through marriage. Similarly, the wide distribution of some fine pottery styles has been seen as the result of cultural interaction and social contacts (Cullen 1985; Halstead 1984, 1989; Rondiri 1985: 71; Washburn 1983):

> "the contrast between the ubiquitous distribution of some fine wares and the more restricted distribution of others suggests that the latter at least were actively signalling long-distance (up to 50-75 km) interactions, or chains of interactions, rather than passively reflecting opportunities for acculturation." (Halstead 1989: 74).

Such exchanges in 'primitive' economies, as the Greek Neolithic is thought to have been, either in the form of foodstuffs in return for craft goods or through marriage alliances, are considered strong buffering mechanisms, not only against scarcity but also against hostility. They are, therefore, considered a force for social cohesion (Halstead 1989: 74; Sahlins 1972: 302). In addition, the idea of food being exchanged in times of extreme need for valuable tokens, for example fine pots, is considered significant as it would have allowed the circulation of food despite any temporal, geographical and social distance between households and villages (Halstead 1989: 75).

2.4.2.2 The Late and Final Neolithic

Several transformations have been recorded during this later period and are thought to have triggered social change. The more drastic ones have once again been related to human population growth and its effect on the size and distribution of settlements (Halstead 1989: 75). As has been mentioned earlier in this chapter, a number of Early and Middle Neolithic sites were abandoned and, during the LN, rather marginal environments were chosen for the establishment of new communities or, in areas like Greek Macedonia, environments previously empty of human occupation. Towards the final period, settlement nucleation has been observed; sites became much larger, more densely populated, and located more regularly but eventually at much greater distances from each other. Of course there were exceptions to this pattern; for example, the small size of hamlets of the relatively drought-prone southern Larisa plain would have facilitated cultivation closer to home (Demoule & Perlès 1993: 388; Halstead 1989: 76). Such changes are taken to have affected many aspects of the economic and social life of the Late and Final Neolithic inhabitants.

Nevertheless, in agricultural production only a few changes have been observed through an enhanced diversification of crop and animal species, e.g., cultivation of bread wheat, barley and lentils, and an increased importance of cattle, pigs and goats, which may indicate greater woodland use. More striking, however, is the evidence of an increase in storage facilities. Firstly, in most Neolithic villages of this period, high quantities of large, coarse storage vessels have been found. Secondly, there is evidence of numerous indoor and outdoor storage facilities such as large, mainly subterranean pits. This development has been explained as an indication of *over*production

(Demoule & Perlès 1993: 390; Halstead 1989: 75; 1992a: 55; Hourmouziadis 1979: 116).

As previously mentioned, settlements were open and closely spaced during the earlier Neolithic phases. In contrast, the new element of segmentation of settlements during this late period, and its implications for food production and consumption have been pointed out. After Hourmouziadis' reinvestigation of Dimini, in Thessaly, it became clear that cooking facilities were located indoors, inside closed courtyards, which may imply that the sharing of food became restricted to members of what was probably an extended family 'household' or 'courtyard group' (Halstead 1989: 76).

With the gradual isolation of the 'household', this lack of reciprocal assistance between neighbouring households would have created the need for the establishment of exchange with more distant ones. This need for long-distance exchange would have become even stronger as a result of the isolating effect of new settlements that were more dispersed in the landscape. It is suggested that this is reflected in the presence of the large pits for bulk storage of normal surplus during this late period, and even more in the increasing investment in fine craft goods to be used as exchangeable tokens. For example, in a marginal environment such as east Thessaly, more labour and scarcer raw materials were invested in the manufacture of fine decorated pottery and shell bracelets to be exchanged inland (Halstead 1984, 1989: 76, 78; Theocharis 1973).

Halstead and O'Shea (1982) argued that in long-distance exchange, the use of material tokens, where direct reciprocity was not sufficient, would have had important implications. First of all, it would have complicated substantially the 'social storage' mechanism to the extent of generating the emergence of some sort of social elite to which a managerial role has been given in order to control and regulate the system. Second, unequal accumulation of wealth, normally kept and maintained through time by the same social groups, would eventually have been the result of unequal accumulation of tokens which had been exchanged for food in an attempt to ensure its equal distribution even during bad years in terms of economy/production.

Such a symbolic manipulation of wealth has been interpreted as a precondition for institutionalised hierarchies, and, ultimately, the emergence of social complexity (Halstead & O'Shea 1982: 93). The above idea closely relates to the way the 'Megara'

of similar size, location and orientation found in Dimini, Sesklo, Agia Sofia and perhaps Visviki are interpreted. It is noted, for instance, "...the status of the emergent élite was related to preferential access to similar high-ranking persons or households in other settlements..." (Halstead 1992a: 56).

Halstead, in his examination of the faunal remains of Dimini, insists that the organisation of food production, based on diversified strategies of crop and animal husbandry, and the use of livestock for the indirect storage of surplus, actually met the expectations of the 'DMP' (Halstead 1992a: 55). Even though some claims of specialisation regarding craft production, e.g., *Spondylus* shell ornaments, are acknowledged, they have been disputed as appearing to fit within the same model of household production (Halstead 1993: 606, 608).

The same comment on specialised pottery production has more recently been made by Demoule and Perlès, arguing in favour of the existence of a few village residents/potters, who worked as part-time specialists to cover the community's needs (Demoule & Perlès 1993: 393).

2.4.3 Craft Production and Exchange

This last point brings up the second interpretative model, mainly developed by Perlès and Vitelli (Perlès 1992; Perlès and Vitelli 1999; Vitelli 1993a), which, integrated to a large extent into the 'Domestic Mode of Production', focuses on craft production. The 'lenses' through which the issue is approached are craft specialisation and exchange. It should be noted that for the first time in the relevant literature some attention is paid to the complex issue of intra-site consumption, although not extensively.

In her definition of craft specialisation, Perlès has argued that the term refers to production in response to needs beyond and above the production group itself "and therefore designed to be exchanged at least in part for other products" (Perlès 1992: 134). Four main parameters have been taken into account in order to measure specialisation: distribution of production centres, output, extent of circulation outside production areas and complexity of required know-how.

Thus, through consideration of the preceding parameters and by directly inter-relating production, consumption (use) and exchange, Perlès suggests three dominant systems, operating during the Greek Neolithic, within which different categories of craft products have been classified and assigned a different function and character (Perlès 1992):

- The first system is assigned a purely economic character and incorporates utilitarian 'goods', e.g., all stone tools (chipped and ground), with extremely few exceptions (some arrowheads found in the 'shrine' of Nea Nikomedeia). These tools are widely distributed geographically and socially.
- The second system is based on inter-group alliances and incorporates (non-utilitarian) objects of high stylistic visibility and social function. Fine pottery is classified here and is considered to be restricted geographically.
- The third system involves the action of trade and incorporates 'prestige goods' that are assigned a symbolic and ritual character; their distribution appears uneven and they are thought to have circulated over long distances.

It is suggested that the aforementioned distinct 'spheres' of function and exchange were closely associated with distinct modes of production that differ strikingly from the EN/MN to the LN/FN, and also between various categories of material culture, with an emphasis on stone tools and pottery.

Lithic production during the earlier phases is characterised by an absence of deliberate stylistic variation, i.e. standardisation in both finished products and their mode of production. This element, combined with the fact that the evenly distributed production output was circulated over very long distances throughout Greece, is taken to indicate non-regionalised group production, in which identification of producers is not considered an important part of the exchange process (Perlès 1992: 136). It is also assumed that both the procurement of 'exotic' raw materials and the production itself, operated by itinerant knappers, was controlled by specialists (Perlès & Vitelli 1999: 97).

In contrast, during the later phases, Perlès distinguishes a twofold evolution in stone tool production. First, an increased regionalisation of production has been pointed out with the emergence of local stylistic variations, which, although sufficient to differentiate producers, are not considered the result of deliberate choices. Second, the occurrence of individualised style, apparently also related to different degrees of

craftsmanship, is identified and interpreted as the result of conscious choice and the producers' intention to promote their personal mark. This picture, however, predominates only in southern Greece. In the North, small quantities of Melian obsidian reach sites as far as central and western Macedonia, whilst in Thessaly the mode of production essentially remains the same. In this case, the North-South divide is linked with developments in seafaring as a result of the colonisation of some of the Cycladic islands. This has 'placed' the South in the 'direct supply zone' (Torrence 1986), where specialists for the first time would have found themselves in competition with local suppliers and producers. Such differentiation is interpreted as a sign of "de-specialisation" (Perlès 1992; Perlès & Vitelli 1999: 97).

In striking contrast, Perlès argues that pottery production remained a local phenomenon and domestic in scale during the EN and MN (when the first signs of intra-village specialisation emerged along with exchange between domestic units only), with numerous and evenly distributed production centres. She suggests, however, that a completely different picture emerged during the LN and FN. Indeed, she argues that, while during the EN stylistic boundaries between geographical areas appear hazy, this begins to change in the MN when decoration becomes abundant and structurally complex, marking sharp stylistic differences and even identifying certain provinces, e.g., those marked by the distribution of Urfirnis and Sesklo pottery. Although the high technical investment in this pottery has been acknowledged, and may even point to part-time craft specialists, the low production output, the limited degree of innovation in experimenting with new materials, forms and techniques, implying lack of standardisation, and the absence of inter-regional exchange is interpreted as indications of non-specialised production. Instead, it has been stressed that production and small-scale (community) exchange of pots of similar quality and skill could not have met everyday 'needs', but rather had social meaning and served to negotiate power and facilitate ties between the giver and receiver (Perlès 1992; Perlès & Vitelli 1999: 101).

As will be discussed in Chapter 3, Costin has recently suggested that labour investment in pottery production should not always be taken to reflect aspects of the economic system, but rather of the socio-political organisation of a society. Thus, she has interpreted the extra energy spent in the elaboration of even utilitarian objects as an action that transforms pots into objects that carry social information, "which the consumer wishes to broadcast" (Costin 1991: 37). In response to this suggestion, Perlès

argues that the intention to broadcast information may correspond to differentiated exchanges between members/partners in close relation, who shared common codes of communication, and more neutral exchanges between individuals who established minimal social relations (Perlès 1992: 138).

Lately, there has been a trend to examine such so-called neutral exchanges mainly within the context of the Late Neolithic, when some key developments are thought to have occurred. These include the emergence of some localised, but not so concentrated, centres of production (corresponding to wares such as Grey-on-Grey, Tsangli, Arapi, and 'Classical Dimini'), along with an increase in quantities of pottery and its regional circulation (apparently not exceeding *c.*70 km). Perlès points out that, although villages locally produced large quantities of pottery with the production centres being located within the users' communities, at the same time they used the bulk of this pottery for local consumption, while producing only modest quantities for exchange (1992: 137).

It has been pointed out that during the LN period diversification and proliferation of styles are striking. Not only are they used to provide chronological information, but also often correspond to distinct production centres, which distributed their output on a relatively large scale. Such exchange networks were at least partly in competition. It is further suggested that during the LN the degree of stylistic variation did correlate to the scale of exchange; for example, the EN pottery, which was not exchanged, although exhibiting high technical investment (carefully finished), bears low stylistic input (Perlès 1992: 139-40).

Only during the later phases of the Neolithic, therefore, has inter-community, regional exchange been suggested to spread and the observed stylistic investment thought to appear not at the level of individual production but rather at the level of production centres. According to Perlès, it is during this period that styles became clear cut, recognisable and in some cases even allowed identification of origin. As for the output of pottery, although it was very low during the EN with the first sharp increase during the MN, it was only during the LN that it increased dramatically and achieved large-scale production. All these parameters have been translated as the first signs of specialised production.

Vitelli, however, has approached the same body of evidence from a completely different perspective and offered an opposite interpretation, according to which pottery production developed from a specialised activity, during the EN and MN, to non-specialised during the later phases of the Neolithic. According to her, although the first potters had no prior knowledge of pottery making, the facts that they knew which clay sources were appropriate to use, discovered and used pigments which could have been subject to exchange, and had control over fuel and the firing process, allow us to consider them specialists in comparison to their Late Neolithic successors (Vitelli 1993a: 247).

According to her, early containers were not used for utilitarian purposes but maintained a rather symbolic/ritual character, and thus potters should be seen not only as specialists but also as 'ritual healers' (Vitelli 1993a, 1995; Perlès & Vitelli 1999: 103). In social terms, this interpretation of the production process in such an early period may have served as a means of resolving conflict between neighbouring communities. This practice, according to Vitelli, dramatically increased in the transition from the Early to the Middle Neolithic, resulting in some individuals becoming socially powerful. The tendency of the emerging individual to stand out through her/his products has been defined on the basis of the technological innovations and the stylistic distinctiveness of each pot. Such qualities would have contradicted the egalitarian and self-sufficient structure of Neolithic society and, therefore, some social levelling mechanisms would have operated to balance these tensions and hierarchical inequalities. Vitelli has suggested that "the rules of broad regional styles" to explain the dominance of the Urfirnis MN pottery all over South Greece, and the "sharing of new knowledge among potters" could have been such conflict resolution mechanisms (Perlès & Vitelli 1999: 104; Vitelli 1995: 60-62).

During the later phases of the Neolithic, new technological and stylistic developments and the dramatic increase in the scale of production, where coarse pottery predominates, have been 'translated' in terms of a re-negotiation of socio-economic and ideological relationships between individuals and communities (Demoule & Perlès 1993: 387; Perlès and Vitelli 1999: 104). According to Vitelli, it is during the LN that the pottery making process lost its ritual character and the relationship between potter and his/her product was broken, replaced by a new one where pots become independent objects maintaining new meanings and roles. Pottery lost its symbolic character and

becomes the product and medium for domestic activities, whilst the potter simultaneously lost her/his social power. Vitelli has read these elements as signs of "de-specialisation" (Vitelli 1993a; Perlès and Vitelli 1999: 105). Even though one may argue that symbolic value and social power could indeed undergo changes, Vitelli seems to weakly justify her argument by suggesting that such elements are completely lost at a certain point in time.

It is fair to point out, nevertheless, that both Perlès and Vitelli have very recently acknowledged the complexity and variety in the social structuring of Neolithic society, which very often has been underestimated in an effort to fit the evidence into current typologies of craft specialisation. Such typologies have often implied a linear evolution from 'simple' to more 'complex' forms of organisation. They insist, however, that all the archaeological cases they have examined throughout the Neolithic fit into the model of 'household production' and 'individual/community specialisation' (Perlès & Vitelli 1999: 99).

2.5 Conclusions

To sum up, during the course of the 20th century, researchers have developed explanatory models through study of different categories of material evidence, in their efforts to explore the organisation of the Greek Neolithic society. In doing so, they have moved from reconstruction of chrono-typological models (e.g., Tsountas, Wace & Thompson, Theocharis) to study of social and economic issues (e.g., Hourmouziadis, Halstead, Perlès, Kotsakis), through analysis and examination of variability and specialisation in what they perceived as cultural processes, and more recently, but to a lesser extent, into explanation of material culture. The bulk of this work is focused on Thessaly, more specifically on its eastern plain, thus excluding evidence from the rest of northern Greece (e.g., Greek Macedonia). In some cases this happened due to historical factors, in others due to the fact that the evidence available from Macedonia was often 'different', and therefore did not fit the already established models of explanation.

The suggested picture of the society under investigation appears to be characterised by a very dense and socially 'busy' landscape, where Neolithic inhabitants interacted and their actions can be traced to some degree in the remains of Neolithic

architecture. Their communities, thought to have been organised in small villages inhabited successively through time on the same spot (*tells*), were supposedly organised around a basic family production unit, the 'household'. According to researchers, this corresponded to a simply organised, egalitarian and self-sufficient society, especially during its early phases (EN and MN), which produced as much as it needed to consume for survival. The first 'seeds' of social change towards more complicated structures are detected during the latest phases (end of the LN and FN), when signs of a rather intensified interaction are acknowledged, for example, in the way raw materials, pottery and other artefact categories were manipulated by the Neolithic inhabitants. Such signs of interaction must have developed on several different levels, resulting in a network of relationships between people, between 'households', and between communities (short- or long-distant).

This chapter has looked at basic concepts pertaining to the structure of the Greek Neolithic society in general, primarily emphasising issues of agricultural production and exchange. It is acknowledged that, at this stage, the preceding account forms only a presentation of the available evidence and the models of explanation (mainly Halstead's), rather than a critical assessment. This will take place in the final discussion, after having properly considered the issue of pottery production and exchange in Neolithic Greece. In the conclusion, both models will be critically re-examined, in relation to the results of the analyses which this research provides, in order to explore whether and to what extent previous models are indeed informed by the new evidence and also to discuss the possible implications. The reason for this lies with the idea that in every society (past or present) any socio-economic and ideological changes that take place are expected to affect most of its different components in substantially compatible ways. Thus, in this particular case, the main ideas that the model of agricultural production and exchange offers should be, to a large extent, in accordance with that which the model on craft (in this case pottery) production and exchange argues for. The task of the next chapter is to investigate this latter model more completely.

CHAPTER 3
POTTERY PRODUCTION AND CIRCULATION

3.1 Introduction

What follows is a brief account regarding issues of pottery production and circulation. The study of the production and circulation of ceramics during the Greek Neolithic is the focal point of this review. The discussion unfolds primarily around the models of the organisation of production and 'exchange' recently suggested for the Greek Neolithic period (Demoule and Perlès 1993; Perlès 1992; Perlès and Vitelli 1999; Schneider *et al.* 1991, 1994; Vitelli 1993a). Reference to ethnoarchaeological and anthropological work carried out by European and American researchers is also incorporated where relevant. The chapter is organised thematically as well as chronologically.

3.2 Pottery Production in the Greek Neolithic

3.2.1 Definition of pottery production

Before the use of any analytic terms, a context-specific definition is desirable, in order to prevent unnecessary generalisations and confusion. In the present study, the term 'pottery production', used with reference to studies of Greek Neolithic pottery, is considered to incorporate three main aspects: a) conceptual approaches to understanding the production process, b) manufacturing technology and its main parameters, and c) the organisation of production. Each of these will be examined separately in the following sections.

3.2.2 General conceptual approaches to the study of pottery production

Amongst the diverse studied remains of material culture, pottery has often comprised the majority. Its abundant presence, in divergent cultural contexts, has generated

research in ceramic studies that has been influenced by theoretical trends/paradigms outside archaeology, into which certain elements were (sometimes) isolated and introduced.

Thus, the interpretation of pottery was firstly approached through an evolutionary lens and, gradually, within the context of culture-historical archaeology. Its study from these perspectives merely facilitated the reconstruction of the past based on chrono-typological classifications (Arnold 1985; Kotsakis 1983; Shanks and Tilley 1987; Trigger 1989). The term *'classification'* mainly describes the sorting and ordering of entities. These can include, for instance, groups of artefacts that exhibit a high degree of obvious similarities that easily distinguish them from other groups showing completely different characteristics (Adams and Adams 1991; Hill and Evans 1972; Rice 1987). Such a concept was derived from biological analogies and, consequently, archaeological artefacts were classified similarly to biological species (Johnson 1999; Shanks and Tilley 1987; Trigger 1989). In pottery, chronological reconstruction through typological sequencing was based on observed decorative and morphological changes through time and space. Often these attributes/characteristics were used to identify 'cultures' and ethnicity whereas, in other cases, they formed the basis of patterns of social organisation and interaction.

In so doing, researchers attempted to trace cultural change through time and space by relying on the assumption that any such changes that took place and affected the structure of a given society would be reflected by the pottery that people produced and used. Archaeologists, however, often overlooked the lack of a direct association between broken pot sherds and socio-cultural processes. Pieces of pottery were wrongly treated as whole entities rather than fragmented units of these entities and thus were 'read' as mirrors of cultural behaviour. Undoubtedly, a great deal of valuable classificatory information was obtained through this perspective but, as Arnold points out, this approach "has greatly limited the kinds of questions that can be answered by ceramic data" (Arnold 1985: 5).

Despite early anthropological views that neglected or underestimated the effect and role of environmental factors on ceramics and culture, a different trend, known as 'ceramic ecology', developed as an answer to the previous theoretical and methodological insufficiency. Early work by Matson (1965), van der Leeuw (1976), Rice (1981) and

Arnold (1985) advocated a need to go beyond the study of pottery *per se* and, through exploration of the materials, techniques and acting environmental constraints, look instead at the cultural and ecological patterns behind this category of artefact. In a similar line of argument, functional analyses of pottery were focused on the technical choices that potters had to make. These took into account the morphological as well as the mechanical performance characteristics of vessels. Such choices were thought to have been determined by the pots' ultimate use by consumers in order to cover material needs (Braun 1983: 108-109; Rice 1976, 1987a; Rye 1981). Interestingly, a few exceptions challenged the aforementioned assumptions and illustrated that potters' choices were often far more complex, being variably determined according to socially-specific parameters and beliefs (Kotsakis 1983; Miller 1985; van der Leeuw *et al.* 1991; Woods 1986).

In striking contrast, style has traditionally been isolated from both functional and environmental factors (Rye 1981: 3) and treated as an ideology, a separate entity identified via examination of morphological and decorative characteristics. Thus, it has been assigned a special role and perceived as "a manner or mode of expression", constantly receiving and transmitting different kinds of information, and also as the medium for communicating social or even symbolic messages (Conkey and Hastorf 1990: 2; Conkey 1990; Hodder 1982c; Rice 1987: 244, 251; Wobst 1977). Furthermore, based on analogous similarities, style has been taken as an indicator of cultural interaction and/or information exchange although such assumptions have occasionally been questioned (Cullen 1985; Plog 1978, 1980; Washburn 1983). On a different level, it is thought to have been responsible for the establishment and maintenance of social boundaries (Conkey 1990: 6; Wobst 1977: 327-28). More recently, however, and within the notion of *chaîne opératoire,* it has been successfully argued that stylistic expressions should be thought of as embedded in the technological process. Through anthropological influence and by introducing the technological dimension of style some archaeologists have demonstrated that technological choices can be equally affected by environmental and functional *as well as* cultural considerations and restrictions, e.g, the potter's knowledge and skill (Gosselain 1992: 580, 582; Lemonnier 1993; Sillar and Tite 2000; Stark 1998).

Over time, considerable ethnographic and experimental work has resulted in a vast amount of data on the wide variety of materials and techniques that, from a modern scientific perspective, appear to have been the most 'appropriate' and 'right' for the ancient potter to use in pottery manufacture (Arnold 1985; Braun 1983; Bronitsky 1986, 1989; Rice 1987a; Rye 1976, 1981; Schiffer 1992; Skibo 1992; Steponaitis 1983). With very few exceptions (Lemonnier 1986; Miller 1985), such accounts were merely restricted to detailed descriptions of the different steps in the production sequence. This standpoint provided archaeologists with a very useful empirical basis for further analysis and consideration. It soon became clear, however, that an important component of the process was being neglected: the potter her/himself. Rather than being treated as a neutral medium between materials and final products, researchers such as Lemmonier and van der Leeuw have successfully argued that the producer should be understood as the crucial carrier of *decisions* and *choices* that are strongly influenced by cultural as well as natural parameters (Lemonnier 1992, 1993; van der Leeuw and Pritchard 1984; van der Leeuw *et al.* 1991: 146).

The essence in this shift of interest was based on the idea that there are no universal rules to determine technological behaviours that have previously been considered to be restricted by environmental and functional constraints. Instead, it has been acknowledged that, no matter how many choices of materials and techniques may have been available, a potter would probably have been aware of only a few of them. This awareness would have been determined by the social, economic and ideological beliefs of the system to which the potter belonged. Extensive ethnographic observation has illustrated the potters' flexibility in dealing with a lack of 'appropriate' materials. Further to this, her/his choices are bound to have been limited by her/his levels of competence and knowledge. Therefore, artisans most probably performed the making of pottery by following inherited 'recipes' that may also have been influenced by the potter's own conceptualisation of her/his 'immediate world'. Consequently, the choices applied could have been to a certain extent free of a conscious cognitive element or technical reasoning, as van der Leeuw *et al.* have shown in their ethnographic study of pottery making in Michoacan, Mexico (Stark 1998; van der Leeuw *et al.* 1991: 147, 150). All these concepts represent what is known in the literature as '*tradition*'.

Amongst the different stages of theoretical and empirical inquiry that the study of pottery has undergone, one in particular has had a major impact up to the present day, especially as far as the study of the Greek Neolithic is concerned. In the 1970s, explanation of socio-economic issues became a major priority, and was compatible with an expressed need for the integration of archaeological theory with scientific techniques. Within the framework of *processual* archaeology, research largely shifted its focus to a different set of questions concerning the nature of pottery production. In this enterprise, there were two main axes of reference: technology and the organisation of production. Both themes will be extensively explored in the following sections.

3.2.3 Approaches to the study of manufacturing technology

Researchers, in order to study the materials and techniques that could have been used by ancient potters, approached and explored the problem through: a) ethnoarchaeological and/or experimental work based on which inferences were made about the past, and b) study of the final products themselves as found deposited in the archaeological record. The parameters of this material from which direct evidence on production technology could in most cases be retrieved are shown in the diagram at the top of the following page.

The study of pottery technology in the Neolithic of Greece was, in the first place, undertaken merely on a macroscopic level, in some cases combined with experimental work. Nearly all of the aforementioned parameters (*fig.* 3.1), representing evidence of production techniques, were explored to a greater or lesser extent. Generally, however, the ultimate purpose of investigating successive manufacturing steps did not emerge clearly in such work. Even the analytical terms that archaeologists adopted, e.g., fabric and ware, were neither precisely nor consistently used and defined, with only a few exceptions (Chapman 1981; Gardner 1976; 1978). Some research at the beginning of the 1980's was still devoted to chronological relationships, through the reconstruction of typologies and technological/morphological changes and processes (Wijnen 1982: 31). In other cases, understanding of such technological processes in the context of environmental factors was

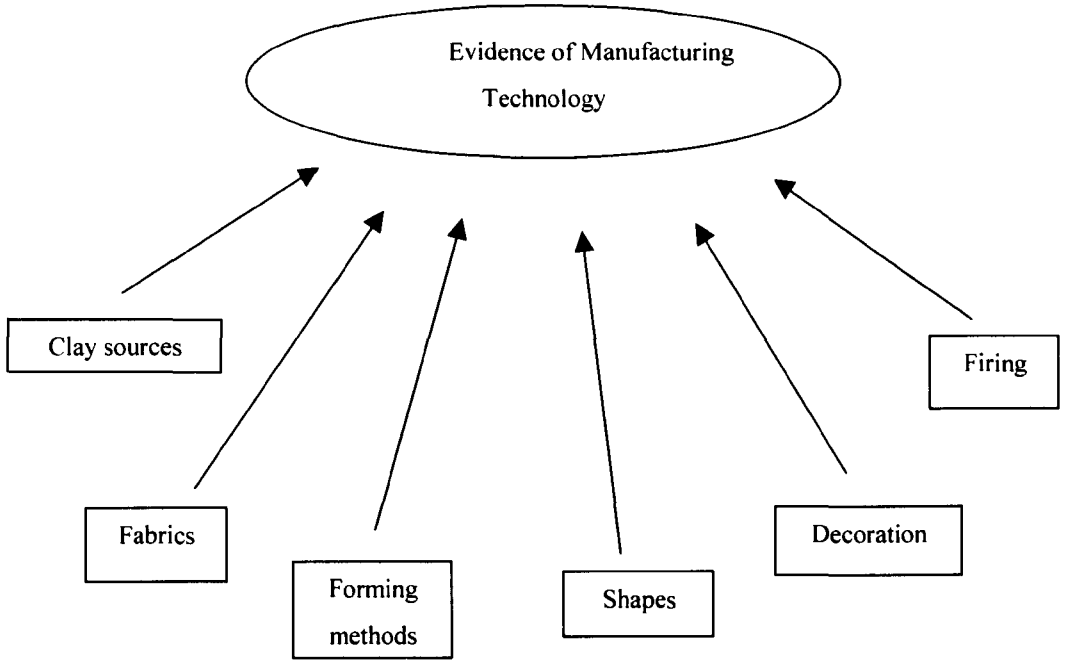

Figure 3. 1. Source of direct evidence for a given manufacturing technology

perceived to be the key to understanding the potters' decision-making as they interacted with their social and ecological environment (Vitelli 1984: 126). At this stage, therefore, the movement and interaction of people and ideas monopolised the researchers' interest, as opposed to the movement of the final products that the artisans themselves had produced. Thus, description of types was eventually replaced and/or combined with description of raw materials and manufacturing technologies. In this way, the development of the techniques employed on the one hand and, on the other, the development of the technological know-how of potters were observed, whilst assessing the degree of complexity throughout time and space (Gardner 1976; Vitelli 1984; Wijnen 1982).

Normative and cultural approaches to the study of the past in general and pottery analysis in particular were seriously questioned by processual archaeologists as early as the 1960's and 1970's, who called for a radical change in perspective. Although certain elements in the previous approach, such as symbolism, were in some cases acknowledged, the lack of the important association between culture and its material elements, e.g., socio-

political and economic components through the study of artefacts, was pointed out. Under this influence, for the first time in ceramic studies, the materiality of pottery became crucial in the explanation and understanding of cultural processes (Arnold 1985). In this theoretical shift, the study of technology became the crucial first step.

Two distinct theoretical branches stemmed from this new direction. The first emerged through the anthropological tradition and conceives technology as purely a social phenomenon. Accordingly, the components technology, function and style could no longer be separated. Moreover, the co-existence of functional, technological and symbolic elements is explicitly suggested, along with the acknowledgement that pots bear biographical information as a result of being influenced by and at the same time influencing relationships on several different levels (Lemonnier 1992, 1993; Sillar and Tite 2000; Stark 1998).

The second trend originally stemmed from the 'trunk' of the 'New Archaeology'. One of the focal points of this approach was the necessity for the discipline to become 'scientific' through the introduction of analytical techniques from the natural sciences to the study of archaeological materials and, through them, the study of the past. Central to this theoretical movement was the explanation of cultural processes, which caused a new set of questions to arise. Description, the constant accumulation of archaeological data and categorisation *per* se were no longer sufficient. A deeper understanding of the material expressions of past societies was thought to be urgently needed, and such understanding was to be achieved through artefact analysis. Within this framework the study of pottery was approached through a new lens and, as a consequence, technological analyses were often associated with pottery economics, largely investigated around issues of production specialisation and 'exchange'.

Elsewhere in the Old and New World this approach has been particularly influential and has been applied to different sets of ceramic materials. In studies of Greek Neolithic pottery, however, similar applications were very limited, even during the early 1980's as discussed earlier. Within the spirit of cultural materialism, Kotsakis' (1983) technological analysis of the painted MN pottery from Sesklo was a pioneering example. In his work,

primarily undertaken on a macroscopic level and in which the terms fabric and ware were redefined and used consistently, the production sequence was followed through the study of clays, non-plastics, manufacturing techniques, surface finishing/decoration and, lastly, firing (see *fig.* 3.1 above for comparison). Where other similar analyses of Neolithic assemblages stopped (i.e., Vitelli 1984, Wijnen 1982), this one was taken a step forward by: a) integrating small scale use of analytical techniques, namely SEM, XRD, XRF and petrographic analysis (albeit of only 13 samples), complementary to the macroscopic-technological analysis, and b) incorporating these results into a theoretical framework calling for further analysis on a socio-economic level, through exploration of sensitive indices such as intra-site variability and distribution, as well as production specialisation (Kotsakis 1983: 106-141; Maniatis *et al.* 1988: 272-74).

A similar approach was adopted to the study of Balkan Late Neolithic pottery, specifically the Vinca ceramics from Selevac and Gomolava (Kaiser 1984; 1990), where all the investigated steps of the production sequence were studied through an integrated technological and economic analysis. Along with the exploration of the potters' know-how in choosing materials and techniques, again as a response to certain constraints, technological change was also traced diachronically. In both studies, however, the use of petrographic analysis, for instance, was applied to only a small number of randomly chosen samples, and was restricted to describing mineralogical composition and their relative proportions (Kaiser 1984; 1990; Kotsakis 1983). The ceramic 'fabric', at this stage, does not seem to have been understood in terms of the potters' manipulation of raw materials (including the understanding of the technological choice of different clays mixed together along with non-plastic inclusions).

Quite similar theoretical and methodological problems occurred in a more recent, diachronic technological study of the Sesklo pottery (Wijnen 1994). Collection and analysis of local raw materials, along with macroscopic and experimental study of the pottery, were employed to assess the changes in the use of materials and techniques throughout the different chronological phases. These were combined with an attempt to explore the use of local and non-local clay sources. The term 'ware' was once again used to refer to raw materials that, according to Wijnen, consisted of 'fabric' and 'non-plastics'

(1994: 149). The technological analysis, interestingly, suggested that coiling should not be assumed to have been the predominant manufacturing technique for the Neolithic period (Kotsakis 1983: 120, 124; Tsountas 1908: 180). Instead, "sequential slab construction" was proposed by Wijnen for the entire Neolithic period not only in Sesklo but also at the nearby sites of Achilleion, Argissa and Otzaki (1994: 151-152). Furthermore, through technological study, it was concluded that for both the Early Neolithic and the Middle Neolithic the manufacture of pottery was "an entirely local industry", with no imports of either decorated or undecorated categories until the Late Neolithic, when the black on buff/white painted Dimini was considered to represent the first rare imports from nearby sites (1994: 152).

What followed in Greek Neolithic ceramic research remained rather traditional, as was the case with the technological and stylistic/typological analysis of the EN/MN pottery from the Thessalian settlement of Achilleion, tracing cultural change through time (Gimbutas *et al.* 1989: 75-101, 334). The confusion in the ways analytic terms were used to incorporate (e.g., ware) or distinguish (e.g., paste and temper) certain attributes is striking. Moreover, the minimal scale of petrographic analysis performed on a very restricted number of samples (5 sherds) was unsuccessfully linked to the main archaeological questions and therefore incompatible.

In a later doctoral project on the same Early Neolithic material from Achilleion, its "function/use" and production technology were investigated through employment of a wide range of analytical techniques applied to a restricted number of samples of the ancient material, as well as modern clay samples collected from the surrounding area. These data were all viewed under the influence of ceramic ecology (Björk 1995: 7-9; Matson 1965: 203). Björk herself claimed: "...I shall therefore make use of current scientific knowledge of material techniques grounded in sophisticated technological experiments to reconstruct a specific human behaviour in the past which was based on only empirical knowledge..." (1995: 7). By addressing the question of the possible domestic or symbolic function of this early pottery, the purpose was to explore further the emergence of pottery either as a result of technological innovation or social interaction, thus challenging the traditional association of a new invention, in this case pottery, with a new domesticated economy (1995: 1-2).

Björk concluded that, according to the technological and morphological analysis, Early Neolithic potters did not seem to acquire specialised knowledge for the deliberate manufacture of distinct functional categories, especially for domestic use, e.g., cooking pots. Thus, she strongly argued in favour of a social rather than domestic function for the pottery, the role of which was thought to be symbolic. Consequently, pots, considered to be the products of "a few talented individuals", were interpreted as symbols of social status and wealth for their owners and, moreover, as "elite goods" (Björk 1995: 137).

In Björk's research, although the exhaustive range of scientific techniques employed combined with the morphological analysis of the studied pottery are rather impressive, they are, however, applied to a limited ancient pottery sample from certain sub-phases of the EN settlement. Consequently, they do not necessarily permit safe theoretical generalisations regarding the function of this pottery. More importantly, the direct connection of the technological study of this particular assemblage, through analytical techniques for the reconstruction of behavioural patterns concerning past producers and consumers, sounds at the very least ambitious and not well-justified.

For the Neolithic period, a better example of technological and functional analysis based on analytical techniques, with an emphasis on petrographic analysis (but with only 5 samples for SEM), is the study of the Early Neolithic ceramic material from Nea Nikomedeia, northern Greece (Yiouni 1996). This pottery assemblage was predominantly examined macroscopically, and the 54 samples that were analysed microscopically essentially served to reinforce the macroscopic technological examination, and, according to the researcher, "to relate to provenance studies" (Yiouni 1996: 55). Care was taken for all the macroscopically observed fabrics to be included in the sample for further petrographic analysis. Provenance ascription relied upon the identification of non-plastic inclusions in the ancient material, with subsequent comparison with the relevant geological map to check the availability of non-plastics in the local area. However, the isolated examination of non-plastic inclusions without close consideration of the surrounding clay matrix cannot offer any safe provenance-related clues, because it ignores the important technological choice of clay mixing performed by potters. This could entail non-plastics and clays that did not come from the parent rock, when used, but rather were deposited

and/or brought from a different geological environment by natural processes. The above methodological problem stems from the way in which the petrographic fabric was defined in this particular case study: the composition, shape and size of the non-plastic inclusions were the decisive parameters (Yiouni 1996: 71). Their distribution and compositional and textural relation to the clay matrix were under-emphasised. Based on these parameters and the macroscopic fabric examination of two decorated wares that shared stylistic similarities with the nearby EN site of Giannitsa B, it was decided that all eight fabrics present in the EN material from Nea Nikomedeia were local, and, therefore, a lack of imported pottery was assumed.

In the same study, a rough estimation of the scale of annual pottery production was made, according to which 25-90 pots per year were considered to have been the output of all the houses in the main excavated area (Yiouni 1996: 185). This interesting finding is notably different to the total annual production at Franchthi, southern Greece, during the EN, as suggested by Vitelli (1993b: 210; 1995: 60). Additionally, the functional analysis of the Nea Nikomedeia ceramic assemblage cautiously suggests the first appearance of storage and even cooking pots, although it is stressed that no obvious functional associations between fabric types and vessel forms can be made (Yiouni 1996: 187-191). This again contradicts previous considerations regarding the function categories of EN pottery from Southern Europe. Gardner, for instance, in her technological examination of the Anza, Achilleion, and Sitagroi materials, identified only vessels for display and storage, excluding cooking pots, and a similar conclusion was reached in relation to the function of the Franchthi EN pottery, the symbolic and social roles of which were explicitly stressed (Gardner 1978; Vitelli 1989).

3.2.4 Approaches to the organisation of production

3.2.4.1 Direct evidence for the organisation of production

Rice emphasised the need for studies of pottery production on a micro-scale level of analysis, focusing on the organisation of production within local communities, rather than

on inter-regional trade and exchange (Rice 1981: 219). Such a task may be possible to undertake through consideration of the *direct* and/or *indirect* evidence available.

Indisputable parameters that can provide direct evidence on production organisation are: a) firing locations, b) tools for manufacture, c) pottery wasters, and d) the location of production centres. Unfortunately, such material evidence rarely appears in Neolithic sites.

This seems to be the case with the Greek Neolithic, during which evidence of pottery kilns and wasters might not have existed, or has simple not been found, whilst tools and production centres are merely assumed. For MN Sesklo, for instance, Tsountas (1908) and Theocharis (1968: 27-30; 1973: 66) refer to a two-room dwelling at the *acropolis* as the "potter's workshop" without, however, providing any substantial evidence. Amongst the very rare published information on a pottery kiln, based on archaeological evidence, is an example from LN Olynthos, northern Greece (Mylonas 1929: 12-18). There are, however, serious objections regarding its chronology, due to insufficient stratigraphic evidence, and its construction efficiency, e.g., a small and shallow firing chamber and problematic heat transfer from outside to inside the kiln (Jones 1986: 776-777; Kotsakis 1983: 136-137; Vitelli 1974: 26, 29).

The latest claim for the discovery of a "pottery workshop" is from the Thessalian LN settlement of Dimini (Hourmouziadis 1978: 207-211; 1979: 156). The simple construction consisted of a round depression/pit (1.15m diameter). This was surrounded by a 0.30m circular wall (thought to have been found at its original height) made of clay, thick tiles and slates of schist. Inside the pit, and in a radius of 3-4 metres, burnt lumps of clay, pottery sherds, clay artefacts, jewellery, carbonised seeds and ash mixed with burnt soil were found to support Hourmouziadis' argument (1978: 211, 213). His claim has not been openly disputed by other researchers (Andreou *et al.* 1996: 544; Halstead 1992a: 31-32; Kotsakis 1983: 137), as his interpretation appears compatible with similar information on pit kilns provided by ethnographic evidence. The practice he describes is seen as the intervening stage between the use of open bonfires and proper kilns (Shepard 1985: 75-76; Rice 1987: 158; Rye 1981: 98).

3.2.4.2 Indirect evidence for the organisation of production

Whether the aforementioned construction at Dimini provided clear evidence of a Neolithic 'kiln' became of secondary importance. The significance of Hourmouziadis' argument, at the time, lay upon his theoretical effort to offer an explanation of the material record and to draw attention to the issue of economic specialisation, in general, and of specialised pottery production, in particular, for the first time in the Greek Neolithic (Renfrew also briefly discussed craft specialisation a few years earlier, Renfrew 1973: 179-191). It was, therefore, suggested that the 'workshop' was operating with full-time specialists who were producing to cover not the needs of a family 'household' but rather the needs of the whole Neolithic community (Hourmouziadis 1978: 211). Interestingly enough, the output of this 'pit kiln' was associated with the production of one particular ware: the well-known Dimini Incised pottery (*pl.* 3.1).

Hourmouziadis' interpretation of specialised pottery production relied primarily on indirect evidence: a) standardisation in shapes, size and the decoration/surface finish of the final products, which were repeated consistently, and b) the high level of technological skill of the LN potters, as observed during macroscopic examination. Strongly influenced by functionalism and 'systems theory', Hourmouziadis drew a clear division between function/use (without distinguishing between the two concepts) and the structural elements pertaining to pottery, that were thought of as not being essential, since they did not resolve problems or cover everyday needs, i.e., decoration (1978: 119-220). Such elements were closely interrelated with the emergence of specialised production as a process assigned only to the Late Neolithic period, after having gradually evolved from the earlier phases of the Neolithic, and were taken to indicate the first signs of social complexity. Thus, it was suggested that the presence and activities of full-time specialist potters, who did not participate in the principal economic activities of the community because they were investing all their time in craft production, might have signified the first social inequalities, without yet reaching the point of social conflict (1978: 222-223).

This exclusion from participation in the crucial aspects of the general Neolithic economy only produced relations of a purely ideological character and made the potters,

according to Hourmouziadis, powerless, as they were dependent on the community and had no access to the means of production and the distribution of the products (1978: 225). On this basis, he claimed that his interpretation was in accordance with the principles of the 'Domestic Mode of Production', and so was compatible with the idea of a simple and still self-sufficient LN society. This was pointed out repeatedly in his later re-investigation of Dimini architecture, in which he stressed the equal distribution of all categories of material culture across the studied site (Andreou *e al.* 1996: 544, note 43; Halstead 1992a: 31-32; Hourmouziadis 1979, 1980, 1981).

Hourmouziadis' analysis and subsequent interpretation were limited to the macroscopic examination of Incised pottery, excluding all the other ware categories and further technological investigation as well as any consideration of the possible circulation of this pottery outside the borders of the local Neolithic community. His analytical criteria, based largely on morphological and stylistic standardisation of the final products, only assumed the high technological skill of potters and speculated about the possible large scale of production from the evidence for standardisation. These conclusions are not adequately justified by reference to the specific socio-economic context. Consequently, the researcher overlooked the alternative choices that the Neolithic producers may have had, and failed to explain why they made the choices they did. Finally, although he suggested a significant change within the economic system he studied (i.e., the Neolithic economy) by pointing to specialised pottery production, he did not provide adequate explanation of this change. Instead, he insisted on an egalitarian structure of societal organisation, viewed through an evolutionary lens, within which the Neolithic 'specialist' potter maintained a passive and rather trivial social role.

Nonetheless, Hourmouziadis' work undoubtedly took Neolithic pottery studies in a radically new theoretical direction, which went beyond chrono-typological descriptions, and marked a new era of archaeological enquiry in the study of the organisation of Greek Neolithic society.

Before proceeding to review other relevant Greek Neolithic case studies, an account of more general interpretative models regarding issues of the organisation of production

must be incorporated. These models, primarily developed from ethnographic research on modern 'primitive' societies and subsequently used as a source of analogy with the past, were introduced by scholars from both sides of the Atlantic. They are considered here in order to investigate whether, and to what extent, they have influenced research on the Greek Neolithic since the beginning of the 1980's.

Around that period, and outside the territory of Greek Neolithic archaeology, the introduction of analytical techniques had been a major breakthrough in pottery studies. Nevertheless, most often they were used in provenance and exchange identification studies on an inter-regional scale, neglecting the study of the organisation of production on a micro-scale, i.e., intra-site level. As soon as research was initiated towards this latter direction, its emphasis became the search for the evolutionary development of economic specialisation, particularly among socially 'complex' societies, and, therefore, an on-going search for its definition and parameters.

Rice was the first to explore this phenomenon by putting forward a test model, applied to a Maya lowlands data set, in an attempt to define specialisation archaeologically (Rice 1981). As discussed earlier, in the archaeological literature economic specialisation has traditionally been linked with 'complex', socially stratified societies that become progressively differentiated until they reach urbanisation (Evans 1978: 113, 126; Brumfiel and Earle 1987; Rice 1981; Roux and Corbetta 1989: 3). Both these elements (specialisation and 'complex societies'), in turn, have been viewed as expressions or results of restricted access to resources and restricted distribution. From an evolutionary perspective, Rice made some deterministic assumptions about the nature and linear progress of specialised pottery production through the study of standardisation and diversity: a) in the final products (with emphasis on ceramic paste), and b) in behaviour patterns (Rice 1981: 219-220). Thus, in her opinion, the organisation of production in egalitarian societies, i.e., the Neolithic, developed as a household level activity for the production of 'utilitarian' vessels only. Access to resources was assumed to have been unlimited, the technology of production simple and lacking any degree of standardisation, except for some expected individual variations due to idiosyncratic parameters.

On a more sophisticated level, this, according to Rice, gradually evolved into developing specialisation characterised by the first signs of standardisation in ceramic pastes, more advanced production technologies, exploitation of restricted resources and wider spatial distribution of final products. Over time, social inequalities are thought to have emerged, triggered by the accumulation and manipulation of wealth. This wealth was supposedly sustained by means of control over resources and the distribution of products. Rice claims that such structural re-organisation of society is reflected in all its aspects, including the organisation of pottery production. According to her, it was at this very stage of societal development that economic specialisation fully occurred. She suggests that this can be traced through standardisation in the morphological, stylistic and technological characteristics of ceramic manufacture; these are assumed to have been the result of production intensification and the high skill and technological know-how of independent producers. Pottery maintained a new role, and from 'utilitarian' was now classified as high-value, obtaining a social and ceremonial function in the hands of powerful elites, who used it either for personal consumption or exchanged it as a gift or commodity in spatially restricted areas (Rice 1981: 222-223).

Rice's model was widely accepted but also criticised by researchers for several weaknesses and omissions, some of which were acknowledged by the writer herself in a later paper (Rice 1981: 227-236, 1991: 257, 279). She attempted to explain the beginning of specialisation in economic and socio-political terms, as generated by the emergence of hierarchically structured societies controlled by centralised authorities.

Simultaneously, other case studies were designed to follow a quite similar empirical path. The 'production step measure', for instance, was tested on ceramic assemblages from divergent (in terms of size, architecture and environment) site types in New Mexico (Feinman *et al.* 1981). Through the study of the social cost of labour input in the production of different types of pottery, researchers investigated the spatial distribution patterns of fine and coarse ceramics. Such patterns were thought to mirror social inequalities and the organisation of exchange. Feinman *et al.'s* analysis concluded that the use of the 'step measure' model could indeed be a reliable index for demonstrating social differentiation through examination of ceramic distributions over time as well as

technological changes in the pottery production process that reflected organisational and societal changes.

Although Feinman *et al.* (1981: 872) claimed that the model "is an ordinal index of production costs which focuses on the number of steps required in a production process", it excluded a crucial stage of pottery manufacture: that of raw material procurement and processing. Local materials available in the studied areas were assumed to have been appropriate and therefore used by producers, without further employment of petrographic analysis. Instead, the study was primarily concerned with labour input into the stylistic investment of pots that took place at different stages of surface treatment and decoration. Also, the analysis was restricted to a single ceramic category: bowls. In addition, all steps of the manufacturing process under consideration were graded equally, even though it is widely accepted that certain production stages are far more energy- and time-consuming. Surprisingly, the writers themselves acknowledged these limitations in that very paper, and yet, they decided to proceed (1981: 873-874). Finally, the 'production step measure' appears to have been founded largely on deterministic assumptions and the researchers, in order to justify their rationale and conclusions, in some cases had to resort to analogies with modern capitalist systems.

Arnold, on the other hand, in his early work, approached the notion of evolved ceramic specialisation from an ecological perspective and through environmental relationships. In his work, "these relationships are presented as processes which help explain the evolution of ceramic specialisation from non-potters to part-time potters and finally to full-time craft specialists" (Arnold 1985: 18). Conventionally, he too associated the emergence of specialisation with demographic parameters, such as population growth, which might have caused a decrease in the available land for new households, a simultaneous shift in different occupations, e.g., pottery manufacture, and a resulting increase in specialised craft production sometimes through innovation (1985: 157-159, 168). Within this framework, Arnold also made a point regarding the socio-economic role of potters in different, mainly modern, 'primitive' societies (for relevant literature see Arnold 1985: 196-197). In social contexts where population pressure forces certain individuals to become craft specialists, their role remains insignificant due to their poverty,

especially when the production output is utilitarian pottery. He argued, however, that, outside the population pressure factor, sexual division of labour differently affects the role of potters in the social hierarchy (1985: 198).

The abovementioned factors were also examined in combination with other considerations, for instance, climatic conditions, available resources or demand. For example, when demand for pottery objects was related to social/ritual symbols the place of specialists on the social ladder was supposedly upgraded. The striking element in this work is the writer's insistence on the man/land relationship as a precondition for the evolution of pottery specialisation. Its emergence is always assumed to have appeared amongst sedentary agricultural communities, where producers performed their craft within the 'right' environment and, thus, were able to cover not only their own but also their community's needs (1985: 168).

Sedentism, in association with the parameters of 'social' and agricultural intensification and competition through the production of elaborate craft objects, was the key element in Kaiser's work (Kaiser 1984; Kaiser and Voytek 1983). In his archaeological study of the production of Late Neolithic Vinca ceramics from Selevac and Gomolava he attempted, from an economic perspective, to define and test craft specialisation by adapting the 'production step measure' after modifications (Feinman *et al.* 1981; Kaiser 1984: 269). Influenced by economic anthropology, Kaiser acknowledged specialisation as a second mode of production (the first being the 'DMP'), associated primarily with hierarchically stratified societies. His definition of the phenomenon suggests artisans or groups who can afford to engage fully in the production of restricted categories of pottery whilst other producers are in charge of the craftsmen's provisions in direct or indirect exchange of craft products. According to Kaiser, the specialists' power lies in their acquisition of technological know-how and access to resources (1984: 280).

Such a definition partly resembles Hourmouziadis' claim for the specialised production of Incised pottery in Late Neolithic Dimini, as discussed earlier in this section. In that case, however, potters were assigned a completely different, rather insignificant, role and were seen to be operating within the logic of the 'DMP' (Hourmouziadis 1978).

Kaiser, challenging Chapman's earlier suggestion for specialised production of certain categories of Vinca ceramics (Chapman 1981), argued that since the pottery lacks morphological standardisation and does not consist of a very restricted range of raw materials, it cannot be considered the output of specialised production. Further to this, he added: "in conclusion, it seems clear that the evidence of both technological and formal analyses bear out all of the test implications of a model of domestic pottery production in the Vinca culture" (1984: 287). Despite this, the writer did acknowledge a high degree of technological competence in the production of this pottery (1984: 294).

Throughout the 1980's, and during the following decade, archaeologists insisted on discussing specialisation in terms of standardised products, increased output and efficiency of production, as pointed out by Clark and Parry (1990: 293). Their definition of specialised production refers to producer/s and consumers that are not members of the same household: "craft specialisation is production of alienable, durable goods for nondependent consumption" (1990: 297). Clark and Parry made the significant point that specialisation is only one form of 'politics' in the "social reproduction" of a society, through production of craft goods that maintain ideological meaning. At the same time, they rightly acknowledge that in non-institutionalised societies, i.e., the Neolithic, there may be diverse ways in which peoples' social reality can be expressed outside specialised production, and through the constant re-negotiation of their relationships. Such relationships can be materialised not only through production, but also, and perhaps more importantly, by the consumption of high-value and scarce objects (Clark and Parry 1990: 296).

The importance of Clark and Parry's perspective lies in the fact that, perhaps for the first time, the search for the development of craft specialisation in relation to the parallel development of social complexity incorporates the crucial parameters of consumption and the "transfer of goods from their producer to nondependent consumers" (1990: 298). They repeatedly stress the direct link between the production of specialised goods and mechanisms of exchange. Their diachronic study, however, was purely ethnographic, and concerned the investigation of 53 societies comprising a variety of institutions and environments. It examined the possible relationship between attached and independent specialised production in the development of complex societies. This clearly shows their

intention to interpret the available evidence in progressive, evolutionary terms. Simultaneously, the possible application and appropriateness of their methodology and suggested definitions for archaeological case studies are not really justified and, therefore, irrelevant.

Costin (1991) critiqued Clark and Parry's definition of specialisation as very broad and rather "loose". Instead, she redefined the term as "a differentiated, regularised, permanent and perhaps institutionalised production system", in which both producers and consumers are involved in inter-dependent relationships (1991: 4), i.e., the former rely on exchange relationships beyond the household level and the latter rely on the producers' knowledge and skill to provide them with the objects that they themselves cannot create. On the one hand, Costin's (1991: 3) point about the importance of understanding the consumption parameter, as reflected in the nature and level of demand for ceramic products, in relation to both production and the "logistics" of distribution, is worth noting. On the other hand, throughout this paper there is a strong inclination on the author's part to interpret the examined parameters in strict economic and linear terms, thus under-emphasising the socio-cultural milieu within which the producers and consumers operated.

This is particularly obvious in Costin's proposed eight-part typology concerning the organisation of specialised production. According to her, this seems to have evolved from *individual*, *dispersed workshops*, *community specialisation* and *nucleated workshops* (mainly referring to unrestricted local and regional consumption and implying a simple pattern of social and economic organisation), into more complex forms associated with *dispersed corvée*, *individual retainers*, *nucleated corvée* and *retainer workshops*. In these latter, part-time and full-time attached manufacturers produce on a large-scale for élite or government institutions (1991: 8-9). Costin largely focuses on four parameters to assess the presence and degree of specialisation: a) *context* of production, referring to possible control over production and distribution, b) *concentration of production*, exemplifying the geographical organisation of production and related facilities, c) *scale* of production units, characterising the size and organisation of labour, and d) *intensity* of production, with regard to the presence of part-time versus full-time specialists.

In general terms, Costin's complex model offers invaluable insights into the understanding of craft specialisation, as has already been acknowledged (Day *et al.* 1997: 279). Nevertheless, the suggested parameters that would potentially facilitate assessment of specialised production within a specific context rely largely upon direct evidence on the organisation of production. This makes its application to certain archaeological contexts (e.g. the Neolithic) impossible, or "difficult to operationalise" (Day *et al.* 1997: 279), as there is very limited or no available evidence on firing locations, tools, wasters and production centres. As for her discussion of the indirect evidence for specialised production, which she suggests can be mainly assessed through standardisation, efficiency, skill and regional variation, a number of ethnographic studies have challenged the objectivity and stressed the variation of these parameters, from one context to another. This indicates that they should be considered unreliable indices for the assessment of specialisation (Feinman 1999; Stark 1991; van der Leeuw 1991; van der Leeuw *et al.* 1991).

In contrast, Rice (1991) suggested a re-evaluation of the term specialisation, which in specific contexts and under certain circumstances could be archaeologically identifiable. She basically argues for different types of specialisation, namely referring to a) site, b) resource, c) functional, and d) producer specialisation; the first three being largely associated with village or community specialisation whilst the last is primarily linked with more complex forms of socio-economic organisation. The focal points around which this paper is organised are standardisation, "a relative degree of homogeneity or reduction in variability", versus diversity that may characterise pottery attributes and based on which the presence of intensified/specialised production could be assessed (Rice 1991: 268). Important is the fact that it is realised and acknowledged that the parameters, so far used to assume standardisation, do not necessarily point to specialised production and that this supposed relationships between standardisation and specialisation is only hypothetical and rather problematic. Nonetheless, Rice insists that the solution for clarification and more accurate understanding lies in the need for further ethnographic testing (1991: 269). Interestingly, this suggestion contradicts the results of ethnographic case studies, which argue that such direct relationship between standardisation and specialisation cannot be established as it largely varies from one ethnographic context to another. It should also be

taken into account that changes in the political organisation of a society, i.e., egalitarian versus hierarchically structured, may play a role, but it does not necessarily reflect changes in the technology and organisation of craft products, something that Rice also acknowledges (1991: 277).

Looking at the most important models for definition of specialisation, one can see that all derive from a strong economic theoretical tradition, where specialisation is viewed as index for the measurement of linear, progressive development of political and social complexity from simple, egalitarian to hierarchically structured societies. Such an approach prevents contextual examination of certain socio-cultural and economic parameters to be studied in their own right in each particular chronological period. Only under these circumstances can the definition of specialisation obtain a useful meaning for further interpretation, devoid of universal laws, generally applied to all contexts and all periods, and unquestioned assumptions. In addition, the phenomenon is largely defined based on ethnographic work, which, when applied to archaeological case studies, underemphasizes variability and differences from one community to the other. More importantly, as it is defined in economic terms, and largely refers to direct evidence of production, it can hardly be applicable to archaeological periods (especially with regard to the Neolithic). At the same time, it has been examined in isolation from patterns of consumption and intra- and inter-site circulation.

It is now necessary to return to the discussion on the Greek Neolithic and assess how the previously presented models of interpretation influenced similar issues pertaining to the organisation of production of Greek Neolithic materials. As presented in Chapter 2 (section 2.4.3), recent research attempted to investigate the organisation of craft production, mainly stone tools and pottery, through understanding of the development of specialisation and the mechanism of exchange (Perlès 1992; Perlès and Vitelli 1999; Schneider *et al.* 1991, 1994; Vitelli 1993a). In this chapter, the focus will remain on pottery. In her earlier paper Perlès (1992) acknowledges, for the first time in the relevant literature, the importance of consumption of craft objects and their direct association with production and distribution patterns. On this basis, she suggests three distinct modes/systems of production and exchange. This scheme classifies pottery as object of social value, due to its high

stylistic investment, assigned a non-utilitarian use, and strictly restricted geographically, as opposed to stone tools, assigned a purely utilitarian character and unrestricted social and geographical distribution, or the ritual character of 'prestige goods' with uneven patterns of long-distance distribution (1992: 148-149).

Perlès' original definition and evaluation of specialisation relies on the main parameters: a) distribution of production centres b) complexity of required know-how (and technical input), c) output, and d) extent of circulation outside production areas (1992: 125). Considering the available evidence based on which this assessment was made, the results are intriguing and have been interpreted in rather divergent ways (Perlès 1992; Perlès and Vitelli 1999; Vitelli 1993a, b, Vitelli 1999). There is, however, a common characteristic in the way they look at the body of evidence: a progressive development in the evolution or devolution of specialisation throughout the three phases of the Neolithic period. Despite the fact that both researchers acknowledge a significant variety and relative complexity in the production and distribution patterns of the studied material culture remains, however, they tend to underemphasize this evidence, and ultimately 'fit' it into the familiar model of the 'DMP'.

On the one hand, Perlès argues in favour of the gradual evolution of pottery production from domestic, covering household needs, during the Early and to a lesser extent the Middle Neolithic, to one specialised at the community level during the Late and Final Neolithic. Her conclusions were drawn based on the aforementioned four parameters. Perlès suggests that, during the earlier phases of the Neolithic, the distribution of pottery production centres was even and numerous throughout the landscape, which is thought to imply predominantly local production in each village/settlement due to abundant available clay sources and non-restricted access to them, as opposed to production of stone tools (1992: 128-130). In addition, the degree of technological knowledge during the EN is evaluated as "simple" and "limited", probably also due to lack of frequent practice. During the Middle Neolithic "the situation ...gradually evolved", according to Perlès (1992: 133). This is how certain technological innovations regarding newly emerging vessel forms and firing techniques have been interpreted by the researcher. And, it is during the Late Neolithic that this linear progress reaches a higher point, where the knowledge and

technical investment in the production of especially painted pottery is characterised "heavy" and beyond functional needs (1992: 134). At this point in time, pottery production is considered specialised on a community level, since the first evidence of medium-scale (in a radius of no more than *c.* 70 km) exchange of restricted ceramic wares emerges (Schneider *et al.* 1990, 1991). Therefore, specialised pottery production, according to Perlès, is production designed for exchange for other products (1992: 134-135). This started to emerge during the MN with pottery exchange between 'domestic units' and extended during the LN on a restricted regional level, where production is thought to be "highly localised" for limited wares, e.g., grey-on-grey pottery but "not so concentrated" for wares such as 'Tsangli', 'Arapi' and 'Classical Dimini' (Perlès 1992: 137; Schneider *et al.* 1990, 1991). The production and circulation of this last category ('Classical Dimini') will be extensively discussed in Chapter 6 in relation to the analytical results that the studied materials provide. Production for exchange purposes is also associated with the parameter stylistic investment, which is low during the EN, hence pottery of this period is locally consumed, increases during the MN, when distinct styles on an individual level started to emerge, and enhances greater importance during the LN, especially with regard to fine, painted wares, that are only regionally exchanged. It is during this period, according to researchers, that pottery styles are highly diversified and visible on a production centre level (Cullen 1985; Halstead 1989; Perlès 1992; Rondiri 1985). Similar differences between the three phases of the Neolithic are observed in relation to the production output for different categories of archaeological materials. Pottery, for instance, is produced in generally minimal quantities during the EN, increases substantially during the MN and reaches large scale production during the LN.

Interestingly, the same evidence has been interpreted by Vitelli in a rather contrasting way (Vitelli 1993a, b, 1995, 1999). She claims that Neolithic pottery production developed from specialised during the Early Neolithic to eventually degrading into 'de-specialised' towards the Late and Final Neolithic periods (1993: 248). What is 'read' by Perlès as technologically simple, is considered rather innovative by Vitelli, considering the lack of previously accumulated knowledge on the potters' part. Two of Perlès' arguments in support of domestic, unspecialised production in the EN are: the even and abundant distribution of clay sources whose exploitation is assumed to be unrestricted

and the lack of any stylistic investment. Yet, Vitelli stresses that only certain clay sources are appropriate for pottery making and knowledge is required to be able to choose the right ones. In addition, stylistic investment should be examined in relative terms, e.g., a burnished pot in the EN should be comparable with a heavily decorated pot of later periods, taking into account the progressive accumulation of technological knowledge (Vitelli 1993: 249). Vitelli also questions Perlès' consideration of production output to assess specialisation. Although both researchers agree on a very small-scale production during the Early and even the Middle Neolithic (Perlès 1992: 141; Vitelli 1993b: 210-211; Yiouni 1996: 185), Vitelli rightly points out that there are no equivalent specific estimates for the production output during the Late and Final Neolithic, even though it is beyond doubt that it dramatically increases. She makes an important point, concerning Perlès' use of the 'domestic unit'/ 'household' as a term to define location of production, by acknowledging that there is not such a clear and justified definition based on the available archaeological evidence for the Neolithic period, mainly due to the lack of horizontally developed settlements (the majority represent *tells* as opposed to *flat-extended* settlements). Thus, study of the intra-site distribution of relative quantities of different archaeological categories may well be biased and should not permit conclusions on distinct modes of production and distribution of different materials (Vitelli 1993: 249).

3.3 Circulation of Pottery

In the study of the Greek Neolithic, the 'exchange' of archaeological craft products has dominated during the last thirty years. Work done in the Aegean in the early 1970s and 1980s (Renfrew 1972, 1973, 1984; Torrence 1986) is still considered to be a landmark in the history of archaeological research on exchange and trade, even though it has been criticised for its strongly orientated economic approach. It has been suggested, for instance, that archaeologists should be looking at the process of prehistoric exchange as being part of a wider, social process where people interacted in order to secure not only material resources but also prestige, social power and alliances (Hodder 1982).

In contrast, Perlès' recent work (1992) pointed out methodological rather than theoretical problems in previous research. Thus, she argues that the weak points lie upon the fact that researchers were a) either studying all craft products as a whole without distinguishing between different modes of production and exchange, or b) were choosing to deal with only one category (stone tools) or sub-category of archaeological material (e.g obsidian) and only in terms of regional distribution without consideration of technological implications on the production level (Perlès 1992: 118). Consequently, she proposes the detailed study of all different categories of materials or finished products separately within a given archaeological context claiming as a prerequisite the direct relationship between exchange and production patterns (with particular reference to specialisation). The main parameters that Perlès considers in examining patterns of exchange are: means of distribution of goods and know-how involved, the circulated quantities, the distances involved and fall-off patterns in relation to the sources as well as the distribution of imported goods on a site and a regional level (1992: 144). The three distinct systems of exchange and production resulted from her study are presented in Chapter 2 (section 2.4.3). Here, the place and role of pottery in this tripartite system will be mainly discussed.

Ceramics seem to be excluded from the discussion of the parameters that define exchange, according to Perlès. According to the available up to the present day evidence, the majority of pottery is believed not to have circulated over long distances, as is the case with obsidian (450 km). The maximum accepted radius for pottery does not exceed *c.* 70 km and concerns the grey-on-grey Thessalian pottery of the earlier phase of the Late Neolithic (Schneider *et al.* 1991: 48). Some very restricted ceramic categories that are assumed possible for exchange in minimal quantities are fine painted wares, which carry high stylistic investment and probably social information through decoration. These wares are thought exceptions to the rule, products of specialised production on a community level, which, however, remains compatible with the model of the 'Domestic Mode of Production' (Perlès1992: 146; Perlès and Vitelli 1999). Perlès introduces another dimension regarding the consumption of the imported wares, which contradicts that of the stone tools, for instance. In the former case, the acquisition of imported, highly decorated pottery is not explained in terms of shortage of the particular types of pots within a settlement as it is believed that each Neolithic community produced sufficient and good quality ceramic

outputs (1992: 147). Therefore, it is implied that the circulation and subsequent consumption of such wares maintains a social character and may signify inequalities and manipulation of social power. The important question of who controls the inter- and intra-site distribution of these pots, however, remains unanswered. Intra-site differentiation based on distribution patterns is suggested for the Middle Neolithic painted pottery from Sesklo, but these wares were locally produced (Kotsakis 1983, 1994). Almost absent is relevant evidence for the Late Neolithic period.

Going back to the review of pottery studies, it was acknowledged that the influence of 'New Archaeology' resulted in the introduction of analytical techniques for mainly provenance identification and more recently technological studies. In examples of the Greek Neolithic, while the investigation of the former (provenance identification) has predominantly incorporated stone tools and 'exotic goods' the latter (technology), applied mainly to pottery, remained isolated from issues of circulation/exchange due to established assumptions that such a process is not relevant to ceramics, traditionally considered largely locally produced and consumed (for a detailed account of relevant studies see Jones 1986). Yet, employment of analytical techniques has normally been applied to a restricted number of samples, frequently biased due to the nature of preserved evidence, or to poorly designed projects due to lack of an integrated methodology which employs the appropriate analytical techniques in order to address specific archaeological questions.

There are only rare examples of such methodology. Macroscopic and petrographic analysis of sufficient samples with more limited SEM work done on Early Neolithic material from Knossos, in Crete, has revealed a wealth of information on ceramic variability and relative circulation of pottery (in a radius of *c.* 70 km) since this early period (Tomkins and Day 2001). These results certainly challenge the established idea of an Early Neolithic that until recently was thought to have been characterised by local production and minimal or absent regional distribution of ceramic material. Another similar example of analytical work has been done on Thessalian material from the transitional phase of the end of the Middle to the early phase of the Late Neolithic (incorporating only limited samples of the later, 'Classical Dimini' sub-phase of the Late Neolithic) (Schneider *et al.* 1991, 1994). This work is significant for providing evidence on manufacture on a centre of production

level for restricted fine wares (i.e., grey-on-grey pottery in the north-western Thessalian plain) and on the regional exchange of this pottery in a radius of no more than *c.* 70 km. The aforementioned work, however, relies heavily on chemical analysis of ancient material and modern clay samples, and only restricted petrographic analysis, which is not properly tested against the results of chemical analysis. In addition, the majority of analysed samples are products of surface survey finds, which does not permit any insights into the intra-site production of pottery for a subsequent better understanding of its consumption and circulation in different locations.

3.4 Conclusions

As has been presented in sections 3.2.2 and 3.2.3 of this chapter, one of the most important theoretical trends to have dominated pottery studies since the early 1970's has been *processual* archaeology. Its invaluable contribution to a better understanding of socio-economic practices, through the establishment of a new set of questions and new methodological tools, i.e., scientific analysis, is acknowledged here. However, there are certain limitations to this approach. Fundamental ones are the general tendency to trace and regard socio-cultural change as a smooth process characterised by the progressive evolution of certain phenomena (e.g., specialisation, technology) over different chronological periods, and to view their occurrence as a means of adaptation to the natural environment (Johnson 1999: 94). Much of the previously mentioned research on Greek Neolithic pottery can be categorised as such, being for example technological studies influenced either by strong functionalism and ceramic ecology or the search for the linear evolution of economic specialisation throughout the Neolithic period. Further to this, even dialectic researchers (Costin 1991; Rice 1981), influenced by cultural materialism, resorted to establishing universal models and social definitions that seemed to be applicable over time and space (Johnson 1999). They have thus underestimated the variability of specific cultural contexts within which certain social, economic and ideological phenomena developed in different societies and different periods for different reasons.

Because this tendency has largely influenced studies of the Greek Neolithic in general and pottery studies in particular, the complex social organisation of this period has been underemphasized. This problematic point in previous work is the main reason why the present research attempts to study and evaluate the production technology and circulation of pottery from Makrygialos (Phase II) in its own right, as stated in Chapter 1, trying to avoid assumptions or concerns to fit the new evidence into previously established models of interpretation.

It is acknowledged that part of the problem has been the paucity of sufficient evidence for attempts to investigate different aspects of the material culture remains of the Greek Neolithic. A lack of an integrated methodology, however, represents another part of the problem, particularly with reference to ceramic studies. As shown in sections 3.2 and 3.3, the number of studies that set out to explore issues of the technology and organisation of production and the circulation of pots, having first established clear archaeological questions and then having adopted appropriate steps of analysis, is extremely limited, especially for the Late Neolithic. This is one reason why this thesis represents an important contribution, by building on the work of previous research.

In relation to pottery, it is clear from this review that there is a need for the small-scale, contextual analysis of not only ceramics but also other material remains so that a better understanding of socially-specific practices and beliefs can be established on a community and then on a regional and inter-regional level. It will be shown in the following chapters that the present research makes the first 'step' towards this direction while acknowledging the important role of the consumption of different materials, in relation to pottery, and their parallel examination in order to arrive at more generalised conclusions. In addition, previous assumptions regarding the nature of pottery production, e.g., whether it is locally produced and consumed, its role in society in comparison to other categories of material remains, and the participation or absence of pottery in networks of long-distance exchange, has to be re-evaluated in the light of the new evidence that this analysis of the Makrygialos (Phase II) and contemporary, comparative materials provides.

It is first necessary to introduce the site of Makrygialos (Phase II) and its material remains, in the following Chapter (Chapter 4). The emphasis will be on the typology of the ceramic material from this site, which is here presented for the first time.

CHAPTER 4

MAKRYGIALOS PHASE II: PRESENTATION OF THE SITE AND ITS CERAMIC MATERIAL

4.1 Introduction

The aim of this chapter is to present briefly the available evidence from the recently excavated, Late Neolithic settlement of Makrygialos, in Pieria, northern Greece, along with its material cultural remains. The emphasis is on the presentation of the ceramic material from Phase II, as the petrographic analysis of this assemblage is the focal point of this thesis.

A brief discussion on typological classifications in general is followed by an outline of the typological model adopted in the present study. Accordingly, the detailed typology of the Makrygialos Phase II pottery, as developed during its macroscopic examination, is presented. Finally, the three comparative sites (Dimini, Agrosykia A and Giannitsa B), examined against the Makrygialos material, and their pottery are looked at briefly.

4.2 The Late Neolithic settlement of Makrygialos (Phase II): Site Description

4.2.1 The Type Site

As a result of research predominantly carried out in Thessaly, the *tell* site was considered to be the dominant habitation type of site during the Greek Neolithic. Since the 1980's, however, new evidence has emerged (e.g. from Vasilika C and Thermi B in central Macedonia), based mainly upon surface survey and small-scale excavations conducted in different areas in Macedonia by the University of Thessaloniki and by the Greek Archaeological Service (Andreou and Kotsakis 1986; Andreou *et al.* 1996; Grammenos 1992, 1996, 1997; Grammenos *et al.* 1992).

The new picture suggests that, particularly in Macedonia, extended settlements, either flat or on the slopes of hills, represent another site-type during the Neolithic period. This habitation model is well known from contemporary examples in Central

Europe and the Balkans (e.g. Selevac, Divostin, Vinca). The pattern of distribution of those found in Macedonia is of great interest. In this particular case, one might expect that in close proximity to a very large, extended settlement some relatively smaller ones would occur, forming a settlement hierarchy within the area. The available evidence, however, suggests a far more complex picture. Some extremely large, flat-extended settlements, whose size is estimated to be up to *c.* 45 ha, have been found situated in very close proximity to each other. Alternatively, huge sites have also been discovered near other, much smaller ones. These elements in the organisation of space have been interpreted as a result of a horizontal shifting of habitation rather than as an attempt to hierarchically order settlements in response to changes in the size of population (Andreou & Kotsakis 1986; Chapman 1981; Kotsakis & Andreou 1988).

This newly discovered pattern of settlement organisation and use of space raises new questions. Could the preferences of the Neolithic inhabitants have been related to their emotional connection with a specific locus, or were they the reflection of dramatic socio-economic changes in the structure of Neolithic society, which, it is suggested, took place during the course of the Late Neolithic? And if this was the case, how could the formation of Neolithic Macedonia's social and natural environment be interpreted in relation to what was happening in Thessaly during the same period? One of the major problems in addressing such questions has been the fragmentary nature of the evidence, which has mostly been from survey finds rather than properly excavated settlements.

Between the years 1993-1995, an extensive Late Neolithic settlement was revealed at Makrygialos, in central Macedonia, northern Greece, providing a good opportunity to fill in a large gap in our understanding, not only of the prehistory of northern Greece, but also of Greek Neolithic society as a whole. Makrygialos represents the largest known, flat-extended Neolithic settlements in Greece, and one of the largest in Europe. It covers an area of 50 ha, of which approximately 12% (ca. 6 ha) has been excavated, revealing a variety of distinctive architectural features and contexts within the same site.

4.2.2 Location and Chronology

The site of Makrygialos is located only 2 km to the west of the coastal zone of Pieria (500m to the south/south-east of the modern village), and 15 km to the east of the

Pieria mountains. Mt. Olympus separates the area from Thessaly to the south (*fig.* 4.1). The settlement was located on the slopes of a low, dramatically eroded hill, which, along with the surrounding extensively cultivated areas, consist of deposits of marls and palaeosoils (Krahtopoulou 2000).

Based upon architectural features and the typology of the pottery assemblage, the excavators suggest that the settlement is securely divided into two main chronological phases (Besios and Pappa 1994; Pappa 1997):

- Makrygialos Phase I extends to the south and south-west of the hill and dates to the earlier phase of the Late Neolithic;
- Makrygialos Phase II belongs to the later phase of the Late Neolithic lying to the north, north-east and the top of the hill, which has suffered the most dramatic erosion. Phase II appears to have incorporated two sub-phases, which were traced on the basis of their architectural remains, and will be described below in more detail. It should be noted that the aforementioned sub-phases were not easily detectable by pottery phasing as the ceramic material found in this particular area was extremely weathered due to the soil erosion.

4.2.3 Intra-site Organisation of Space – Makrygialos Phase II

The second component of the Makrygialos settlement, covering the later phase of the Late Neolithic, developed in the area adjacent to the Phase I site (*fig.* 4.2). The two phases did not generally overlap and they seem to have developed horizontally over time. No pottery from Phase II was found within the area of the earlier Phase I; this was taken to prove that after the abandonment of Phase I, there was a chronological gap before the area of Phase II was again inhabited (Besios & Pappa 1998; Pappa & Besios 1999b). Although this later phase covered a much smaller area compared to the Phase I component, it was more densely inhabited. The erosion has been especially dramatic on the top of the hill, where only the foundations of features have been preserved, but is less drastic between this area and the north end of the settlement, where the deepest deposits have accumulated. Following the patterns of Phase I, Phase II has also provided some traces of enclosures. Even though evidence of the latest phase is more fragmentary than that from the earlier, it is quite clear that, through these constructions, the intention was to demarcate space and declare boundaries. At the western end of the settlement, for instance, the presence of a natural boundary (a watercourse) was

identified, 100m long and 10m wide. This joined with another ditch found in the northern part of the settlement that was only partially preserved (Pappa & Besios 1994). A similar construction was detected on the top of the hill, but it was not clear whether it could be related to the aforementioned ditch or was an inner partition, as more features were also excavated further south.

It has been suggested that Phase II may have incorporated two main sub-phases. This notion is based solely on differences in the architectural structures. Although there is still a lack of evidence for an analysis of their chronological succession the differences in the architectural features seem to present a strong case for their division. These sub-phases have been called: a) sub-phase of pit-dwellings (*fig.* 4.3), and b) sub-phase of apsidal structures (*fig* 4.4) (Besios & Pappa 1998; Pappa & Besios 1999b).

4.2.3.1 The 'Pit-dwellings' Sub-phase

The interpretation of the character and the function of these pits has been made on the basis of observed variations in their shape, size and depth, and according to the distribution of archaeological material within each of them (Besios & Pappa 1998; Pappa & Besios 1999b). Nevertheless, it is accepted that this working hypothesis might need revision after detailed analysis of each category of archaeological materials is completed. The dominant groups of pits of different character are presented below:

The first group consists of rounded and sub-rounded pits, 2 to 5m diameter, that represent only "the underground part of the settlement" (Pappa & Besios 1999b). Some of them were interpreted as 'houses', following parallels from Central Europe and the Balkans (e.g. Cucuteni and Vinca). They were often surrounded by postholes indicating the presence of walls. The use of stone was not evident in any of these constructions. In contrast, some remains of wattle and daub attested to walls and subterranean or semi-subterranean floors. Fragmentary evidence, above floor level, suggests the presence of stone-paved yards located in open spaces between the 'houses'. Hearths and ovens were also situated in open spaces, inside specially formed, shallow pits. Occasionally, small clusters of three or four ovens or hearths were found, located in what might have been communal cooking areas for groups of houses (Pappa & Besios 1999b).

This type of Neolithic 'house' has been linked in the literature with earlier forms of architecture mainly from the Early Neolithic, specifically Achilleion in Thessaly, Nea Makri in Attica, and Agios Yiannis in Pieria (Pappa & Besios 1999b). Such forms of early architecture were interpreted as necessarily primitive and were directly associated with simple, egalitarian, self-sufficient societies and economies. Moreover, according to ethnographic literature, round houses may be related to seasonal rather than permanent habitation. This view has been adopted by the excavators of the Makrygialos settlement for the interpretation of its character (Pappa & Besios 1999b; Whittle 1996). One should be cautious with these analogies, however, especially when important issues such as adequate definitions of the 'household' unit and permanent versus non-permanent settlements still remain open to lively dispute (see Chapter 2).

The second major group of pits consists of large, sub-rounded, deep constructions that were considered to be 'basements' for storage purposes. Two of these were well preserved compared to the other structures. Pit 24 was dug into the ground and preserved its entrance with earthen staircases leading to a ground floor 2m below the present ground surface (*fig.* 4.5). Here three holes marked the position of large storage vessels (pithoi), sherds from which were found in the floor deposit. Based on this evidence the excavators suggested that this pit was used as a cellar (Pappa & Besios 1999b). It is noteworthy that the deposits in Pit 24 included all pottery types present in Phase II (see section 4.2.4) plus some rarely occurring sherds, which, typologically, seem to belong to an earlier phase. The other 'basement' pit was located on the summit of the hill and was more or less of the same size and depth. It exhibited a rather interesting and different pattern of pottery distribution. It was situated further south, outside the area that was encircled by the watercourse feature to the west, the fragmentarily preserved ditch to the north and the other ditch/inner partition of the Phase II settlement to the south (see *fig.* 4.2).

Another group incorporated extensive, shallow pits enclosing structures such as large ovens and hearths. In close proximity to this area, shallow pits, side by side, were found filled with either very fine, raw clay or large quantities of marine *Cardium* shells. The nature of the layout of these constructions may imply the carrying out of 'household' and/or settlement activities related to food or materials processing.

The last category included small, shallow pits, perhaps used as depositories for rubbish or for cooking facilities. Occasionally, a considerable amount of ash was found in the deposits. Their interpretation is rather crucial. If, for example, these pits were used for cooking or for the preparation of a fire in order to cook, it would be useful to know whether they were located in or outdoors. Specifying the location of each 'hearth' will in turn hint at the character of the activities that were associated with them (Andreou *et al.* 1996).

4.2.3.2 The 'Apsidal Structures' Sub-phase

The later sub-phase of Makrygialos Phase II incorporates very large, rectangular 'megaroid' buildings with apsidal ends. One of these was identified in the north-eastern part of the settlement and another two at the top of the hill. The actual remains of the 'megara' were very limited and in some cases were represented only by the lowest part of their foundations. Fortunately, shapes of the buildings were also traced by the presence of postholes of large diameter. Best preserved was the 'megaron' to the north-east of the settlement, which had a length of up to 15m (see *fig.* 4.4). The structure was divided into two rooms. The one facing the north revealed four large postholes, which formed part of the roof support. The space with the apsidal end incorporated a quite deep, sub-rounded pit where a considerable amount of flax was found.

This distinct, dual pattern of spatial organisation and use within a relatively short period of time raises questions concerning continuity or discontinuity in the use of the same space, an element which cannot be easily observed in *tell* sites. Moreover, it has been suggested that the transition from one construction model to another probably signifies structural differences and changes in the social and economic life of the settlement (Andreou *et al.* 1996). This might have come about as a result of economic changes in, for example, methods of land exploitation, storage, surplus redistribution and the circulation of material objects. These possibilities will be further explored in the Discussion chapter (Chapter 7) of this thesis in relation to the new evidence that the study of the Phase II pottery provides.

4.2.4 Intra-site Pottery Distribution in Phase II

After the completion of the Makrygialos excavation in 1994, its directors considered the possibility of the Phase II settlement being organised around, and somehow sub-divided into, different functional activity areas. After going through all the excavation diaries, the researcher decided that six areas across the site incorporated the most representative types of pottery, in terms of their quantity and variety. On these grounds, samples for petrographic analysis were taken from the activity areas described below:

Activity Area I

This is located in the area with the deepest preserved deposits in the Makrygialos Phase II habitation space, to the north-west of the site, where part of a ditch was identified. According to the excavators (Besios and Pappa 1998; Pappa and Besios 1997, 1999a, b), these deposits were originally pits created by soil removal and then filled with deposits transferred from the slopes of the hill during floods. In-between the deposits, where charcoal remains were preserved in high percentages, incidents of human activity occurred. Distinctive features, such as clay floors and hearths, appeared together with extremely rich concentrations of pottery and other portable finds. The important element here is that a large amount of well-preserved pottery from this phase was concentrated in these deposits, of which a great deal is painted, 'Dimini' phase pottery.

Activity Area II

Across the area with the deep deposits (Activity Area I) there were three large, deep pits that were identified as basements. The most interesting, in terms of variety of different wares and fabrics present, and the deepest is Pit 24. Some of the preserved features inside this pit suggested that the area was used exclusively for storage purposes. For instance, an earthen staircase dug into the soil led down to the basement floor, where 'cases' were found, coated with clay to support the bases of large storage jars. Large fragments of pithoi and storage jars were found deposited on the surface of the many successive floors that were identified (Besios & Pappa 1994). Pit 24 represents another of those very few areas in the settlement where a considerable amount of the

decorated 'Dimini' pottery was found. What makes this pit special is the fact that the variety of pottery deposited covers almost the whole range of ware, fabric groups and shapes identified in the Makrygialos Phase II ceramic assemblage, including the unusual wares and fabrics which must be dated to the earlier Phase I.

Activity Area III

The second of the deep, large pits identified as basements was found at the top of the hill, in the excavated section B in the southern part of the settlement, where the soil erosion was dramatic. The interesting characteristic that this pit exhibits is the large amount of Incised II pottery compared to the proportions found in other activity areas of Phase II. Large, open pedestalled bowls with incisions that create zones covered with red and brown slip intermingle with mainly undecorated coarse storage jars. No painted pottery has been recorded within this pit.

Activity Area IV

Moving from the top of the hill further down towards the north end, in the area with the deep deposits, there is another large area with a very dense distribution of archaeological features. This can be sub-divided into smaller activity areas according to the archaeological features that have emerged.

One of these features is Pit A, a large, roughly circular and relatively shallow pit, which was surrounded by postholes. The majority of the pottery found here was undecorated and weathered, along with smaller amounts of incised I with white paste, black-topped and black-burnished bowls. The size of the coarse pottery sherds, their surface treatment, and the traces of fire, quite often found either on the external or internal surface, suggests that they functioned as cooking pots. No painted pottery was found, except very few extremely weathered, small sherds, which according to the main macroscopic fabric types could originally have been painted. The rest of this rich archaeological context consisted of large amounts of shells, animal bones, chipped stone tools, some clay figurines, seeds and ornaments made of shells. The whole picture suggested, according to the excavators, that Pit A represented a very good example of the inside of a house. Outside this area a gravel pavement was found together with an

oven situated in very close proximity, which indicateed that cooking took place outside the houses, in open yards (Besios & Pappa, 1994).

Activity Area V

At the eastern end of the excavated area of the habitation Phase II a rather interesting group of architectural features was revealed. The presence of hearths and ovens ('Kataskeues') indicated that they were originally constructed either within large and elongated shallow pits, or in open areas. In close proximity to these constructions, a complex of small, relatively shallow pits, one next to the other, were filled either with seashells or very fine clay. It seems that around these features several activities were organised, such as food preparation, cooking and/or processing of raw materials (Besios & Pappa 1994). Although considerable amounts of pottery (mainly weathered) were found in this area, alongside burnt soil and traces of fire, yet, the evidence is not strong enough to support a claim for pottery making facilities.

Activity Area VI

The so-called 'megaron'. A wall divided this building, which was 15m in length, into two main rooms. To the north, in the area of the second room, four large postholes were identified which have been interpreted as elements to support the roof. In the front room there was a large, relatively deep pit that 'followed' the internal wall of the apsidal building. This is considered to be a storage pit, not only because of the high proportion of storage vessels present, but also because of the considerable amount of flax seeds that were identified (Pappa 1997; Valamoti 1999). Although it has been suggested that the 'megaron' seems to belong to a different architectural phase (the latest sub-phase of Makrygialos Phase II according to Besios & Pappa), the pottery does not seem to exhibit the considerable morphological and decorative variability that might be expected to define these two archaeological phases.

4.3 Makrygialos Phase II: Material Culture Remains

Before proceeding to present the typology of the ceramic material under investigation, a concise account of the other major categories of material debris from Makrygialos Phase II will be given; these are remarkable for their richness and

diversity. More importantly, all classes of these remains were recovered from sealed, non-disturbed archaeological contexts. The most representative of them are introduced below.

4.3.1 Stone Tools

This assemblage consists of chipped and ground tools. The former category comprises an interesting set of material in terms not only of its quantity but also of the wide variety of raw materials used and the quite distinct modes of production that it exhibits (Skourtopoulou 1999). Thus, based upon differences in the quality and origin of the materials used, three main modes of production have been distinguished which are thought to have been followed by distinct technological traditions.

Firstly, the production of the largest part of the material has been characterised as local or regional. It mainly consists of flakes with no standard morphological characteristics. This is taken to suggest (K. Skourtopoulou, pers. comm.) that, at this level, production was restricted to the household and designed to cover everyday needs. In contrast, standardised manufacturing techniques were used to produce small or larger blades. Regional or even exotic raw materials seem to have been used for these products, whereas for the production of flakes, two varieties of quartz were predominantly used (of good and poor quality). Both materials are thought to have their geological origin in the geographical area of central Macedonia, mainly Pieria. However, the fact that this region's geology has not been extensively explored creates problems, as it leaves gaps in any attempt at identification of sources of raw materials. For the production of blades, using the pressure-flaking technique, some radiolarian jasper was also used. It is suggested that this was probably imported from Thessaly.

The presence of secondary products (e.g., waste flakes) in quite high percentages implies a second mode of production. Pre-formed raw material was exchanged and brought to Makrygialos for final finishing. In this case, the presence of a class of specialists, individuals or groups, who were able to work on the already pre-formed cores, may have been required.

The last production pattern consists of a very small proportion of blades made of different kinds of flint. What is special about this category is the fact that the raw

materials can be characterised as exotic and therefore imported from somewhere else. All the technological and morphological characteristics of this group suggest specialised production and a high level of know-how and labour investment, which in turn implies that the products were either imported from a distant centre of production or made on-site by itinerant specialists.

This multi-levelled organisation of production hints at a possible social and economic complexity that may characterise the society of the Late Neolithic period despite many traditional assumptions of a simple, self-sufficient society. This issue is of special importance when examined in comparison with production patterns of the ceramic material from Phase II (see Chapter 6).

The ground stone tools are a quite different case. Although they form two dominant categories based on levels of technical skills and know-how, both had been made of local materials available in the region. The fact that they were found deposited in different forms and stages of the operational sequence (i.e. broken during manufacture or overworked through use) attests to this. Polished axes, chisels and adzes, made mainly of serpentine and jadeite, were elaborately manufactured and belong to the first group. Of a poorer quality are the raw materials (local rocks) used for the manufacture of the second category of ground tools that consists mainly of pounders, querns, polishers, hand-grinders and whetstones (Pappa & Besios 1999b).

4.3.2 Metal Objects

Considering the lack of basic information on the production and circulation of metal artefacts during the Neolithic period, the presence of 65 copper objects, the majority of which were found within the Makrygialos Phase II deposits, is striking. This assemblage is considered to be the earliest and largest known in Greece (Besios and Pappa 1998: 26; Demoule and Perlès 1993: 394; Pappa and Besios 1999b: 188-189). It mainly consists of cylindrical beads and other metal objects such as pins, awls and a well-preserved small chisel. Mass spectrometry analysis of 21 samples suggests that their production signifies a transition from the use of local native copper sources "to the smelting of copper from its ores" (Pappa and Besios 1999b: 189).

4.3.3 Figurines

As with all the other cultural remains, figurines also represent a substantial assemblage (more than 250 have been found in total from the two architectural phases). An important element regarding these objects is their apparently equal distribution amongst different contexts across the settlement, according to preliminary study of the material (Pappa and Besios 1999a: 117, 1999b: 189-190). Of course, this picture might be altered after detailed analysis of their deposition patterns is completed. The figurines, outstanding for their stylistic diversity, are predominantly anthropomorphic, and either repeatedly accentuate different parts of the human body, or depict private occasions such as pregnancy and birth. The majority are made of clay or white marble. This latter material is associated only with the Phase II contexts. It is noteworthy that whilst the clay figurines appear to stylistically resemble analogous examples from the central and eastern Balkans the abstract, stone ones exhibit common characteristics with examples from the Thessalian tradition. Despite the large quantities of this category of material culture, however, little has been concluded about their consumption and ideological meaning, although detailed study of the assemblage has not yet been completed. Problems of interpretation apply, not only to the Makrygialos figurines but also to similar assemblages from all Neolithic sites in Greece and the Balkans (for further discussion on this issue see Gimbutas 1986; Talalay 1993).

4.3.4 Other Finds

Small finds exhibit an equally distinct variety of materials, forms and functions. Stamps are amongst the most interesting ones. Made of clay, they cover two major morphological types that correspond to the different chronological phases. The ones associated with Makrygialos Phase II are oval-shaped and comprise plastic linear motifs in different arrangements with a handle on the reverse. The excavators argue that they were only found in areas that are considered inhabited space (Pappa and Besios 1999b: 190). Stone and bone tools, along with clay objects for weaving and spinning that are found less frequently, comprise another part of the Makrygialos material cultural remains. Alongside these, there are some objects that were classified as 'exotic'; for example, small, shallow containers made of marble and pieces of jewellery that exhibit an outstanding degree of technical and stylistic investment.

4.3.5 Subsistence

Animal exploitation: The faunal assemblage from the site is rich and diverse. The majority of the remains consist of domesticated species: pig and sheep commonly occur alongside goats and cattle, whose presence is less frequent, whilst the fish and bird bone sample is substantially smaller. The striking element here is the occurrence of wild mammal remains. These were only associated with the Phase II deposits. Red and roe deer, boar, wolf, fox and hare were amongst the commonest species found (Collins and Halstead 1999: 139). Their presence in archaeological contexts of this latest phase of the Late Neolithic may be significant when associated with evidence of increased employment of hunting strategies. The combination of these two elements (wild mammal remains and increased evidence of hunting) might offer some insights towards the suggested idea of the gradual isolation of the Neolithic 'household' (Collins and Halstead 1999: 140; Halstead 1999b). Another interesting aspect of this assemblage is the evidence it provides for the exploitation of secondary products, e.g., meat and milk, based on the high rates of mortality for young sheep in contrast to the much older mortality pattern of cattle and goats.

Plant exploitation: The rich assemblage is the most representative example of plant exploitation in terms of quantity and diversity for the Neolithic of Greece. Cereals, and fruit, with smaller quantities of pulses, are the species most widely represented. They include einkorn, emmer, free-threshing wheat and barley, lentils and peas, as well as flax, fig, and blackberry (Valamoti 1999: 136). Yet, due to their deposition or preservation, only three of the existing species (lentils, flax and terebinth) can be securely considered as gathered and systematically cultivated by the Makrygialos inhabitants (Valamoti 1999: 137). The importance of the study of this material lies in its potential to shed some light on the agricultural practices and land use that were employed. This aim becomes crucial considering the fact that Makrygialos, as a flat-extended settlement, represents an, until relatively recently, unknown type of site. Of course, such an attempt will have to involve not only detailed contextual analysis of the plant remains themselves, but also interpretation alongside the faunal remains assemblage. It is important to note, however, that preliminary study of both the animal and plant remains does not apparently suggest that the character of the Makrygialos settlement was seasonal (Collins and Halstead 1999: 139; Valamoti 1999).

4.3.6 Burial

Before the discovery of Makrygialos, evidence from well-recorded Neolithic human remains and burial practices, especially from northern Greece, was fragmentary. Within Makrygialos, there are some obvious differences in the deposition of skeletal remains between the two chronological phases. In Phase II in particular, with the unique exception of a child's cremation in a small urn, all the human bones and cranial remains (about 11 individuals in total) were found disarticulated and scattered in rubbish pits, mainly at the north-west end of the site with the deep deposits. It has been suggested, however, that the primary burials of this phase may not yet have been discovered (Triantaphyllou 1999: 130-131). In addition, some ten articulated burials, inside pits, were found in very close proximity to the Phase II settlement, and were originally thought to be Late Neolithic. Further analysis, however, suggests a later date, i.e. Early Bronze Age. Unfortunately, due to the fragmentary evidence of the Phase II remains, very little can be inferred from a palaeopathological point of view.

4.4 The Pottery from Phase II

4.4.1 Typological Classification and the Makrygialos Ceramic Assemblage

As mentioned in Chapter 3, scholars initially used biological species as prototypes to similarly classify archaeological 'types' of artefacts. It has subsequently been argued that the term 'typology' should be used to define a "theoretically oriented" classification that is set up in order to solve certain research problems (e.g., Dunnell 1971; Hill and Evans 1972; Rice 1987: 283). Typological categories, according to Barrett (1991: 204), are in a way technical inventions created by humans in order to "sustain an understanding of how the world operates". He continues:

> "We cannot assume that because we, as archaeologists, are able to create classes of material out of the corpus of material residues which are available to us, that these classes were in the same way 'real' to those who once engaged in those other social strategies which created that corpus of material (Barrett 1991: 204).

Barrett's important point was taken into account in forming and interpreting the typology of the present ceramic material. The following categories of pottery are, indeed, only analytical tools that were created to ease the process of macroscopic

examination, rather than 'real' entities meaningful to the producers of this particular category of cultural remains.

One should remember that every typological scheme, with its advantages and limitations, can only be used as an effective interpretative tool by the researcher who designed it and who keeps in mind the specific archaeological questions which s/he wishes to address (Kotsakis 1983). Thus every new typological scheme, even if it partly incorporates existing ones, must be orientated towards particular questions that the researchers, who are currently studying the material ask. Of course, there are some basic requirements needed to validate such a process. Firstly, any typology should be verifiable and replicable (Rice 1987a; Sinopoli 1991), such that any archaeologist approaching the material will be able to recognise the same types by looking at the main, visible characteristics of each type. In addition, the typological model should be structured in a way that makes it suitable for basic statistical treatment. If the variables and typological characteristics identified in a ceramic assemblage show some sort of correlation, they may reveal meaningful patterns for interpretation. It is also useful for the classification to be open, so that every time there is a need, new material can be added and fitted into the already existing categories. In choosing the appropriate typology, one should seriously consider the fact that most of the time archaeologists do not deal with whole pots but with hundreds of thousands of sherds. With these considerations in mind the following section describes the pottery typology that has been developed and used in this thesis. This typology will be later examined in conjunction with the results of the macro- and microscopic analysis in the general discussion chapter (Chapter 7).

4.4.2 Typology of the Makrygialos Phase II Pottery

The present research investigates the ceramic assemblage of Phase II, which is outstanding for its size (estimated quantity is about 18 tonnes) and diversity. The importance of the material becomes even greater due to its morphological similarities with the well-known 'Classical Dimini' pottery, which comes from one of the most important settlements of the later Late Neolithic in Thessaly. The definition of Dimini pottery led to the naming and classification of a whole ceramic category and a chronological phase. Its special character lies also in its limited distribution – in Thessaly, for example, it mainly appears in the eastern plain – and the fact that, when

present in settlements outside this area it is always represented by minimal quantities. Furthermore, the rare finds of 'Dimini-style' pottery outside the area where it is supposed to have been produced have until recently been interpreted as local imitations, appearing as a result of the diffusion of ideas and/or the sharing of common traditions (Aslanis 1997). Alternatively, its presence outside Thessaly was assumed to have been the result of a possible, wider exchange network, but the implications of this were never explored.

Whilst in Macedonia 'Classical Dimini' pottery has been discovered at very few sites and the quantity recovered is insignificant, this is not the case for Makrygialos Phase II. Although the proportion of painted pottery on the site is generally small compared to the rest of the ware categories, the number of vessels represented is very high when considered alongside other known sites. The other wares, on the other hand, stand out not only for their large quantities but also for the variety of surface treatment, decoration and clay pastes. What follows is the first presentation of the pottery typology of Makrygialos phase II, based on the macroscopic examination of the ceramic material.

4.4.2.1 Brown-on-Cream (I) Ware

This category was initially identified and named by Tsountas (1908) and Wace and Thompson (1912) in Thessaly. The term 'brown-on-cream' ware has continued to be used since, it best describes the ware, although it has also been known as 'dark-on-light' or 'chocolate-on-cream'. In this study, the term 'brown-on-cream' has been retained.

Surface treatment: within the Makrygialos pottery brown-on-cream ware consists of the following characteristics: the decorative motifs are predominantly formed by brown (5YR 3/2-3/3 dark reddish brown) to dark brown pigments (5YR 2.5/2 dark reddish brown) on a light creamy surface (10YR 8/3-8/4 very pale brown) (*pl.* 4.1). The decoration is usually applied directly onto the natural clay body, although a slip layer intervening between the decoration and the clay body is occasionally used to give the desired contrast when the natural clay body is slightly darker (5YR 7/6 reddish yellow). A small proportion of this ware exhibits a colour variation (7.5YR 8/6-7/6 reddish yellow). The surface is always evenly and carefully burnished and quite often

very well burnished. All the vessels are painted inside and out. The way the surface of each pot is divided symmetrically into distinct areas surrounded by clear boundaries (made up of vertical lines) and the way the decorative motifs are arranged within these boundaries is highly elaborate. Amongst the most common motifs are meanders, created by groups of thin parallel lines demarcated by thicker ones and aligned either vertically or diagonally to the vessel walls, or a combination of meanders with spirals. The latter are depicted either with solid lines or by using the well-known 'hatching' motif. The 'chessboard' motif is also commonly used either plain, in combination with groups of parallel lines cutting it obliquely and/or sometimes along with spirals (*pl.* 4.2). Alternatively, rhomboid motifs are used, or combinations of 'step-patterns', kept apart from spirals by groups of thin parallel lines. No colour differentiation between the core and the margins of the vessels has been observed.

Shapes: Brown-on-cream ware is associated with a very restricted number of shapes:

Bowls: open, conical and shallow (rarely deep) with flat bases and rims that thicken and 'turn' slightly inside. This is the typical shape in the 'Classical Dimini' style and it means that it is the most common pottery type in settlements of this period. In Makrygialos, bowls predominate within this ware group (*fig.* 4.6). Most of the time they appear with two or four (a pair on each side) appendages or projecting knobs, just below the rim, and with 'string holes' (Wace and Thompson 1912). It is significant that 'repair holes' quite often appear along old breaks (*pl.* 4.3). Their presence has been associated with the value ascribed to the objects themselves, which meant that when they broke they were not replaced by new ones but were repaired.

Other shapes identified within this ware are *'fruitstands'* and *small kalathoi*, the latter having a basket-like handle by which the pot can be held (see *fig.* 4.7). The representation of these shapes within the brown-on-cream category is restricted, being limited to a few sherds that do not offer much help for adequate reconstruction. They are probably similar to the ones known from the Dimini ceramic assemblage.

Comment: very similar to the brown-on-cream ware, in terms of shape, decorative motifs and manufacturing techniques, is a small category named 'brown-on-buff' according to the macroscopic classification (*pl.* 4.4). Apart from the fact that the vessel surface is only smoothed and never burnished (which sometimes gives the

impression of a matt-painted synthesis), with a soapy-like feel, the difference from the typical brown-on-cream here lies in the fabric attributes.

4.4.2.2 Black-on-Red Ware

This category has also been known since the pottery classifications based on the Thessalian material at the beginning of the 20th century.

Surface treatment: within the Makrygialos Phase II pottery the black-on-red ware is macroscopically defined in the following way: decorative motifs are expressed rarely in black and more often in dark brown pigment on a red/brownish orange background. The majority of this category have clay bodies that are not really red (as in some examples from Thessaly). Instead, their body generally appears to be 2.5YR 5/8-4/8 red. In order to decorate on a red background, ancient potters applied a slip (10R 5/8-4/8 red) that intervenes between the clay body and the decoration. In this ware the colour differentiation between the margins and the core is striking (2.5YR N4/dark grey). The vessel walls are much thinner than those of the brown-on-cream ware. The decorative motifs do not appear to be as sophisticated nor as varied and dense as those of the brown-on-cream ware, although some of them do look similar. Instead, they mainly consist of linear patterns in different combinations (*pl.* 4.5), spirals filled in with a 'net-like' type of decoration or a combination of these two (*figs.* 4.8-4.9). These patterns are also arranged within the boundaries of areas demarcated by lines vertical to the vessel walls. Here again the arrangement of decorative motifs is symmetrical as in the brown-on-cream examples. There are some noticeable differences, however, regarding the technical competence in the manufacture of the two wares, e.g., in the quality of surface treatment and the application of painted decoration. In the case of the 'black-on-red' most of the time slip and/or pigments were peeled off.

Shapes: if the black-on-red category is known for more restricted decorative motifs this is not the case for the shapes associated with it. Those most commonly represented are the *conical bowls*, which have flat bases and one to three single or double projections just below the rim, with or without 'string holes'. They are very similar to the examples in the brown-on-cream ware but have thinner walls. These bowls can either be shallow (*pl.* 4.6) or very deep with projecting handles starting just below the rim; the handles' section is usually rounded to sub-rounded (*pl.* 4.7). Another

shape, closely associated with this ware group, is that of the *'fruitstands'*. These are basically very shallow, open bowls, usually with a four-pointed rim and a long conical stem, which are well known in Thessaly. The quality of the surface treatment and its medium to coarse fabric appear rather poor compared to the Thessalian examples.

Along with bowls and 'fruitstands', small- and medium-sized jugs are also represented within this ceramic category. Unfortunately, there are few diagnostic sherds to help reconstruct their shape, but the way the internal surface of some sherds with black-on-red decoration was treated confirms that they were closed vessels. Even when these sherds are highly weathered, they can still provide valuable information. Generally, such vessels bear a single handle that is formed from strips of clay and with an oval to sub-rounded section.

Comment: in-between the categories brown-on-cream and black-on-red there is another group of pottery which combines morphological characteristics taken from the former ware and compositional ones taken from the latter. For that reason, this ware was given the name 'brown-on-cream II' during the macroscopic examination. The shapes and forms in this ware are exactly the same as those in brown-on-cream I, and the decorative motifs are identical, with a few exceptions (*pl.* 4.8). Differences in the two wares lie in their surface appearance, treatment and the colour of the clay body. The colour of the pigment used for the decoration is brown and is applied onto a brown to greyish brown background, which sometimes gives the impression of matt-painted pottery (see *pl.* 4.14). Surfaces are predominantly smoothed and are only rarely burnished. Although the colours are different from those in brown-on-cream I, they are also distinct in comparison with those in black-on-red ware. In addition, the appearance of the fabric is more identical to the macroscopic Fabric II, associated with the black-on-red ware. The core, the colour of which is light grey, covers nearly 90% of the 'biscuit' and the remainder at the margins has a colour similar to the actual clay body. The number and size of the voids increase dramatically which may imply a different (reduced?) level of technical skill with regard to the manufacturing and firing techniques used to produce these vessels.

4.4.2.3 Polychrome Ware

The representation of this ware group within the whole assemblage is very limited and fragmentary, and even the preserved sherds are often small and very weathered.

Surface treatment: the decoration mainly consists of linear motifs and/or bands and zones created by the application of different colour slips, mostly combining two colours. One of these ranges between 5YR 6/8 reddish brown-5/8 yellowish red and 2.5YR 5/8-4/8 red, while the second one (the background) ranges from 7.5YR 7/4 pink-6/4 light brown to 5YR 6/3-6/4 light reddish brown. The impression of a third colour is given by the use of lines, made of dark brown/black pigment (primarily 5YR 3/2-3/3, dark reddish brown), as boundaries to demarcate the zones. These zones are most commonly orange, reddish/yellowish brown or red, on a brown or creamy brown background with dark brown defining lines between them (*pl.* 4.9). Some of the most typical examples are shown in *plate* 4.10. Most of these are morphologically very similar to examples from Dimini. At the same time, it is very possible that there may exist in this category the products of more than one location of production, not only due to differences in surface treatment (often their surface is only smoothed and rarely burnished as is the case with the typical polychrome), but also due to the different raw materials and firing techniques used.

Shapes: unfortunately, the number of diagnostic sherds within this ware group is very limited and represents a small percentage of the whole vessel (a general problem with most ware groups). Therefore, the reconstructions are not really secure and mainly depend upon previous knowledge of the Thessalian material. Based on the available information, the commonest shape is the *'fruitstand'*, an open, shallow bowl, usually ending in a four-pointed rim and with projections just below these four points (see *fig.* 4.10). This type of bowl stands on a tall conical stem. It is more usual to find parts of these stems rather than fragments of the rim.

4.4.2.4 Incised I Ware

This category is well known from Thessaly where its shapes, decorative motifs and surface treatment are exactly the same.

Surface treatment: the main decorative motifs here are created and defined by incisions arranged in different combinations of linear, zig-zag, spiral and 'antenna-like' motifs (*fig.* 4.11). Very often, the incisions contain a white or pinkish filling, where it is preserved (*pl.* 4.11). The clay body is generally dark grey, greyish brown or black. When the surface of these vessels is not very weathered, signs of burnishing are visible. All these are more close to the Thessalian than the Balkan tradition.

Shape: within the Makrygialos assemblage, one of the commonest shapes is the small, closed amphora-like vessel with vertical, strip-like handles, a flat base and a neck that narrows upwards.

Comment: as discussed in Chapter 3, Hourmouziadis relates the Incised category of pottery within the Dimini assemblage with specialised production on the basis of the standardisation observed in the decorative motifs, in the forms, size and shape of the vessels (for more detailed information on this ware, see Hourmouziadis 1978: 213-222). The examples from Dimini appear to have been much larger compared to the ones from Makrygialos. Samples of this category of pottery were taken from both sites (Makrygialos and Dimini) for petrographic analysis. In chapter 6, where the results of the petrographic analysis are presented, it will be shown whether such morphological differences also correspond to compositional differences and whether they imply production in different locations. Also, Hourmouziadis' idea regarding the Dimini Incised pottery will be examined in relation to the equivalent category in Makrygialos.

Within the same ware from Makrygialos there is a distinct group of incised vessels which have morphological and stylistic characteristics that refer to the Balkan tradition. Their fabric is coarser than that previously mentioned and their clay seems to be 'local'. There are also differences in their surface treatment as most of them are rough to smooth and are only occasionally burnished or, even more rarely, slipped with reddish or brown slips. Their functional character also seems to differ; whilst the fine, amphora-like category described above (*pl.* 4.11) consists of predominantly small, thin-walled vessels, pots in the latter category are larger, with much thicker walls, rough surfaces, and vertical or horizontal handles (*pls.* 4.12-4.13). All of these features indicate use of the second category in 'household' activities.

4.4.2.5 Incised II Ware

Surface treatment: this is classed as a separate category as the vessels it refers to are very distinct from the rest of the incised ware, in terms of both decoration and surface treatment. The element that characterises this type is the presence of wide zones created by the incisions themselves and covered, when the pottery is not weathered, with brown, red and occasionally black slips (*pl.* 4.14). Incisions are normally filled with white material. The surface of the non-weathered pottery is not only slipped but also well burnished. There is more than one fabric closely associated with this ware.

Shapes: the shape that predominates in this ware is *pedestalled, fenestrated bowls*. These are basically open, shallow conical bowls. Their rim ends in probably two (or possibly four) projections facing upwards which look like bird's beaks. They stand on long, conical, fenestrated stems (*pl.* 4.15 and *fig.* 4.12). Exactly below these points there is usually a pair of holes, which were perhaps used to hang the vessel, from a wall for instance. In some cases, the bowls are not conical but slightly carinated (*fig.* 4.13) with plain appendages and 'repair holes'. These might be related not to the typical pedestal vessels but to ones with a shorter 'foot'. Another rather interesting shape related to this ware is a small, shallow bowl with a rounded base (shown in *pl.* 4.16). This is preserved in very good condition, which is why the white filling in the incisions and the slipped and very well burnished surface can be clearly seen. It is noteworthy to mention that traces of burnt material were preserved inside this pot. Such evidence should perhaps be considered alongside the fact that the Incised II ware appears exclusively in the deep 'basement' on the summit of the hill.

4.4.2.6 Black-topped Ware

Surface treatment: the name of this ware is self-descriptive. The upper half of the vessel is black and, when it is not weathered, is very well burnished. The lower half is either just smoothed or burnished on the natural clay body. Alternatively, a brownish red or brown slip was applied (*pl.* 4.17). Bowls that do not exhibit sharp profiles usually carry impressed decoration on their top half. This consists of small dots or triangles in groups of double parallel or zig-zag lines (*pl.* 4.18). These impressions were probably filled with white material. The largest bowls of this ware group, with a diameter up to 30cm, maintain a 'soft' carina (*fig.* 4.14). Their walls are much thicker,

their fabric coarser, and their burnished and slipped surfaces are much better preserved than those of the small vessels.

Shapes: *small* and *large bowls* are the only shapes associated with this ware. The small bowls are quite sharply carinated and retain either an appendage with 'string holes' on the level of the carination (*fig.* 4.15) or just plain projections. Quite often 'repair holes', similar to those found in brown-on-cream and black-on-red vessels, are also observed. The latter observation could imply that they were 'valuable' objects. Apart from appendages, these vessels come with proper handles, usually vertical, starting from the level of the rim and having a nearly rounded section. Lastly, shapes such as open bowls with straight, nearly vertical profiles, jugs with flaring rims (*fig.* 4.16) or hole-mouthed pots appear less commonly within this ware.

Comment: within this broad category, there is a type of vessel which is special because of its rare occurrence. Although it belongs to the black-topped ware, could also be grouped independently due to its different shape and decoration. The upper half of the pot is typically black, with traces of burnishing, and with a double line of triangle-like impressions just above the line where the carina starts. Below this level, the body is decorated with orange or reddish brown slip that creates zig-zag zones. In-between these zones the natural clay body is visible and it seems that it may have had another slip which has probably peeled off. This could well have been white (*pl.* 4.19). The walls of this shape are very thin and its base is flat. What is even more special about this small sub-category is the fact that it exhibits painted, spiral decoration on its inner surface, just below the rim (*pl.* 4.20). Despite the morphological differences, the fabric in this ware appears very similar to the rest of the black-topped vessels.

4.4.2.7 Black Burnished Ware

In general, the morphological characteristics of this group are very similar to those of the previous ware. One difference lies in some of the profiles of these vessels, which have become 'softer' (*fig.* 4.17). Their walls are also thicker and the fabric occasionally appears coarser. In addition, there are larger pots incorporated into this ware group which may suggest that their functional character is more closely related to 'household' activities, for example storage or cooking (*pl.* 4.21). Probably, there is an overlap between the black-topped and black burnished wares. Some of the sherds

counted as black-burnished may belong to the black-topped ware; for instance, *plate* 4.19 shows a black burnished and a black-topped ware when seen separately, but one ware (black-topped) when put together.

4.4.2.8 Brown/greyish Brown Burnished Ware

Surface treatment: due to the soil erosion in most parts of the Phase II settlement, a high percentage of the pottery is very weathered. As a result, it is often extremely difficult to determine whether vessels are undecorated or brown/greyish brown burnished. In addition, the shapes, forms, and sometimes the fabrics involved are the same in both ware groups. Surface treatment of the brown burnished ware involves only burnishing, probably with pebbles, a wooden stick or leather (*pl.* 4.22). Due to burnishing, the colour of the surface sometimes gives the impression of being slightly darker or, when the process has been successfully completed, appears more like a slip. Generally, the colour of the clay body and the surface varies between 7.5YR 5/2-5/4 brown and 2.5YR 5/4 reddish brown to 5/6 red. Vessels, the size of which increase dramatically during this period, are both open and closed. In the former case, the inside surface is most often smoothed and rarely burnished, whereas in the latter the same surface is undecorated and quite rough.

Shapes: the shapes associated with the ware described above cover a relatively wide range in terms of size, type and function. Starting with the smaller pots, *plate* 4.23 shows a very shallow, open dish, very rarely found, with a slightly in-turning rim. The form suggests tableware, although the burnt part should be considered to be the result of an accident rather than associated with the use of the pot. Shapes which are predominantly present in this ware are of a relatively small (*fig.* 4.18) and medium (*fig.* 4.19) to large size (*fig.* 4.20). Probably used for storage or even cooking purposes, with flat bases (*fig.* 4.21) and vertical handles, they have either a sub-rounded section on the level of the 'belly' (*pl.* 4.22) or are strap-like, starting from the rim and going down to where the 'belly' begins (*pl.* 4.24). Sometimes the vessel bases are not flat but stand on a 'ring' or a relatively high 'foot' (*fig.* 4.22).

4.4.2.9 Undecorated Ware

Surface treatment: as can be seen in Appendix A, the undecorated and the brown/greyish brown burnished wares represent the vast majority of the whole ceramic assemblage of Phase II. The surface of these vessels appears untreated or perhaps occasionally smoothed but one should not forget to take into account the degree of erosion attested to in this particular part of the settlement, which might have affected the present picture (*pl.* 4.25).

Shapes: the range of shapes along with the technological and morphological characteristics assigned to this ware appear much wider compared to those of the same ware in earlier periods. The size of most vessels is large (rim diameter ranges from 22cm and up to 30cm), which implies their possible use for storage (*figs.* 4.23-4.26). Large, open and deep bowls co-exist with closed ones, along with *pithoi* of different size. The variety in the types of bases represented is quite remarkable. They range from plain flat ones (*fig.* 4.27) to ones with a low disc or ring. Vessels standing on a relatively high 'foot' are also present (*fig.* 4.28). Lastly, handles appear more frequently during this phase and are represented by a variety of types ranging from knobs (*fig.* 4.29) to mainly vertical and horizontal large handles with sub-rounded, rounded and strap-like sections (*fig.* 4.30). Miniature vessels are also present in the phethora of shapes along with relatively rare small cups with either flat or 'foot-like' bases.

4.4.3 Rare and Unusual Wares

These wares represent an insignificant percentage of the Makrygialos ceramic assemblage, are associated with 'odd' fabrics and they were found concentrated in a particular activity area: Pit 24 (see *fig.* 4.5), the main 'basement' in Activity Area II (see section 4.2.4). They are briefly introduced in the following section.

4.4.3.1 Black Painted and/or Rippled Ware

Only a few sherds represent this ware group. Their black surface is very well burnished, creating linear patterns when painted decoration is also applied (*pl.* 4.26). Alternatively, a rippled pattern creates a spiral that gives the impression of a shallow

grooved surface (*pl.* 4.27). The shapes associated with this ceramic category are either small, open bowls or small, closed vessels with a relatively high neck.

4.4.3.2 Red-on-Red Painted Ware

This very rare category consists of only a couple of sherds. The matt, dark red spiral decoration is applied onto a red background that is hardly smoothed in both internal and external surfaces (*pl.* 4.28). The high percentage of white mica in the inner and outer surfaces creates a silvery, shiny impression. The vessel wall is very thin and the lack of any diagnostic features makes it difficult to comment on its possible shape.

4.4.3.3 Red-on-Orange Painted Ware

Red-painted linear decoration, which creates a triangle, is directly applied to the smoothed, orange natural clay body (*pl.* 4.29). Here again, the shape of the vessel cannot be identified as the sherd is not diagnostic.

4.4.3.4 Red-on-Brown Painted Ware

This rare form preserves faint traces of red-painted parallel, vertical lines that start from a flat rim and run down towards the 'belly' of the vessel, both on the inner and outer surface. The decoration is applied on the smoothed, light brown, natural clay body. A distinct feature of this relatively large, open vessel is a spout just below the rim (*pl.* 4.30).

4.4.3.5 White-on-Black Painted Ware

The single, non-diagnostic sherd of this ware is decorated with an off-white pigment on a black, well burnished clay body (*pl.* 4.31). The clay is fine and the vessel wall rather thin, which probably points to a small vessel.

4.4.3.6 Brown-on-Brown Painted Ware

The surface treatment and overall aesthetic impression of this fragment resemble, to some extent, the brown-on-cream II category even though the motifs used

are dissimilar. The matt painted, abstract decoration consists of dark brown and brown zones applied to a light/chocolate brown background (*pl.* 4.32). The vessel wall is also far thicker than that of the brown-on-cream II and the composition of their fabric is distinctly different.

4.4.3.7 Impressed Ware

Only a few sherds represent the impressed ware. Their surface is predominantly undecorated and the impressions are created by thumb pressure, generally just below the rim (*pl.* 4.33). This ware is mainly associated with utilitarian vessels and a coarse fabric.

4.4.3.8 Plastic Decoration Ware

This ware also occurs very rarely. The decoration is usually below the rim and imitates a thick rope decorated with impressions. The fabric of this ware is usually medium to fine and its surface treatment can be from smooth to burnished.

4.4.3.9 Black, Red and Brown Slipped and Burnished Wares

These three categories also appear very rarely. Due to soil erosion their weathered surfaces offer very limited information on both the surface treatment and shapes of the vessels associated with them. Whenever they occur they also exhibit burnishing but one should remember that they may be fragments of a different ware group, e.g. the lower part of a black-topped or incised II vessel that does not preserve the incisions between the slipped zones (see sections 4.4.2.5 and 4.4.2.6). Generally speaking, the most common shapes related to these wares must have been relatively large vessels.

4.5 Comparative sites

One of the main aims of this research project is the examination of any inter-site circulation of pottery over a long distance, along with the study of the intra-site production technology of the ceramic material. For this purpose it was necessary to analyse pottery from sites contemporary with the Makrygialos Phase II settlement be

analysed for comparative purposes. The sites chosen are the Late Neolithic settlements of Dimini, in Thessaly, along with Agrosykia A and Giannitsa B in western Macedonia (*fig.* 4.31). Dimini was chosen for three main reasons:

- it is the best investigated and the best preserved Late Neolithic settlement in Thessaly;
- it has provided the largest, in terms of quantity and variety, assemblage of 'Dimini' painted pottery, after which the respective chronological phase was named after;
- it has been assumed to be the main centre of production of the homonymous painted ware groups.

The other two comparative sites were chosen because:

- they are amongst the few sites that have provided examples of 'Dimini' pottery, albeit significantly limited ones, and
- because they are located in western Macedonia, a different geographical area to Dimini (Thessaly) and Makrygialos (central Macedonia).

Even though there are known examples from a few other sites in the same region, most of these sites have not been systematically excavated but are survey finds. In addition, Agrosykia A and Giannitsa B represent two different site types, lying in close proximity to each other. The former is a small (estimated 1,3 ha) settlement situated on a high hill whilst the latter is a flat-extended settlement with an estimated size of 10 ha . A brief account of these sites, their settings and pottery is presented below.

4.5.1 Thessaly

4.5.1.1 Dimini and its material culture

Intra-site spatial organisation

Dimini lies on a low hill, 25m above sea level, on an outcrop of schists on the western edge of the coastal plain of Volos. Its size does not exceed 30 stremmas. The first extensive clearing of the site took place at the beginning of the 20th century (Tsountas 1908). This was followed by a detailed re-examination at the end of the 1970s, with the research aim of evaluating and defining economic specialisation. This

was attempted through the study of architecture and the intra-site distribution of several types of material culture remains (Halstead 1992b; Hourmouziadis 1979).

The settlement was organised around a central courtyard dominated by a 'megaroid' building that consisted of three rooms. The six concentric circuit walls, made of stone, were the key architectural elements around which the site was organised (for a detailed discussion on the construction and use of these walls see Hourmouziadis 1979: 57-87; Tsountas 1908 and for a critique Aslanis 1990: 26-46).

Due to the presence of other buildings located in between these walls, Hourmouziadis (1979) argued that their purpose was to incorporate/encircle 'domestic units'. According to his interpretation, such an organisation of space resulted in the creation of four main 'domestic wards' each organised around a large building that was surrounded by smaller areas related to storage, cooking and material processing facilities. Access between these areas and from the centre to the periphery was ensured by radiating entrances (Andreou *et al.* 1996: 543; Halstead 1992b: 30; Hourmouziadis 1979).

Throughout his investigation Hourmouziadis stressed the equal distribution of most categories of material culture across the site, especially those of food refuse and tool discard (Halstead 1992b; Hourmouziadis 1979). Halstead's work on the faunal remains from Dimini was aimed at the investigation of patterns of food production and consumption. It essentially strengthened the previous researcher's view as no significant variation in food refuse patterns was observed between the different domestic areas. That in turn was interpreted as an indication of equal access to production although Halstead noticed that certain domestic units had consumed not different kinds of animal species but rather larger quantities of meat (Andreou *et al* 1996; Halstead 1992b). This evidence perhaps should be examined along with the (surprising for this period) fact that cooking facilities were not placed in open spaces between the houses but rather indoors or in yards with no access from the outside (Andreou *et al* 1996; Halstead 1992b).

On the other hand, Tsuneki (1989) argued in favour of specialised production related to restricted categories of materials, i.e. *Spondylus*-shell ornaments (Halstead has recently challenged this idea in relation to the former (1993)), and Incised pottery

(Hourmouziadis 1978), within the Dimini settlement. In the latter case, although Hourmouziadis implied economic specialisation, he concluded that the role of such specialists within this society could not have affected its economic structures, as the potters would have been powerless dependents, controlled by the community (1978: 225).

Hourmouziadis' developed his argument on the basis of the traditionally held assumption of a self-sufficient Neolithic society within which each 'domestic unit' produced to cover its needs and to secure autonomy (see Chapter 2). Besides, his interpretation of the perimetric stone walls around Dimini as non-defensive 'intra-site boundaries' for the optimal use and organisation of space was closely linked with the above theory. In contrast, the idea of a Late Neolithic community that has to build defensive walls to protect its 'acropolis', where a 'megoron' is located around a central courtyard, thought to refer to a hierarchically ordered society, and so does not fit with the traditional model of a Neolithic economy which produces for 'domestic' purposes. The traditional interpretation, however, does not recognise that any kind of demarcation of space or enclosure could, indeed, imply restricted access to some social groups, either physically or symbolically (Andreou *et al* 1996: 543; Halstead 1992b; Hourmouziadis 1978; 1979).

Pottery

The first presentation of the typological sequence of the pottery from Dimini took place as early as the beginning of the 20th century (Tsountas 1908; Wace and Thompson 1912). It was further established during German excavations in the area (for a detailed account see Alram-Stern 1996; Hauptmann 1981; Milojcic 1960; Theocharis 1973; Weisshaar 1989). According to these pottery classifications, the Late Neolithic in Thessaly is sub-divided into the 'Pre-Dimini', or 'Tsangli-Larissa' (*c.* 5300-4800 BC), and the 'Arapi' and 'Classical Dimini' (*c.* 4800-4500 BC) sub-phases. This thesis in concerned with the second sub-phase as it exhibits morphological parallels with similar pottery found mainly in Makrygialos Phase II and, to a lesser extent, in Agrosykia A and Giannitsa B. Black-on-red, white-on-red, polychrome and matt-painted are amongst the wares assigned to the so-called 'Arapi' sub-phase, although often the same wares are classified into the preceding sub-phase. Yet, only the 'Agia Sofia', 'Otzaki' and 'Classical Dimini' categories are considered the main 'Dimini' phase pottery. Here,

the most commonly-occurring motifs are spirals, meanders, chessboard-like motifs, parallel and zig-zag lines (either filled or hatched) or vertical zones. The latest, 'Classical Dimini' sub-phase is associated with painted and incised wares (see Hourmouziadis 1978). The brown-on-cream, black-on-red and incised I present in the Makrygialos II assemblage exhibit great similarities with those of the aforementioned 'Classical Dimini' phase. It has been repeatedly pointed out that the artistic excellence and technological skill of these particular classes of pottery within the Dimini material is of a very high level. The similarities between the Dimini and Makrygialos materials also extend to cover vessel shape. In both sites open, conical bowls, shallow and less often deep vessels with flat bases, and also 'fruitstands' are associated with the painted wares. On the other hand, smaller closed vessels with globular bodies, vertical handles and necks that narrow upwards are largely linked with incised pottery. It should be noted that in Thessaly these wares are thought to have strictly circulated within the eastern Thessalian plain. This point will be discussed extensively in Chapter 6, where the results of the petrographic analysis will be presented and interpreted.

4.5.2 Western Macedonia

Based essentially on surface survey, 40 Neolithic settlements have been traced in this particular area and comprise what appears to have been a densely populated environment. The site types represented are a combination of tells and, predominantly, extended settlements on plateaus and the slopes of low hills (the latter ones mainly date to the LN and FN). They have been sub-divided into three to six main groups based on their size, location and pottery categories: Agrosykia A is an example of a small site whilst Giannitsa B is estimated to be one of the largest (Aslanis 1997: 87; Chrysostomou 1997a: 159; Chrysostomou and Chrysostomou 1993: 173-4). Both Agrosykia A and Giannitsa B, lying in close proximity with each other, are located on the fertile plain of western Macedonia, whose main relief consists of three components: mount Paiko to the North, hill-land and the alluvial plain (Bintliff 1976: 242; Chrysostomou 1992: 119).

4.5.2.1 Agrosykia A and its Pottery

Location

The site, situated on a 20m high hill, lies to the north-west of the modern village and represents, according to researchers, a 'fortified' Neolithic settlement (Aslanis 1997; Chrysostomou and Chrysostomou 1993). Its occupation length stretches from the early Late Neolithic (the so-called 'pre-Dimini' phase) to the early Byzantine period without any stratigraphic disruption.

Pottery

Generally speaking, before the discovery of Makrygialos, 'Dimini' wares were only found at a very few sites, and were usually represented by a handful of small, non-diagnostic sherds. Giannitsa B is one of these sites; Agrosykia, on the other hand, despite its smaller size, provides a relatively larger amount of 'Classical Dimini' material. Black-topped and monochrome pottery characterise the earlier Late Neolithic phase of Agrosykia. This picture changes towards the end of the period when painted and incised wares, apparently similar to the 'Classical Dimini' style, appear although in minimal quantities. It has been suggested that the presence of brown-on-cream, black-on-red and polychrome wares, in particular, signifies imports from Thessaly. As a result, economic relationships are assumed to have taken place between western Macedonia and areas immediately to the South (Aslanis 1997: 83).

The painted wares have conventionally been classified into the so-called 'high quality' pottery, supposedly imported, as opposed to the 'lower quality', locally produced vessels. This division has been made on the grounds of observed differences in surface treatment and application of decoration. In-between these groups is a third, referred to as 'medium quality' and named "non-typical Dimini type", which is considered local (Aslanis 1997: 86). Morphologically, this ware does not bear the usual decorative motifs of the 'Classical Dimini' pottery but linear and wavy motifs instead.

The stratigraphic evidence shows that the largest quantity of the best-preserved painted pottery accumulated in the earlier habitation layers at Agrosykia, and co-existed with an insignificant amount of 'locally produced' pottery. This picture is gradually reversed towards the end of the LN and the beginning of the FN, when there is a

substantial amount of 'locally produced' painted wares and a minimal quantity of 'imported Dimini' pottery that eventually disappears. Aslanis (1997: 84) argues that this possibly indicates imports during the later Late Neolithic and production of imitations of the 'originals' towards the end of the period (which he calls the Chalcolithic). He further points out that most of the sites where 'Dimini' pottery has been found are near the coast of the Thermaikos Gulf, e.g. Makrygialos, Agrosykia A, Giannitsa B, Paliambela and Archontiko. In contrast, the same pottery is almost absent from the majority of the contemporary known Neolithic settlements, especially the ones located further west, e.g. in the Grevena, Kozani and Florina areas of western Macedonia (1997: 85). Aslanis, however, repeatedly admits throughout his analysis that all these suggestions are at the level of speculation since there is still a lack of sufficient data and, more importantly, no analytical work to test his hypotheses (1997: 86, 87, 88, 89).

Despite these serious limitations, Aslanis further advocates a regional settlement hierarchy according to which small satellites/sites evolve around a large, powerful one. He suggests that it is largely the main sites that must have acquired and consumed the imported wares without influencing the parallel development of the local pottery production system. In conclusion, he proposes that local, wealthy élites were responsible for the circulation and consumption of the assumed 'imported Dimini' wares due to their economic power and the acquisition of advanced technological knowledge. Unfortunately, as he admits, there is not yet sufficient evidence to prove the aforementioned ideas. In the relevant sections of Chapter 6 of this thesis, the petrographic evidence provided from the analysed sites will be assessed alongside the aforementioned assumptions.

4.5.2.2 Giannitsa B and its Pottery

Location

This site incorporates two main chronological phases, the Early Neolithic and the Late Neolithic. Both phases are established by secure stratigraphic evidence, pottery and other categories of material remains. The Late Neolithic deposits were found in the south-east end of the modern city of Giannitsa, and seem to have spread over the slopes of a low hill. Although only a few trial trenches have been properly excavated, it is

estimated that the original site must have covered a very large area forming an extended settlement (estimated 100 stremmas). There is a fragmentary evidence for the presence of a system of double ditches that morphologically seem to resemble those found at Makrygialos.

Pottery

Amongst the wares present in the assemblage, undecorated coarse pottery predominates. This co-exists with a substantial quantity of black burnished pottery, whose surface was elaborately treated. Such ceramic type is normally abundant in pre-Dimini layers. At the same time, there are a number of painted wares such as graphite-painted, known from the east Macedonian tradition, brown-on-brown, black-on-red/orange, and very few only sherds that belong to the well-known 'Classical Dimini' brown-on-cream. According to the excavator, some of these categories try to imitate the original 'Dimini' types or some rare examples are assume to have been imported (Chrysostomou 1992: 127).

4.6 Conclusion

In this chapter, the spatial organisation of the Makrygialos Phase II settlement and the character of its cultural remains, with special emphasis on the ceramic material and its typological classification, have been established. The material evidence from the comparative, contemporary sites from which pottery samples for petrographic analysis have been taken has been sketched. What follows in Chapter 5 is the methodology employed in the present thesis.

CHAPTER 5
METHODOLOGY

5.1 Introduction

In this chapter the methodological steps that were followed throughout the analysis of the pottery from Makrygialos Phase II will be presented and justified. The methodology itself was designed to suggest answers to the archaeological questions that were outlined in Chapter 1, by applying the most appropriate analyses given the practical problems that the nature and quantity of the material itself imposed.

As discussed in Chapters 1-3, this research examines pottery as an aspect of material culture which can reveal valuable information on human groups and their role in production and consumption. As a result, it can provide insights into a past human society which identified itself and negotiated its socio-economic and ideological relationships through the products of its material culture. It is concerned with potters (male or female) who made conscious and/or unconscious decisions as part of a given social, ideological and economic environment. One possible route to follow in order to tackle these issues is by investigating two crucial aspects involved in the production of pottery: a) techniques and processes (e.g., collection and processing of raw materials, clay composition, possible sources, manufacturing techniques, firing); b) characterisation e.g., vessel forms and shapes, surface treatment and decoration. In addition, its circulation on an intra- and inter-site level can be considered. This approach was adopted in the present study.

For the study of ceramic assemblages, however, and especially where scientific analyses are to be employed, it has been widely accepted that in building up a methodological approach the researcher should move from simple to more sophisticated tools (Peacock 1977). Especially with regard to the processes followed, s/he should start working "from the bottom to the top" and not the other way around (Day 1988). Such rules are even more applicable when the assemblage under study is original and has never been studied macroscopically or analysed microscopically before, which is the case with Neolithic Makrygialos and its ceramic material.

5.2 Steps of Analysis

With the above considerations in mind, the study of the Makrygialos Phase II pottery was carried out on several different levels of analysis, as described below:

- Morphological examination of the ceramic assemblage on a macroscopic level. In addition, classification of the material into ware, fabric and shape categories in order to facilitate further analysis and observe possible associations between these variables.
- Petrographic analysis of a large number of selected representative samples, based on the detailed macroscopic examination.
- Study of the geological deposits from the Makrygialos area and comparison with the ancient pottery.
- Petrographic analysis of comparative material taken from three other contemporary settlements (namely Dimini, Agrosykia A and Giannitsa B) located in Thessaly and western Macedonia.

The analysis undertaken at each level will now be discussed in detail.

5.3 The Macroscopic Analysis of the Pottery

5.3.1 Introduction

The large amount of pottery made a representative sample necessary in order to be able to draw inferences about the observed patterns. The researcher herself had to accept eventually that, due to the limited time available as opposed to the large quantity of material, there were only a certain number of steps that could be followed under the circumstances. The resulting problems will be discussed in the relevant sections.

The broad sorting of the Makrygialos Phase II pottery into categories was organised around the attributes *ware* and *fabric*. Rice originally used and defined these attributes (1977) in her critical reassessment of the type-variety system (Dunnell 1971; Gifford 1960; Hill and Evans 1972; Sabloff and Smith 1969). Wares and fabrics are treated, according to Rice's proposal, as two different and independent technological attributes, which cannot be incorporated into one single concept, as ware had originally

been defined. In this thesis, *ware* is used to describe the decoration and/or any surface treatment that the ceramic container carries. *Fabric*, on the other hand, is used to describe the paste composition and appearance as expressed through certain attributes, to be discussed below.

Amongst the ceramic categories found in Makrygialos, the painted ones correspond to and bear morphological similarities with the well-known 'Classical Dimini' pottery. It was largely based on these wares that the excavators dated this phase to the end of the Late Neolithic (the so-called 'Classical Dimini' phase). In the study of the prehistory of northern Greece, most of the evidence came until recently from Thessaly, and it was on the basis of this material that the first typological classifications of Late Neolithic 'Dimini' pottery were made (Tsountas 1908; Wace and Thompson 1912).

Due to these typological parallels, one of the aims of the present research was the investigation of the possible circulation of the Makrygialos Phase II pottery over distance. Therefore, inter-site comparisons of ceramic material from contemporary settlements were necessary first on a macroscopic level, before any further research by petrographic means was undertaken. So, the categorisation of this same pottery into ware groups partly incorporated previously existing typological schemes applied to Thessalian ceramic assemblages. Thus, it was decided that the first element to be considered should be something readily verifiable and replicable (Rice 1987; Sinopoli 1991) to anybody approaching the material: the presence or absence of decoration or any kind of surface treatment. The identified ware groups that resulted from this classification have been presented in Chapter 4.

As mentioned in Chapter 4 (section 4.4.1), however, every new typological scheme, whatever its advantages and limitations and even if it partly incorporates existing ones, must be orientated towards the archaeological questions that are asked by the researcher. In this thesis, the focus is the reconstruction of the organisation of the pottery production technology on an intra-site level. Therefore, although the ware concept was used as a first step to deal practically with the large amount of information that needed organising into easily recognisable categories, it was considered alongside the concept of fabric. The latter is a very useful way of classifying pottery. Furthermore, examining the interplay between wares, fabrics and shapes can offer insights into the

pottery production process. More generally, an integrated study of stylistic expressions that are not viewed separately from the potters' technological choices can be invaluable.

During the first period of fieldwork, a considerable amount of time was devoted to the investigation of the ceramic assemblage in order to become familiar with the types and range (in terms of frequency and morphological characteristics) of wares, fabrics and shapes present. A close macroscopic examination of large amounts of pottery took place so as to determine a final pattern that would indicate the different ceramic categories present in the material and to create a basic typology. The purpose was to distinguish different fabrics (clay recipes) and shapes within each ware group, so that associations within and between ware, fabrics and shapes could be made, which in turn would reveal information on the system of production, the function of pottery and perhaps - based on its intra-site distribution - the use of space.

Most of the terms used to describe ware groups based on decoration and surface treatment were already established in the literature (Hourmouziadis 1979; Theocharis 1973; Tsountas 1908; Wace & Thompson 1912). The difference in the present research is that, for the first time for a Neolithic assemblage from northern Greece, the analysis of the pottery incorporates not only isolated, single types of pottery or only decorated pottery but rather combines the whole range of ceramic styles (both decorated and undecorated) and shapes present within the studied assemblage. A similar methodological approach has also been employed for the study of EN (Tomkins and Day 2001) and EBA ceramic materials from Crete (Wilson and Day 1994; 1999).

The general examination of the macroscopic fabric groups was carried out in the field with a magnifying glass (x10). The establishment of the main macroscopic fabrics and the unusual ones was achieved through macroscopic fabric description forms (see Appendix A), each of which was designed to record certain of the attributes that were observed. Peacock was the first to suggest a systematic method for macroscopic fabric description (1977). This method was adopted and further elaborated by Whitbread (1995). In the present study, a very similar version to that employed by Whitbread has been applied with some modifications. There were two main components of the fabric characteristic records: a) the appearance and texture of the fabric expressed through colour, hardness, feel, fracture and voids, and b) the frequency, sorting and macroscopic identification of non-plastic inclusions (composition, average size and shape). A key-

chart introduced by Peacock (1977) was used cautiously for the identification of the most common inclusions in the macroscopic ceramic fabrics. The frequency (visual percentage) of inclusions was measured using detailed composition charts introduced by Matthew *et al.* (1991).

5.3.2 Detailed Recording of the Macroscopic Data

Before the actual analysis started, the researcher went through all the excavation diaries related to Phase II. This process provided data on deposition patterns and significant, in terms of quantity and variety, concentrations of pottery or its absence. Based on this information, over 20% of the estimated total amount of pottery was observed with the purpose of deciding a 'representative' sample of the whole population that could be chosen with confidence. Founded on this, the final samples for the petrographic analysis could be derived. Before the samples for the making of thin-sections were taken, a method for detailed recording of chosen '*passes*' was decided on, so that some inferences and associations between the observed variables could be made ('*passa*' = minimum excavation unit or artificial subdivision of archaeological layers). It is worth mentioning that emphasis was placed upon *passes* of a specific nature, either due to their particular deposition pattern or due to the remarkable concentration of pottery and other material remains in one layer or near certain architectural features; there were the ones mainly selected. In total, seventy *passes* were recorded and analysed systematically, corresponding, in terms of quantity, to nearly 750 kg of pottery (~4.2% of the estimated total) (see *fig.* 5.1).

5.3.3 Processing of the Macroscopic Data

As stated in section 5.3.1, the ceramic assemblage was classified according to ware, fabric and shape. After these categories were established the aim was to trace relations between the aforementioned variables, e.g., to observe whether certain fabric groups and shapes were associated with each ware group. The issue of pottery quantification has been hotly debated and remains disputed. Orton *et al* (1993: 169, 171), for instance, have argued that weight and vessel-equivalents can be used (without bias) to reliably compare between different assemblages, whilst sherd count and

numbers of vessels represented cannot This means that to quantify pottery within the same ceramic assemblage a combination of approaches should be adopted, e.g., weight and sherd count.

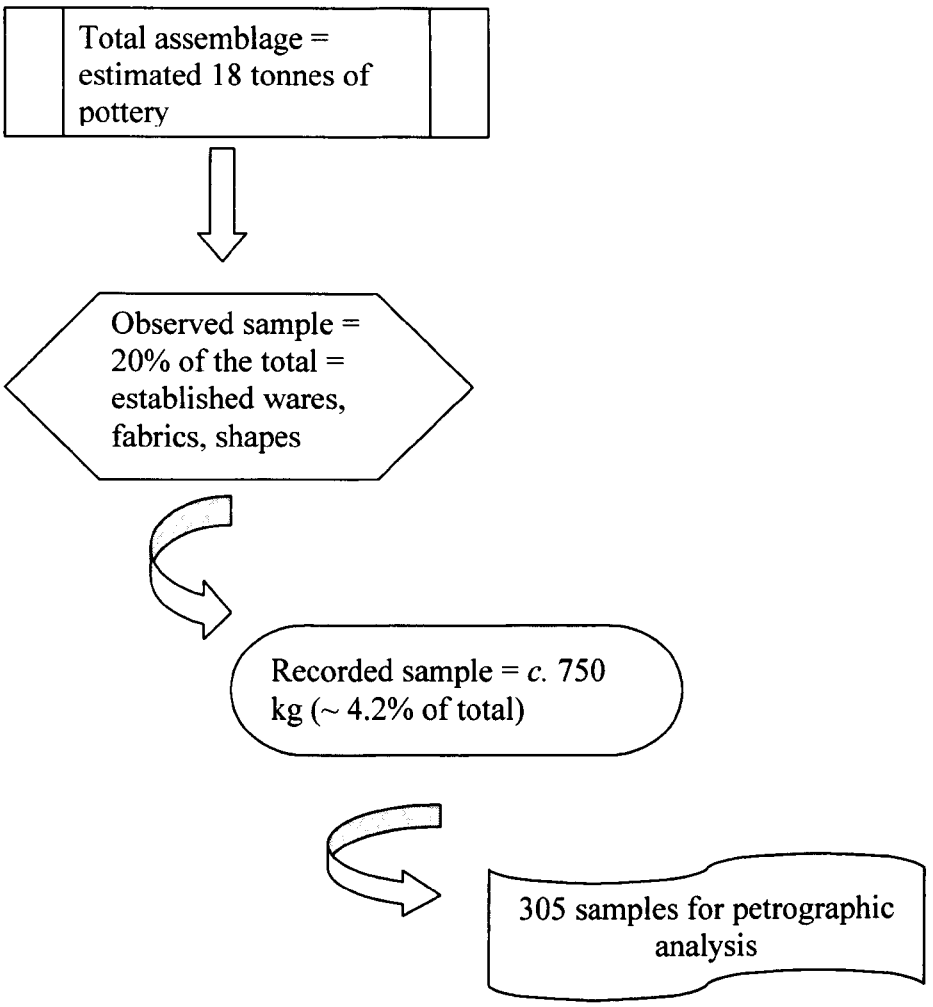

Figure 5.1. Sampling strategy during macroscopic examination of the Makrygialos Phase II pottery.

In the case of the Makrygialos ceramic assemblage, such an option would have been impossible given the time limitations of the current research, the focal point of which is the site's pottery production technology and inter-site circulation through petrographic analysis. Moreover, the combination of weight and sherd counting applied to an assemblage that comprised nearly 20 tonnes of pottery made such an attempt even less feasible. The choice of only sherd counting had to be abandoned as no use of such data could be made for comparisons either between sites or within the site (Orton *et al.* 1993: 169). Thus, weight count was chosen in order to obtain some idea of the relative

frequencies of each established analytical unit, i.e., ware, fabric, shape. This information could be used in future for comparisons between different assemblages from other contemporary sites. For the Makrygialos pottery assemblage, the relative frequencies of each ware and fabric and the total amount of pottery in each *passa*, measured here in grams and percentages, are used carefully and without generalising as it is acknowledged that a detailed study, combining weight and sherd counting, is needed for the estimation of the intra-site distribution of each category of pottery.

Descriptive statistics were used as a first step so as to obtain a general idea of the frequency of the different groups. The corpus of information collected during macroscopic examination that could be quantified was organised into a large table processed in Excel with the use of pivot tables to give indicative percentages between and within different categories of vessels. In the final table, the *presence* or *absence* of wares, fabrics and shapes recorded within each *passa* was indicated by the numbers 1 and 0 respectively. Where there were doubts about the classification of sherds into one group or another (predominantly due to pottery being weathered), and even if other characteristics such as fabric, or combination of variables gave some clues as to their identity, the number 0.5 was used. These data are presented in Appendix A.

What was of great interest to trace was any possible association between the observed variables. Consequently, a statistical treatment, appropriate to the nature of the data collected, was needed to indicate any such associations. For the type of categorical data that were collected, the most appropriate method to investigate significant patterns was the chi-squared test. Traditionally, this test has been used as a measure of non-randomness in the data set. In the present study, the data were sparse due to their organisation into many categories, thus producing a very large table with many empty cells. Because of this, the usual asymptotic approximate significance level could not be used. The dramatic progress of computationally intensive methods, however, allows the accurate treatment of sparse data with the employment of different versions of the chi-squared test. One of these is the 'Monte Carlo' method:

> "...[which] provides an unbiased estimate of the exact p value, without the requirements of the asymptotic method. The Monte Carlo method is a repeated sampling method. For any observed table, there are many tables, each with the same dimensions and column and row margins as the observed table. The Monte Carlo method repeatedly

> samples a specific number of these possible tables in order to obtain an unbiased estimate of the true *p* value..." (Mehta and Patel 1996: 3).

Based on this logic the Monte Carlo method was applied to the data. The results, which are presented in Appendix A, alongside the ones derived from the use of descriptive statistics, appear to be very significant.

5.4 The Petrographic Analysis of the Pottery

5.4.1 Introduction

This part of the analysis is the main focus of the present research. Following the patterns that the macroscopic examination revealed regarding the range of wares, fabrics and shapes represented in the assemblage, samples for petrographic analysis were taken. The aim of the sampling was to cover a representative range of all the different categories of ceramic material observed. Thus, 305 samples were removed from pieces of both diagnostic and body sherds for further petrographic analysis. As there was no intention of treating the petrographic data statistically in the future, it was not necessary to ensure that the number of samples representing each category was analogous to their actual proportions within the whole assemblage.

5.4.2 Sampling Strategy

Under different circumstances *simple random sampling* might have been chosen, but with such a method there is always the possibility of some areas of the settlement being heavily sampled while others are hardly examined at all (Shennan 1988). If the researcher is only concerned with estimates of the overall population under study, then random sampling does not create major problems. However, where the study of combinations and meaningful associations within the sample is the aim, then *stratified random sampling* is considered more appropriate, as this method secures samples from as many different areas of the settlement as possible. In addition, Shennan also points out that:

> "The second reason for stratifying is that if the population characteristic of interest is more homogeneously distributed within the strata than between them (i.e. there is

> variation between strata but not within them), then the precision of the overall estimate obtained will be greater for a given number of sample units than with simple random sampling" (1988:317).

Thus, care was taken to ensure that samples were chosen from archaeological contexts that were sealed, according to the excavation diaries, and 'meaningful'. The latter included layers with remarkable concentrations of different types of archaeological remains, in addition to pottery, with evident or possible clay floors, with areas near and around hearths and ovens, or with other constructions ('Kataskeues') interpreted as facilities for food and materials processing. All the above contexts and features were incorporated in the Activity Areas discussed in Chapter 4.

5.4.3 Laboratory Work: Thin-section Preparation

During the first fieldwork period of working on the Makrygialos material, in summer 1996, 230 samples were removed from an equal number of sherds with a pair of pliers. During this process care was taken to limit damage to the sherds' surface. The size of each sample was as large as could possibly be obtained under the restrictions imposed. It was sufficient, however, for a thin-section, leaving a small fragment as reference material for comparative purposes. During the second period of fieldwork, in summer 1997, another 75 samples were taken from the Makrygialos assemblage for analysis in order for some already identified and new fabric groups to be more securely established and cross-examined. The pottery samples taken from the Makrygialos Phase II material for petrographic analysis covered the whole range of wares, as presented in Chapter 4, including both the frequent and rare examples. In addition to this, they included the whole range of macroscopic fabrics (frequent and rare) as well as the shapes that were established during the close examination of the observed total sample (see *fig.* 5.1).

In addition, 126 comparative samples from the contemporary Late Neolithic sites of Dimini (Thessaly), Agrosykia A and Giannitsa B (West Macedonia) were also taken for petrographic analysis. These samples were randomly chosen due to a) the fact that detailed analysis of the intra-site pottery production within the aforementioned settlements was not within the scope of the present research; b) the limited time for sampling granted to the researcher to examine the materials. The focus was largely

upon the painted (brown-on-cream, black-on-red, polychrome) and incised wares as their origin and location of production are of great interest to the present study due to the wider implications of their possible inter-site circulation. Some further categories of decorated pottery were also sampled along with a few examples of undecorated large storage vessels, where their macroscopic fabric seemed to resemble similar categories within the Makrygialos Phase II assemblage.

The labelled samples were transported for laboratory processing and thin-sections were made by the researcher. This process was laborious and time-consuming. The samples were first sawed with thin or thick blades according to the thickness of the sherd's walls. The chips were left to dry and their identification number was written with pencil on both surfaces. All samples were then impregnated on a hot plate placed inside a fume cupboard and heated gradually to approximately 200^0C. The epoxy resin used to impregnate the samples was a mixture of 5 parts of AY-103 resin with 1 part of HY-957 hardener by volume.

Once the resin was set it was scraped off the sherd surface and the samples were left for at least 24 hours to allow the resin to set properly. This was followed by polishing, initially on a grinding wheel with a mixture of carborundum powder (usually 700) and water, and later on a glass plate, using again the same material. In this latter case the carborundum used ranged from 300 up to 700 depending on the type of clay. The samples were washed and left to dry, whilst glass slides were frosted and cleaned with acetone and the number of each sample etched on the unfrosted surface with a diamond marker. Impregnation was used again in the next stage of sticking the pottery samples onto the slide surface, although at a lower temperature than earlier (around 100^0C). Care was taken to ensure that air bubbles were not trapped between the surfaces of the chip and the slide. Then the samples were left inverted to dry and stick properly. Although the required time for this stage is theoretically 24 hours, in practice it on several occasions took up to five days due to the resin's reaction to the damp atmosphere in the laboratory.

The next stage was to grind down the chip to the size required for the actual thin-section which is 30 μm (0.03mm). This was followed by final polishing on a glass plate with 700 grit carborundum and water. A microscope was used to check that the quartz grains had changed from yellow to a grey/whitish colour, which indicated that

the thickness of the section has reached the desired level. Then, the sections were properly washed, the excess epoxy resin was scraped off and the samples were left to dry overnight. Finally, the sections were cover slipped. Epoxy resin was heated on a hot plate to around 100^0C and placed on the ceramic section to be covered. At this stage it was necessary to be very careful to prevent air bubbles from being trapped inside the section whilst squeezing out the excess resin. Once they were dried, the excess resin was scraped off with a scalpel and the sections were finally cleaned with acetone.

The next analytic step was the detailed petrographic analysis of all samples under the polarising microscope. A Leica (Leitz Laborlux 12 Pols) microscope was used during this process.

5.4.4 Processing and Interpretation of the Petrographic Data

Ceramic petrography, according to Whitbread's definition, is the systematic description of the composition and texture of ceramic pastes, defined both macroscopically and microscopically. Along with the analysis of relevant raw materials, manufacturing technology and provenance identification, they encompass *ceramic petrology* (Whitbread 1987a, 1995b: 365).

Ceramic petrology has only recently become an established analytical technique in production studies of ancient ceramic materials. Initial hesitation in appreciating its analytical merits was due to a number of reasons. First of all, until quite recently, pottery studies were focused only on inter-regional exchange issues, overlooking the importance of intra-site production and consumption patterns. In addition to this, previous assumptions that pottery (especially Neolithic pottery) was merely locally produced resulted in ceramic petrology being thought inappropriate for the analysis of fine clays. Instead, researchers concentrated on the identification of the non-plastics component of a clay paste, easily visible only in coarse fabrics. On the other hand, as petrography was mainly used for provenance identification, the examination of coarse fabrics was thought unnecessary on the basis of the assumption that coarse pottery does not circulate.

Recent years, however, have witnessed a shift of interest in the geographical scales studied, e.g. from inter-regional to regional/local, and in the suite of archaeological questions asked. The research focus has moved from simple problems of provenance determination, through either identification of rocks and minerals or chemical elements, to more sophisticated issues of production technology and/or consumption. These changes have affected dramatically the role that ceramic petrology can play as a research methodology to bridge the gap between basic archaeological and more complex analytical work (Day 1991, Day *et al.* 1999).

Ceramic petrology may not be considered as sophisticated as some other structural, mineralogical or chemical analytical techniques, such as X-ray diffraction (XRD), neutron activation analysis (NAA) or scanning electron microscopy (SEM). In addition, it is true that microscopic fabric characterisation cannot always be interpreted in 'objective terms'. For example, data regarding clay composition and texture cannot be quantified precisely and in detail, but similar problems can also occur with some of the aforementioned techniques (e.g., XRD and SEM). The advantages of petrographic examination, however, overshadow its limitations. They are only summarised briefly here:

- Petrography is the next natural step after the macroscopic examination of pottery and before SEM (on a visual continuum) and thus both sets of data can be directly related.
- Integrated study of microscopic data with relevant geological information and, ideally, collected raw materials, can give clues as to the locus of the clay sources used.
- The fact that the researcher can examine visually not only the compositional but also the textural characteristics of a clay, provides her/him with valuable indicators of the potters' technological choices and the way they manipulated raw materials.

The main components of this particular analytical approach are: description and characterisation of fabric classes. Furthermore, it incorporates a great deal of information on production technology and provenance ascription. Each of these will now be discussed briefly.

5.5 Description and Characterisation

The first step in analysing a ceramic assemblage petrographically is its characterisation through the detection and justification of fabric classes. Even at an early stage of the process, the forming of different petrographic groups maintains an exploratory rather that simply descriptive character (Whitbread 1995b: 372). This means that certain fabric attributes between and within samples are visually assessed and, based on the degree of their similarities and differences, are classified accordingly. Therefore, each fabric class consists of samples that exhibit a high degree of homogeneity in compositional and morphological terms. In reality, it is rare that within the same observed assemblage different classes of pottery will be readily discernible. This is the case for only a few classes; the rest are normally interlinked either through compositional or textural characteristics, and it is up to the ceramic petrographer to decide where to draw the line and further sub-divide or cluster them. It is the scope and the particular questions of the research project that will, surely, determine such decisions. This process, according to Whitbread, could dramatically restrict the importance of this analytical approach if accomplished only on the basis of the fabrics' differences: "characterisation on a purely comparative basis impedes the identification of fabrics when they are viewed in isolation" (Whitbread 1995b: 2). Sufficient justification of each fabric group is necessary so that significant associations between different classes can be made. When this prerequisite is maintained and strong "genetic" links between fabric groups are possible to establish, important issues concerning the manipulation of raw materials, manufacturing technology and provenance determination can subsequently be addressed (1995b: 373).

During the characterisation process, evaluation and even unconscious interpretation of the material under study often happens. A process of describing in detail each fabric group helps to a great extent to control such a tendency. Whitbread argues in favour of consistent, detailed and systematic descriptions of fabrics that can be used by archaeological scientists as a resource database. From this, different sets of information can be retrieved and interpreted, for comparisons not only with regard to a particular set of materials, but also across different materials published in the literature. His suggested system of petrographic description successfully integrates principles and elements taken from sedimentary petrography, soil micromorphology and ceramic petrography (1989; 1995b: 2). Despite this, Whitbread rightly draws attention to an

essential difference between ceramic and sedimentary petrology: the fact that although ceramics are sediments they are formed and become an entity, i.e., pottery, through technological rather than natural processes. This is a crucial factor for archaeologists to consider when interpreting a ceramic assemblage (1995b: 366).

Before proceeding, a definition of the *petrographic fabric* is necessary here in order to establish a common code of communication. Whitbread (1989, 1995b: 368) proposes a broad definition according to which the term incorporates the arrangement of inclusions in the clay matrix, their size, shape, frequency and the composition of all plastic, non-plastic and void components. The emphasis in describing these components is *equally* upon the identification of the composition of minerals and rocks *together* with their texture, distribution across the thin section and colour of the matrix. Perhaps the most important part of such a detailed description is the final *Comment* section, where a brief account of the main characteristics of the fabric group is given. Ideally, associations with other fabric classes of the same assemblage can be achieved, combined with geological information on the relevant area/s under study, to arrive at a provenance determination, where possible. By incorporating all the aforementioned parameters, Whitbread takes into consideration, for the first time, the factors that can be used to draw inferences on the social parameters that pertain to the study of pottery technology. His definition of 'fabric' basically incorporates the human dimension in the pottery making process. This methodological approach is applied in the present thesis.

One can still not argue, however, for 'objective' fabric characterisation. Certainly an established system that consists of specific principles, as Whitbread's system does facilitates this difficult process. Yet, even though there is a certain degree of confidence in following a system and using well-informed manuals (Kerr 1977) and atlases (Adams *et al.* 1984; Mackenzie and Adams 1994; Mackenzie *et al.* 1982) for the identification of rock-forming minerals, it is only experience, built through time, in dealing with diverse assemblages that balances and secures the description/characterisation process (Whitbread 1995b: 366-367). There are other factors that also influence the researcher's attempt to produce meaningful 'fabric' categories of ceramic assemblages without following firm petrographic terms. These are related to the archaeological questions being asked, which differ from one project to another, the size of the assemblage studied and, of course, the natural variation that

clays can exhibit. As a result, the same material can be characterised in different ways that can still be valid.

5.6 Technology and Provenance

As mentioned in section 5.4.4, until relatively recently the identification of the composition of the rocks and minerals in a ceramic 'fabric' was the primary focus of microscopic research. This information was then used to make associations with the relevant geological formations of the areas studied. The aim was to ascribe provenance. This proved feasible in some cases where the non-plastic inclusions were rare and the geology under investigation very distinct (Peacock 1979; Shepard 1975). Unfortunately, this is not always the case. In many geological environments, for instance in Greece, formations without a diagnostic mineralogy repeatedly cover very large areas.

The basis of the aforementioned methodological approach was the perception that ceramic pastes derived from different geological sources have necessarily different compositions that can be traced analytically. So, clays with similar compositions were assumed to have the same provenance and *vice versa.* Therefore, any observed variations were justified on the basis of geological and geographic parameters (Harbottle and Sayre 1977; Rands and Bishop 1980).

The contribution of ceramic technology, as revealed through the application of petrographic analysis, towards characterisation and provenance identification has been until recently largely underestimated. Some research, by overlooking technological parameters, automatically excluded crucial factors of the manufacturing process, which could shed some light even on provenance speculation/determination. For instance, it ignored the decisions and technological choices of the potter to a) mix several clays of different lithologies (Whitbread 1995b), b) add non-plastic inclusions (Neff *et al.* 1988, 1989), or c) remove coarse inclusions by sieving or levigating (Kilikoglou *et al.* 1998). It also underestimated the natural variation that may be present in a clay source, which can be very misleading. Furthermore, it overlooked the fact that the clay composition of a finished ceramic product can be seriously altered due to firing or the conditions of its deposition.

Studies of Aegean ceramic material demonstrated that detection of clay mixing could be achieved through thin-section analysis (Day 1991; Riley 1983; Whitbread 1987a, 1989, 1995b). In most of these cases, it was achieved through observation and interpretation of textural concentration features. In some others, it was achieved through examination of fossiliferous material mixed with clays of different lithologies that co-existed within the same assemblage as independent fabric classes (Quinn 1999; Riley 1981)

The detection of temper in an ancient ceramic paste seems to be a more complicated issue. Its definition and use in the literature has not been very clear despite its importance, for a potter's choice to add materials into a clay can dramatically affect its properties in forming (Braun 1983; Bronitsky & Hamer 1987; Kilikoglou *et al.* 1998). Some researchers have used the term to describe only the non-plastic inclusions present in a clay paste (Rye 1981: 147; Shepard 1985), whereas others incorporate both the plastic and non-plastic components (Day 1991; Whitbread 1987a; 1995b: 374). In petrographic analysis, the criteria that researchers often use for the identification of tempering evidence concentrate on the size and shape of rock and mineral grains. These, however, can sometimes be misleading. For example, large grains of non-plastics can occur naturally in a deposit and not necessarily as a result of tempering. In addition, research on storage jars in Neopalatial Crete has demonstrated that, whilst angular fragments can occur in a natural deposit and not as a result of crushed and added material, rounded rock fragments, such as sand, can be used as a temper (Day 1988b). Grain size variation and assessment of sphericity of compositionally similar inclusions can perhaps offer some clues as to the problem of temper (Whitbread 1995b: 375).

The best way to tackle this problem could be through a combination of different methodological tools. Any of the above parameters used in isolation could restrict the potential information that an ancient ceramic assemblage offers. Thus, modern clay prospection, ethnographic work, petrographic analysis and, in some cases, grain size analysis (Whitbread 1987a, 1995b) could contribute immensely to our understanding of the technological choices that ancient potters made.

The fabric characterisation and technological investigation of an ancient material, through petrographic analysis, can be essential for facilitating issues of

provenance ascription, and this can be applicable not only to coarse- but also to fine-grained clay bases. Once different fabric groups are characterised and described in detail they can be related a) to similar/identical fabric groups from different sites studied, and b) to other diagnostic characteristics such as vessel shape and decoration. Further to this, close examination of clays technology, e.g., the manipulation of raw materials by ancient potters and firing conditions, combined with the previous attributes, may prove to be an invaluable source of information as to the production area of a given pottery type (Whitbread 1995b: 376). This can be extremely useful in cases where the clay mineralogy is not very informative and/or the geological formations in the area under investigation are repeated or are not distinct. Even when geological maps are used to associate the ceramic fabric with the local geology, this knowledge is very rarely sufficient by itself as geological maps normally record large formations that incorporate several different lithologies. In this case, relevant geological literature, if available, should be used as a complementary methodological tool.

As Whitbread points out, however, it is the archaeological evidence that comprises one of the most important pieces of information in determining provenance. The results of macroscopic analysis, which provide insights into the pottery typology, style and its distribution across the different sites under investigation, should be combined with the results of petrographic analysis in order to attempt provenance ascription (1995b: 376). Ideally, chemical analysis, e.g., NAA or ICP should also be employed at the point where the most basic questions have been answered and their range narrowed down to very specific enquiries.

5.7 Conclusions

Day (1991: 75) has rightly pointed out that, with the study of large ceramic assemblages – like the present material - clear and, up to a point, repeated patterns referring to human choices may be revealed. The more research is focused towards this direction, the greater the amount of information that will become available, so that researchers will be able to compare typologically similar fabrics from other sites and interpret their results.

The Makrygialos Phase II ceramic project is the first major contribution to such an approach for the Neolithic of northern Greece. With its integrated methodological approach it combines macroscopic and petrographic results to investigate both technological and provenance related issues. These results are retrieved from a large pottery assemblage that is also studied in comparison to other ceramic materials from contemporary Late Neolithic sites.

In analysing microscopically the Makrygialos, Dimini, Agrosykia A and Giannitsa B materials the researcher has followed the system and terms of analysis that Whitbread has proposed (see section 5.5). Initially, all samples, examined together rather than split by site, were characterised into different fabric groups. Each fabric class was defined on the basis of compositional, morphological and textural similarities. As expected, some groups displayed a higher degree of homogeneity than others. In order to take into consideration not only the mineralogy of the ceramic fabric but also the distribution of plastic, non-plastic inclusions and voids across the thin-sections, as well as their texture and the colour of the matrix, the groups were sometimes not classified based on strict petrographic terms. Subsequently, each of these fabric groups, named after their main mineralogical components, was described in detail following the thin-section systematic description that Whitbread has established.

Every description comprises five main components:

a) *microstructure:* here identification and frequency of different types of voids takes place along with the orientation and spacing of both voids and inclusions;
b) *groundmass:* the degree of homogeneity, in terms of inclusions, voids, colour of the matrix, and possible variations within the fabric class is stated in this part of the description along with the colour in both PPL and XP and optical activity;
c) *non-plastic inclusions:* these are examined in two fractions, i.e., coarse and fine, depending on the mode of their distribution and sorting, where the upper limit of the micromass is set at 10μm. This part involves the identification of minerals and rock fragments, their shape and size and usually their textures and appearance;
d) *textural concentration features:* these are described in detail following Whitbread's (1986b) proposal for the identification of tcfs in thin-sections. This part can be crucial for the detection of any evidence on clay mixing and tempering by ancient potters;

e) *comment:* this last part of the petrographic description may be the most important. A summing up of the main fabric characteristics is followed by an attempt to associate different fabrics and to state differences and similarities in compositional and textural terms. In addition, any technological observations regarding tempering (clay mixing and/or addition of non-plastics), manufacturing techniques and firing conditions are made here. Finally, associations between fabric groups and their comparison against geological information, based on maps and literature, are made to investigate whether this can lead to successful provenance determination.

All the aforementioned parameters are applied to the ceramic materials under investigation in the following chapter (Chapter 6), where the petrographic analysis, results and interpretation of the new evidence, in terms of its implications for understanding the production technology of the Markygialos Phase II pottery and its inter-site circulation, are presented in detail.

CHAPTER 6
PETROGRAPHIC ANALYSIS

6.1 Introduction

The aim of this chapter is to present and discuss the results of the petrographic characterisation and the detailed description of the four ceramic assemblages under study along with an account of their production technology. Provenance ascription is attempted where possible.

First, the location and geological environment of each site is discussed in conjunction with any previous analytical work carried out in the area under investigation. This is followed by characterisations of all the fabric groups based on the analysis of the studied assemblages. These materials have been classified and analysed together rather than split by site. The purpose was to examine the interplay within and across categories of pottery from the different sites in order to investigate the manipulation of raw materials by the ancient potters and the possible different traditions of pottery making. Compositional and textural similarities and differences were the main criteria in forming the fabric groups. Such 'entities', however, are only analytical tools. The ultimate aim was to trace their possible significance, leading to an understanding of the potters' technological choices and the implications on the social system within which these people operated (produced and consumed). Due to this concern, some of the fabric groups were justified not only on strictly petrographic grounds, but also bearing in mind certain key research questions.

Detailed petrographic descriptions, based on Whitbread's system of thin section analysis (Whitbread 1986, 1989, 1995), are presented in Appendix B. The comparator charts used in the study, the frequency categories of rocks and minerals, sorting, sphericity and roundness were taken from Bullock *et al.* (1985), Kemp (1985) and Pettijohn *et al.* (1973, 1987) respectively. The grain size classification is measured on the Udden-Wentworth Scale. Geological maps, provided by the Greek Institute of Geology and Mineral Exploration (IGME), were used as the main source of relevant information (scale: 1: 50,000). Finally, the provenance of the various fabric groups is discussed and related to the find spots of the pottery.

6.2 Sites Studied

6.2.1 Makrygialos: Location and Geological Environment

The site of Makrygialos is located 1km inland from the modern coast of north Pieria, northern Greece. This is a landscape that has changed dramatically over time, where soil erosion and alluviation have affected the visibility and preservation of archaeological sites in the region (Krahtopoulou 2000).

Makrygialos lies on Pleistocene Aeolian deposits that alternate with well-developed paleosols (*fig.* 6.1). The brown Aeolian deposits consist of clayey loam rich in carbonate material. A relatively small area surrounding Makrygialos (more extensive to the North and South) is covered by Neogene (Upper Miocene – Lower Pliocene) fluvioterrestrial deposits (IGME 1982-83). These consist of alternations of loam and sandy-loamy clays along with bodies of marly and clayey sandstones and inter-bedded sand. Further to the West, and covering large areas, extensive geological formations are found, which are presented briefly here in order of increasing age. To the South, sandstones and clays cover the relatively small area of Sevasti-Kitros, which consist of fine- to medium-coarse, whitish sandstones in alternation with clays. These deposits pass laterally into the Alonia-Sfendami Formations and upwards into the Makrygialos-Methoni brown-coloured Formations. To the North are the Aeginio-Katahas Neogene Formations. These are alternations of light-brown loamy sand, medium to coarse sand, sandy loams and marls and small intercalations of fossiliferous loams and clays (containing *ostracodes/cyprideis* microfossils). Finally, the older, extensive Formations of Sfendami-Alonia lie to the West and South-west of Makrygialos. These consist of alternations of medium- to coarse-grained sand, sandy loam, loamy sand, marly fossiliferous clays and marly limestones. Their colour is grey, greenish or bluish. These Formations also contain *ostracodes* as well as *Cardium* macrofossils.

Published information on the geological development of this area is limited. Similarly, no previous analytical work on archaeological ceramic material has been carried out.

6.2.2 Dimini: Location and Geological Environment

Dimini lies on a natural knoll 18m above sea level and 3km from the modern coast of the Pagasitic Gulf. It belongs to the Pelagonian Zone of the Central Hellenic Nappe (Zangger 1991: 3). The geological environment of the area appears to be quite complex (*fig.* 6.2). The largest part is covered by the Eohellenic Tectonic Nappe, which is a complex of mainly ophiolitic rocks and metasediments (IGME 1986). These formations have undergone three different metamorphic phases: a) greenschist facies metamorphism, b) a high pressure, low temperature metamorphism in the glaucophane facies, and c) an epizonal metamorphism. The Eohellenic Tectonic Nappe consists of:

- Serpentinised peridotites – serpentinites covering very small areas and occurring sporadically to the North-west and South of Dimini. These are found on the upper part of the Nappe and consist of dark green to brown rocks which are mainly serpentines.
- Amphibole – epidote – chlorite schists lying mainly to the North of Dimini. Their main mineralogical constituents are: amphiboles (actinolites, green hornblende and a lesser amount of glaucophane), quartz, epidotes, feldspars, muscovite and chlorite. They are often accompanied by crystalline limestones and marbles. Meta-volcanic rocks also occur locally.
- Gneisses, gneiss – schists, mainly extending to the South and West of Dimini, covering a relatively large area near to the Dimini settlement. These are greenish to whitish in colour and consist mainly of feldspars, muscovite, biotite, epidote, chlorite, and quartz. Sometimes thick-bedded marble intercalations also occur.
- Mica schists – phyllites of the Upper(?) Jurassic, found in a small area to the West of Dimini, but re-appearing extensively to the North and North-west. These are rocks of a greenish colour which exhibit schistose structure and are locally intensely folded. Their mineralogical constituents are micas (mainly muscovite, with less biotite), quartz and either orthoclase or acid plagioclase feldspars. In addition, amphiboles (actinolite and glaucophane), chlorite, epidote, sericite are found, whilst accessory minerals such as apatite, titanite and Fe-oxides also occur.
- Marbles of the Middle Triassic – Upper Jurassic found very extensively to the far North of Dimini. They mainly consist of calcite schists, cipolins and muscovite schists with metabasite intercalations.

Previous analytical work: relatively recent analytical work, both chemical (X-ray fluorescence) and mineralogical (petrographic) along with clay prospection, has been carried out (Schneider *et al.,* 1990, 1991) on a number of samples from Neolithic Thessalian sites; most of these samples come from surface surveys rather than stratified contexts. Moreover, the sites under investigation are not contemporary with each other and essentially concern the transitional period from the end of the Middle to the early phase of the Late Neolithic (the 'Tsangli-Larissa' pottery). The work did incorporate, however, limited samples from the final phase of the Late Neolithic (namely from Dimini). The results of the chemical analysis, with regard to 'Classical Dimini' pottery, suggest that the painted 'Brown-on-Cream' ware belongs to a first distinct chemical group which is rich in calcium (containing more than 6% of CaO). Schneider *et al.* argue that the technological properties of calcareous clays are totally different that those with poor calcium content (1991: 8-9). For instance, and in striking contrast, the contemporary categories 'Black-on-Red', 'Incised', and the majority of the coarse pottery are particularly poorly represented in calcareous material. It has also been pointed out that the painted 'Classical Dimini' pottery stands out because of its compositional homogeneity, even when the analysed samples come from sites outside Dimini, in eastern Thessaly. Nevertheless, it was acknowledged that the microscopic analysis was not sufficient and parallel to the chemical analysis, and that the grouping of all the collected samples was not properly conducted in petrographic terms (1991: 13).

6.2.3 Agrosykia A and Giannitsa B: Location and Geological Environment

Both sites lie close together on low terraces between the courses of the Loudias and Axios rivers, in the plain of western Macedonia that comprises three main units: mountain Paiko, hill-land and alluvial plain (Andreou *et al.* 1996: 562; Bintliff 1976: 242). Giannitsa B and Agrosykia A were built on large alluvial, lacustrine and terrestrial deposits of the Upper Miocene – Pliocene respectively. The Pliocene deposits consist of conglomerates, sand, marls, clayey material, marly limestones, clays and sometimes lignite beds. This geological environment is structurally similar to that surrounding the Makrygialos area and by itself cannot be characterised as distinct. The relevant IGME geological map has not yet been published and therefore all the basic information given here is mainly derived from the general geological map of Greece (scale 1: 500,000) and the Edessa, Skra and Koufalia sheets that show the areas

surrounding that covered by the Giannitsa sheet (scale 1: 50,000). According to the Skra map, to the North of the Giannitsa-Agrosykia area is the Upper Jurassic Volcano-sedimentary series of Kastaneri, belonging to the Pro-Paeonian Subzone; this mainly consists of alternations of sericite-chlorite-muscovite and mica schists, tuffites and pyroclastic materials with limestone intercalations. The southerly extension of this series beyond the Giannitsa sheet continues with sericite porphyroids. Pliocene and Upper Jurassic magmatic rocks are also observed, including volcanic rocks (mainly trachytes and andesites), the pink-coloured granite of Fanos (mainly consisting of quartz, microcline and microperthitic orthoclase, oligoclase, biotite and apatite); the granite has generally been kaolinitised and sericitised. In addition, migmatites and the extensive ophiolitic complex are also incorporated in the magmatic rocks. To the West of the area of study is the Upper Cretaceous series of the Paikon zone, with extensive deposits of dolomites, calcareous dolomites and the horizon of flysch type.

No previous analytical work has been carried out on ceramic material from the areas of Giannitsa B and Agrosykia A.

6.3 Results of the Petrographic Analysis

6.3.1 Presentation of the Fabric Groups

1. Very Fine, Calcareous

Samples: MAK 96/6, 13, 15, 16, 20, 23, 34, 41, 45, 61, 66, 85, 86, 87, 100, 116, 192, 193, 197, 220; MAK 97/19

DIM 97/1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 25

AGR 97/1, 2, 10, 12, 22

GIAN 97/1

This fabric group is very fine, rich in calcareous material and consists of generally well-sorted inclusions, set in a homogeneous groundmass whose distribution is unimodal to weakly bimodal, with about 10% voids. The inclusions, usually sub-angular to rounded, comprise mainly monocrystalline quartz, biotite, muscovite mica, polycrystalline quartz, textural concentration features, amphibole, small highly birefringent mineral grains (e.g., epidote group minerals, clinopyroxene), feldspar, small

metamorphic rock fragments (e.g., fine phyllite and schist), very rare shell fragments and a small volcanic(?) rock fragment (*pl.* 6.1).

Technological information

The micromass in this fabric group is generally inactive and, whilst slightly active in DIM 97/15, is in some samples even glassy (see relevant description); this suggests a high firing temperature compared to the rest of the groups. Due to this glassy appearance, samples MAK 96/45, DIM 97/7, 13, and AGR 97/12 form a 'sub-group' within the main fabric group. Their difference lies in the colour of the groundmass which is greyish green in PPL and green to olive green in XP (x40), and is due to the fact that, on account of a high firing temperature, it appears nearly vitrified in some areas (*pl.* 6.2). These samples represent the high-fired end of Fabric Group 1. Similar examples of over-fired, olive green fabrics are presented in a number of studies. Day, in his study of Neopalatial pottery production and consumption in the Siteia Bay area, defines a 'Green fabric with grey siltstone inclusions' and argues that these green fabrics with siltstones are highly fired calcareous clays (1995: 161). Whitbread also identifies a green fabric (Fabric Class 1) of Corinthian Type A' amphorae; the texture is coarse in this case and the main inclusions consist of reddish brown to grey radiolarian mudstone breccia and textural concentration features (1995: 271, 287-89). Further to this, the very dark brown to greenish brown groundmass in most of the samples exhibits homogeneity, as there is normally no colour differentiation between the core and margins of the vessels, which probably hints at a constant, well-controlled firing atmosphere. More importantly, the presence of three different types of textural concentration features, especially swirls and streaks of clay with tails, comprises evidence of incomplete clay mixing (MAK 96/220, DIM 97/6, AGR 97/1) rather than added crushed material or the use of a single clay (*pls.* 6.3, 6.4). It is suggested here that this base clay was manufactured by mixing different fine clays, of which at least one was rich in calcareous material. The functional purpose of this process would be the production of the light cream background of the vessels' surface which was desirable in order to give the appropriate contrast to the chocolate brown painted decoration. Previous analytical work justifies this hypothesis/consideration and confirms that during firing a high-calcium content gives the clay a light colour (Jones 1986). Schneider and co-workers demonstrated that all samples of painted 'Dimini' style and part of the Sesklo Red-on-White samples are rich in calcareous material; they

argued that such a choice by the Neolithic potters should be considered as deliberate (Schneider *et al.* 1991: 9).

In addition, certain samples exhibit strong alignments of voids, diagonal to the vessel's margins. These examples are taken to indicate the manufacturing technique used (coiling) (DIM 97/12, GIAN 97/1 and AGR 97/10) (*pl.* 6.5). Finally, in some samples the dark brown, manganese slip used for the decoration of this ware has been preserved on at least one or both surfaces of the vessel, e.g., MAK 96/13, 96/20, MAK 96/34, 96/45, 96/66, 96/85, MAK 96/86, DIM 97/2, DIM 97/5, 97/9, DIM 97/10, 97/11, 97/12; its thickness ranges from 0.02 mm up to 0.04 mm. Often the slip incorporates small grains of monocrystalline quartz.

Discussion

All 43 samples in this fabric group, from all four comparative sites under study, belong to the Brown-on-Cream ware and are open conical bowls, with the exception of two samples from Dimini (DIM 97/13, 14), which are 'fruitstands'. In this main fabric group, as well as Fabric Groups 2, 3 and 4 that follow, (also related to the same ware and shape), calcareous clays were used in different recipes for the manufacture of Brown-on-Cream ware vessels.

In Fabric Group 1, the small grain size, the shape and the weakly bimodal distribution of non-plastics creates difficulties in attempting any association with a possible clay source. The composition of inclusions in itself is not diagnostic and therefore cannot offer reliable clues as to the location of the production of this ware. The textural and technological characteristics of the samples from all sites under investigation as revealed under the polarising microscope, however, may offer such clues. It can be suggested that all samples of Fabric Group 1 were the products of a single centre of production. This is supported by a number of observed characteristics; a) homogeneity in the size, shape and distribution of non-plastics across the majority of samples and across all sites; b) the similar colour of the groundmass with no differentiation between core and margins (well-controlled atmosphere); c) the occurrence of texturally identical concentration features as evidence of clay mixing, present in samples across the four comparative sites (*pls.* 6.6, 6.7).

Furthermore, in samples from all the different sites, very few to few small epidote group minerals are present, along with amphibole, clinopyroxene, and relatively small metamorphic rock fragments evenly distributed in the clay matrix. These seem to have derived from the same as each other metamorphic environment and it is one of the attributes that associate Fabric Groups 1-3 with some of the coarse metamorphic fabrics from Dimini (Fabric Groups 6-8 and especially 12), as will be discussed later in this chapter. This particular suite of minerals is related to the amphibole-epidote-chlorite schist and the gneiss-schist formations of the Eohellenic Tectonic Nappe that lie to the North, South and West of Dimini respectively (IGME 1986). In addition, quartz-amphibole-epidote schist or quartz-mica-epidote schist rocks are referred to as typical of the Dimini coarse pottery and the Dimini local clays by Schneider *et al.* (1991: 37). Furthermore, the particular combination of minerals associated with this dark brown/green, fine calcareous and homogeneous optically inactive matrix, is not present in any of the fine and coarse 'local' fabrics of Makrygialos, Agrosykia A and Giannitsa B. In contrast, amongst the ceramic material taken from Dimini, about four fabric groups are associated with the aforementioned base clay, with coarser metamorphic inclusions. These fabric groups are not only linked with the Brown-on-Cream, but with a number of different wares.

2. Calcareous with Textural Concentration Features (Tcfs)

Samples: MAK 96/46, 108

MAK 97/8, 32, 48

DIM 97/18, 47

This fine to semi-fine calcareous fabric group is closely associated with the previous Fabric Group 1. Its non-plastic inclusions are poorly sorted, set in a generally homogeneous groundmass with about 10% voids, and exhibit a strongly bimodal distribution. The shapes of the inclusions vary from angular to rounded and consist of mainly red/brown textural concentration features (siltstones), monocrystalline quartz, rock fragments of low grade metamorphism, biotite and muscovite mica laths, mineral grains of the epidote group and rare serpentine (*pl.* 6.8). The calcareous material (ostracods and micritic limestone), which increases considerably in MAK 97/8, is dispersed throughout the sections and is clearly visible under the polarising microscope.

Discussion

Samples in this fabric group incorporate material from only two out of the four comparative sites: Makrygialos and Dimini. Whilst most samples belong to Brown-on-Cream ware and are open conical bowls, there is one from Dimini which is classified as Polychrome and is the upper part of a 'fruitstand'. It should be noted that during the first year of fieldwork devoted only to the Makrygialos assemblage, the relevant samples incorporated here were characterised macroscopically as 'Brown-on-Buff'. This was due to their olive green appearance, their lack of elaborate burnishing, their 'soapy' texture compared to the typical Brown-on-Cream and their few dark brown inclusions, visible in hand specimen (*pl.* 6.8d). The close association between this fabric group and Fabric Group 1 is not only due to the fact that their groundmass exhibits great compositional, textural and colour similarities, but also because of the mineralogy of the red/brown Tcfs, which may represent the coarse red component of a clay mix. All the main mineral and rock fragments included in the Tcfs (e.g., quartz, feldspar, zoisite, micas, amphibole, quartz-mica-epidote schists and rare phyllite) seem compatible with the amphibole-epidote-chlorite schist deposits to the North of Dimini, as well as the Mica schists-phyllites deposits of the Upper(?) Jurassic in the same area. As seen earlier, a similar suite of minerals and rocks predominate in Fabric Group 1; only their grain size is considerably smaller. In terms of mineralogy and texture, Fabric Group 2 stands between the fine Fabric Group 1 (comprising samples from all four sites under study) and the coarse Dimini fabrics. If this is correct then, along with more evidence from coarse Dimini fabric groups that will be presented later in this section, it supports the argument that the Brown-on-Cream found in Makrygialos, Agrosykia A and Giannitsa B were imported and produced in the same area as the Brown-on-Cream found in Dimini, probably somewhere in its broader region. The association between the main fine Fabric Group 1 and the coarse fabric groups from Dimini is not direct but becomes clearer through the identification of the mineralogy of the textural concentration features (Tcfs) present in Fabric Group 2.

3. Calcareous, Medium to Coarse

Samples: MAK 96/ 42, 188; MAK 97/7, 25; DIM 97/20, 73; AGR 97/23

The mineralogy of this fabric group, along with the texture and colour of the groundmass, resembles that of Fabric Group 1. The difference between the two lies in

the fact that there is a considerable increase in the frequency and grain size of inclusions (especially of monocrystalline and polycrystalline quartz) of the metamorphic rock fragments and the percentage of carbonate rocks (micritic limestone). Therefore, Fabric Group 3 is considered the coarser version of the main Fabric Group 1 (*pl.* 6.9).

Technological information

DIM 97/73 preserves, on one surface, a red/reddish brown slip whose thickness ranges from 0.02 mm to 0.04 mm. It incorporates not only monocrystalline quartz grains but also small mica laths aligned parallel to the vessel's walls. In MAK 97/7, traces of a dark brown slip are visible partially and on the external surface only.

Discussion

These samples were found at Makrygialos, Dimini and Agrosykia A and are mainly associated with the Brown-on-Cream ware and the open conical bowl shape, except DIM 97/73 which is Brown Burnished with reddish painted zones (probably Polychrome) and is a 'fruitstand'.

Heterogeneity is quite marked in sample AGR 97/23, but a small volcanic rock fragment present here appears very similar to one found in DIM 97/25 (Fabric Group 1) and in DIM 97/18 (Fabric Group 2). The apparent coarseness of this group may be related to the process of clay mixing.

Within a single ceramic assemblage (Dimini), the fact that different clays are used to produce the same ware and shape can be explained in a number of alternative ways:

- perhaps the main Fabric Group 1 could be ascribed to a main centre of production which distributed its products over long distances while the small Groups (2-3) could be seen as the products of smaller, contemporary centres of production located in the same region;
- as due to the temporal parameter: the duration of the later Late Neolithic is estimated as 300 years which means that probably 10 generations of potters were involved in the manufacture of this ceramic category. Natural variation within the clay sources used could also create the impression of different sources being exploited;

- contemporary potters used different clay sources within the same region, either due to restricted access to the main source used for the major Fabric Group 1 or as a deliberate choice to follow a certain tradition.

It is striking, however, that the majority of Brown-on-Cream ware found in Makrygialos, Agrosykia A and Giannitsa B is associated with Fabric Group 1 (the largest in terms of quantity). Within these sites the same clay recipe is not used in the manufacture of any other ware group. This is taken as another indication that Dimini and its region could be considered as the location of production of this particular ware.

4. Limestone with Phyllite

Samples: MAK 97/1, DIM 97/3

This semi-fine to medium-coarse fabric group is distinctive in terms of the texture and colour of the groundmass, but also in terms of the distribution and composition of non-plastics. The moderately sorted inclusions, usually sub-rounded to rounded, are set in a generally homogeneous, yellowish brown to brown groundmass, which is relatively optically active, along with about 5-10% voids. The inclusions comprise monocrystalline quartz, limestone (rounded micrite) and less frequent microfossils, fine to semi-fine phyllite rich in biotite mica, muscovite mica, polycrystalline quartz, quartz-mica-zoisite schist and rare serpentine (*pl.* 6.10).

Discussion

This fabric group was found only amongst the pottery of the two major sites (Makrygialos and Dimini). Within the Makrygialos assemblage it is rare and does not seem to be common in Dimini on the basis of our sample. Although the clay recipe is associated with the Brown-on-Cream ware, the production technology of this fabric category clearly differs from the previous Groups (1-3). The light, yellowish brown groundmass, with a relative optical activity, suggests lower firing temperatures, although lack of colour differentiation between core and margins does point to a stable, controlled firing atmosphere, as was the case with Fabric Groups 1-3. The different manipulation of the raw materials here is reflected in the distribution of non-plastics across the thin-section and the lack of similar textural concentration features found in Fabric Groups 1-3, and is an indication of clay mixing. On the other hand, there are certain types of non-plastics that link Fabric Group 4 with the previous groups; the

rounded micrite, for instance, appears in Fabric Group 3. Also, some of the metamorphic rock fragments, e.g., quartz-mica-epidote schist, or the rare serpentine, were also present in samples of the fine calcareous groups. In general terms, however, it is difficult to make these associations with confidence. Due to this and the lack of distinct mineralogy, it is not safe to suggest a possible source for the raw material.

5. Fine to Semi-fine with Carbonate Rocks

Samples: MAK 96/103, DIM 97/17, GIAN 97/9

This fabric group consists of sub-rounded to rounded inclusions that exhibit a weakly bimodal distribution and are set in a yellowish to orange brown, generally homogeneous, slightly optically active groundmass. The clay matrix, containing *c.* 10% voids, is densely packed. The non-diagnostic inclusions comprise carbonate rocks (mainly micrite and rarely sparite crystals), monocrystalline and polycrystalline quartz, muscovite and biotite mica laths, some dark brown Tcfs (which increase in GIAN 97/9) and very rare quart-biotite schist (*pl.* 6.11).

Technological information

Slight optical activity of the clay matrix suggests a lower firing temperature than that in Fabric Groups 1-3, where the groundmass is inactive to even glassy in some places. All of them (including Fabric Groups 4 and 5), however, show no colour differentiation between core and margins, which points to a stable, well-controlled firing atmosphere. MAK 96/103 preserves, on one surface only, parts of a dark brown slip which incorporates very small monocrystalline quartz grains and mica laths; its thickness ranges from 0.02-0.03 mm. An orange brown slip is also partially preserved on the inside surface of DIM 97/17. It should be noted that, due to its very weathered surface, it is not really clear whether this sample belongs to the Brown-on-Cream ware.

Discussion

The Dimini and Giannitsa samples inthis Fabric Group belong to the Brown-on-Cream ware and are open conical bowls, as are the majority of the samples related to this ware. The sample from Makrygialos belongs to the Polychrome ware and it is part of a bowl (probably a 'fruitstand'). Although all Fabric Groups (1-5) so far share, more or less, the same wares and shapes, Fabric Group 5 cannot be linked with the fine,

calcareous Groups 1-3 due to their striking differences, mainly in texture, colour of the groundmass, distribution of non-plastics and firing conditions. In contrast, Fabric Group 4 appears to be more similar to Group 5 in terms of these characteristics but, compositionally, the former incorporates more limestone and microfossils; additionally, there is an increase in the amount of metamorphic rock fragments in Group 4 and it is coarser and more densely packed than Group 5. Here again, provenance ascription is not attempted as there are no clear, direct or indirect, links between this particular mineralogy and either closely associated fabric groups or relevant geological formations.

6. Calcareous with Biotite Schist and Limestone

Samples: DIM 97/21, 46, 66, 67, 75

This coarse fabric group comprises only samples taken from Dimini. The angular to rounded inclusions are set in a calcareous, fine to semi-fine, homogeneous groundmass and, together with about 10% voids, exhibit a strongly bimodal grain size distribution. The dark brown to greenish brown clay matrix is optically inactive. The non-plastic inclusions consist predominantly of large, coarse metamorphic rock fragments. Quartz-biotite schist dominates, often with brown clay 'veins' and/or opaque minerals and common micritic limestone, polycrystalline and monocrystalline quartz, feldspars, sericite, rare textural concentration features and very rare fine phyllite along with small metamorphic fragments that contain minerals of the epidote group (*pl.* 6.12).

Discussion

The above fabric group stands between the fine and semi-fine Fabric Groups 1-3, associated with the painted 'Thessalian' Brown-on-Cream ware (found in all four sites under study) and the coarse fabric groups which follow, the majority of which are found within the Dimini material (only extremely limited samples from Makrygialos belong to these groups and are considered to be imported).

Of the five samples, two are Red Slipped and Burnished storage jars (pithoi), one is a Brown-on-Cream deep conical bowl, one a Red-on-White open bowl, and the last a Polychrome 'fruitstand'. Here again, calcareous clays seem to have been chosen

for the manufacture of painted wares with a light background, as is the case with the 'Dimini' Brown-on-Cream.

This fabric group is closely linked with the calcareous Fabric Groups 1-3 (found in all four comparative sites and associated only with Brown-on-Cream ware), through striking similarities in the composition, texture, colour of their groundmass and firing conditions. What sets this fabric group apart, however, is the composition and distribution of non-plastic inclusions across the thin section. It is possible that for the making of this clay recipe ancient potters used a similar calcareous clay to that found in Groups 1-3, but added large, angular metamorphic rock fragments. The choice of a calcareous base clay can be explained by the presence of painted decoration on a light background in all samples. It is not clear, though, whether the coarseness of the fabric served a functional purpose as only two of the samples are large storage jars.

This particular suite of rocks and minerals may be associated with the Gneiss-schist formations of the Eohellenic Tectonic Nappe to the South and West of Dimini, which extend to a relatively large area around the settlement. Their main constituents are feldspars, biotite, muscovite mica, epidotes, chlorite and quartz with occasional thick-bedded marble intercalations (IGME 1986). It is, thus, cautiously suggested that the clay source of the non-plastic inclusions may have been located to the South-west of Dimini.

7. Biotite Schist

Samples: DIM 97/43, 44, 48

This generally homogeneous, coarse fabric group consists of a densely packed, relatively optically active clay matrix, about 10-15% voids and coarse non-plastics. The angular to rounded inclusions are set in a reddish/orange brown to brown groundmass that appears rather 'sandy'. The distribution of non-plastics is strongly bimodal; they consist of quartz-biotite schist and rare quartz-muscovite schist, polycrystalline (strained in some cases) and monocrystalline quartz, biotite and muscovite mica laths, feldspar and dark reddish brown textural concentration features. Much lower is the percentage of plagioclase (polysynthetic twinning), and smaller metamorphic rock

fragments, which contain quartz and small, high birefringent mineral grains (mainly zoisite and less epidote and clinopyroxene) (*pl.* 6.13).

Discussion

All three samples in this fabric group were found within the Dimini ceramic assemblage and all three are Polychrome fruitstands'.

In terms of the composition of inclusions this fabric group is closely associated with the previous Fabric Group 6, except that in Group 7 the limestone inclusions are not present (apart from sample DIM 97/43 where some sub-rounded micrite still occurs). The striking elements that separate Fabrics Groups 6 and 7, however, are the texture, composition and colour of the groundmass, along with the different firing conditions. The processing and firing of clay are markedly different; in Fabric Group 7, for instance, the non-plastics are set in a densely packed matrix which appears very 'sandy' and is characterised by weak optical activity. This may indicate a lower firing temperature. In addition, and in contrast to Fabric Group 6, there is an observed colour differentiation between core and margin (especially in DIM 97/44, 48): from greyish/yellowish brown core and reddish brown margins in PPL to yellowish brown core and dark reddish brown margins in XP (x40). The firing horizon in Fabric Group 6 changes from greyish/yellowish brown margin to reddish brown core to orange yellow margin in XP (x40). This probably suggests poor control over the firing process. In contrast, the bright orange/red clay base of DIM 97/43 in both PPL and XP (x40) shows that it was fired in an oxidising atmosphere.

The mineralogy of the non-plastic component of this fabric group seems compatible with that of the previous Fabric Group 6 and, therefore, it can be argued that these inclusions represent crushed and added material that originally derived from the Gneiss-schist formations, lying to the South and West of Dimini (IGME 1986).

8. Coarse Schist-Phyllite-Serpentine

Samples: DIM 97/24, 38, 39, 42, 45, 59, 64, 65, 68, 70, 72, 76

This very coarse fabric group is characterised by a general homogeneity in terms of the colour and composition of the groundmass, and non-plastics of markedly

different lithologies. The plastic component and the angular to sub-angular inclusions, which are set in a densely packed groundmass, along with about 10% voids, form a strongly bimodal distribution. The clay matrix is generally optically active. Non-plastic inclusions consist mainly of metamorphic and sedimentary rock fragments: cataclastic rock fragments (mylonitised polycrystalline quartz, plain or with brown veins of possibly biotite mica and/or opaques), quartz-biotite schist, and carbonate rocks (mainly micrite but also sparite crystals) predominate in the fabric. Also present are coarse phyllite, often with dark brown clay veins or opaques (iron oxide?), chlorite schist, rock fragments consisting of mica, epidote/zoisite and/or actinolite, serpentine/serpentinite, amphibole (both actinolite and hornblende), clinopyroxene, slate, and black and dark brown opaque minerals. These co-exist with less frequent aggregates of limestone (or metamorphosed limestone/marble?) with polycrystalline quartz and/or plagioclase, and some dark red and brown textural concentration features (some of them with 'snowball' texture or siltstones) (*pl.* 6.14).

Technological information

The strongly bimodal grain size distribution and the angular to sub-angular inclusions, along with the nature of the Tcfs, probably suggest crushed tempering material rather than clay mixing.

Discussion

All samples in this fabric group were found at Dimini. In contrast to the previous fabric groups, where clay recipes were ware and shape specific, here there is a much wider range of wares and associated shapes; mainly Black-on-Red open bowls, with one Brown-on-Cream, open conical bowl, Polychrome associated with 'fruitstands', Undecorated pithoi and large bowls, Black Burnished, Reddish Brown Burnished and Brown Slipped Burnished.

What separates this fabric group from the previous two is the noticeable mixture of different lithologies. Both Fabric Groups 6 and 7 lack the quantity as well as the variety of sedimentary rocks present in Fabric Group 8 and the phyllites and schists in this group are much coarser than the ones in the previous fabric groups where no serpentine is present either. More importantly, the texture of mainly zoisite and amphibole grains contained in the metamorphic rock fragments that are present in this fabric group appear to resemble those that represent the main constituents of the textural

concentration features (Tcfs) of the calcareous Fabric Group 2. These in turn are closely related to the non-plastics of Fabric Group 1, which is only associated with the Brown-on-Cream ware.

The varied lithologies that characterise this Fabric Group may suggest that the raw materials used were not primary rock material but rather taken from alluvial deposits. The composition of most of the non-plastic inclusions are compatible with some of the metamorphic facies of the Eohellenic Tectonic Nappe of the Thessalian Dimini area; namely, the Mica schists-phyllites (Upper ? Jurassic), the Amphibole-epidote-chlorite schist, and the Marbles (Middle Triassic-Upper Jurassic) deposits, which all extend to the North and North-west of Dimini (IGME 1986).

NB: There is one sample from Dimini (DIM 97/63), an open undecorated vessel, which stands between Fabric Groups 7 and 8. It is compositionally and texturally closer to Fabric Group 7; what mainly separates the groups is the lack of carbonate material in Group 7. This particular type of sedimentary rocks links the above sample with Fabric Group 8 which incorporates a high percentage of limestone. However, the type of schist and phyllite within the two clearly differs in terms of grain size and texture.

9. Cataclastic Biotite Schist and Limestone

Sample: DIM 97/19

This homogeneous, coarse fabric group consists mainly of cataclastic material and micritic limestone set in a dark brown, optically inactive groundmass, along with *c.* 10% voids. The angular to rounded inclusions exhibit a strongly bimodal grain size distribution. They dominantly comprise strained polycrystalline quartz (probably due to dynamic metamorphism) and carbonate rocks (micrite); less frequent is the presence of quartz-biotite mica schist with very few to rare dark brown textural concentration features and serpentine (*pl.* 6.15).

Discussion

This sample is from Dimini and its fabric group was not found in the other comparative sites. It is the matt painted Brown-on-Cream (unusual for this ware) associated with the typical open conical bowl. Again, this painted ware is linked with a

specific calcareous base clay that exhibits general similarities with that found in Fabric Groups 1-3 and 6, although this one appears coarser. The inactive to glassy groundmass and lack of colour differentiation between core and margins suggests a high firing temperature and a controlled atmosphere, as is the case with the aforementioned fabric groups. In compositional terms this coarse fabric group differs from the rest, although some links may be made with Fabric Groups 1-3 through their dark brown, inactive to glassy, calcareous groundmass.

10. Cataclastic Muscovite Schist

Samples: DIM 97/58, 60

This medium coarse to coarse fabric group consists of moderately to poorly sorted, sub-angular to sub-rounded inclusions, set in a yellowish brown, generally optically active, homogeneous, 'sandy' groundmass along with *c.* 10% voids. The non-plastics, which exhibit a strongly bimodal grain size distribution, consist of mainly quartz-muscovite schist, strained polycrystalline quartz, muscovite mica laths, few to rare quartz-muscovite-clinozoisite schist, phyllite, very rare acid igneous rock fragments, alkali feldspar (sericitised) and plagioclase with polysynthetic twinning (*pl.* 6.16).

Discussion

Both samples are from Dimini and are of Black Burnished ware, representing open and closed vessels. In both cases there is a strong preferred orientation of the non-plastic inclusions: parallel to the vessel's walls in DIM 97/60 and diagonal in DIM 97/58.

Although this fabric group is dominated by cataclastic material, an element that could associate it with Fabric Group 9, there are certain compositional, textural and technological features that separate the two groups. First of all, in this fabric group, muscovite rather than biotite schist predominates along with mylonitised polycrystalline quartz, whilst the rare coarse igneous rock fragments and feldspar with crystal intergrowth are not found in Fabric Group 9. The yellowish brown, generally optically active, groundmass indicates relatively low firing temperatures. This particular rock and mineral suite appears compatible with the Mica schist-phyllite formations of the

Upper(?) Jurassic, which are found in a small area to the West of Dimini and extensively to the North and North-west (IGME 1986). The main mineralogical constituents of these rocks, which exhibit a schistose structure, are predominant muscovite and lesser biotite mica and either orthoclase or acid plagioclase feldspars. It is therefore suggested that, due to this compatibility, and the fact that similar mineralogy is not found in any of the samples belonging to the rest of the comparative sites, this pottery may have been manufactured somewhere near the Dimini area.

11. Metamorphosed Igneous and Metamorphic Rocks

Sample: DIM 97/40

This single sample stands out for the coarseness of its large, angular to rounded non-plastic inclusions comprising different lithologies; they also form a clear bimodal grain size distribution with a medium coarse, non-calcareous clay matrix with *c.* 15% voids. Inclusions that dominate consist of metamorphosed igneous rocks together with sub-rounded to angular metamorphic rock fragments, the constituent minerals of which are quartz and weathered grains of mainly epidote/clinozoisite, zoisite and/or clinopyroxene. These are also present in other coarse 'Dimini fabrics'. Also present are less frequent biotite and/or chlorite schist along with serpentine or serpentinised rocks and fine phyllite; in addition, there are rare, well-rounded acid igneous rocks with opaque minerals (iron oxide?) and dark brown to orange red mudstones (?). Relatively smaller is the percentage of micritic limestone, mono- and polycrystalline quartz, feldspar (often with quartz grain intergrowth), plagioclase feldspar with polysynthetic twinning and an aggregate of four large, well-preserved interlocking crystals of clinopyroxenes (diopside?) with reddish brown clay veins and small opaques (*pl.* 6.17).

Technological information

There is a colour differentiation in the firing horizon, from a dark brown core to greyish/yellowish brown margins. The dark colour possibly suggests a reducing firing atmosphere. On the inside surface of the pot there are remains of an orange red slip, whose thickness can in some places be up to 0.04 mm, incorporating small quartz mineral grains. This slip covered the vessel's clay body in order to create a contrast with the black painted decoration.

Discussion

The combination of this particular fabric group with the Black-on-Red ware is only found within the Dimini material. Although most of the rocks and minerals present in the fabric group are found individually in other coarse 'Dimini' fabric groups, this particular clay recipe seems to be very different from the majority of the Black-on-Red samples represented, in terms of fabric, within the Dimini material (see below, Fabric Group 14). The sub-rounded to rounded shape of inclusions, along with the different lithologies mixed in one clay recipe, probably suggest that the material was not taken from the parent rock but from available alluvial deposits. It is, thus, difficult to suggest a single, possible clay source.

12. Epidote, Clinopyroxene, Metamorphic Rocks

Samples: MAK 97/11, 52

DIM 97/26, 36, 41, 49, 51, 61

This fabric group is characterised by a general homogeneity. The angular to sub-rounded non-plastic inclusions are set in a very dense, optically highly active (DIM 97/41, MAK 97/52) to optically slightly inactive (DIM 97/56) groundmass and form a strong grain-size distribution. Voids represent *c.* 5%. The inclusions consist mainly of individual mineral grains of epidote/clinozoisite, zoisite, clinopyroxene, amphibole (some of these minerals appear weathered – with a very cloudy appearance and/or cracks), polycrystalline quartz and plagioclase feldspars, usually with quartz grains and mica intergrowth, together with coarse metamorphic rock fragments with interlocking crystals that in some cases exhibit foliation. They comprise mainly coarse zoisite-clinozoisite/epidote-mica schist (gneiss?), biotite-muscovite-zoisite and/or glaucophane rock fragments, quartz-biotite-garnet (?) schist (DIM 97/61), quartz-chlorite-epidote schist, and amphibolite facies rock fragments (*pl.* 6.18).

Technological information

The optically active groundmass is taken as an indication of a relatively low firing temperature. A colour differentiation between core and margins appears in most samples; it ranges from yellowish/greyish/greenish brown core to reddish brown and orange/red margins. The alignment of the long-axes of both non-plastic inclusions and voids to the vessels margins is moderate to poor and, thus, does not offer clear

information on the manufacturing technique used.

Discussion

This fabric group is associated with a rather wide range of wares. Three samples are Incised, small closed vessels, three are Black-on-Red, open conical bowls and one is a 'fruitstand', whilst the last two are Polychrome and Black Burnished, associated with a 'fruitstand' and an open bowl respectively.

In terms of the composition of non-plastics, this fabric group does include some minerals and metamorphic rock fragments also present in the coarse metamorphic fabrics of Dimini, e.g., Fabric Group 8. It differs from the rest, however, in that it has no cataclastic rock fragments and fewer to absent carbonate rocks or metamorphosed limestone, phyllite-mica schists and serpentinite. In contrast, the percentage of epidote group minerals, clinopyroxene and amphibole increases as they appear in different combinations with micas and quartz. Here, the metamorphic rocks are much coarser and consist of interlocking crystals. It is suggested that this particular suite of minerals and rocks may be related to the greenschist facies metamorphism of the Eohellenic Tectonic Nappe of the Dimini area, in Thessaly, namely, the amphibole-epidote-chlorite schist and the Gneisses, gneiss-schist deposits that lay in the North and South-southwest of Dimini respectively (IGME 1986).

What is of a great importance in this group is the presence of one Incised and one Black-on-Red sample that were found within the Makrygialos assemblage rather than Dimini where all the others come from. As this fabric group is considered to have its origins in Thessaly, it can be suggested that this represents strong evidence for the movement of two more categories of pottery (in addition to the painted Brown-on-Cream ware) over a very long distance (up to 220 km).

13. Micaceous with Quartz-Biotite-Muscovite Schist

Samples: MAK 96/18, 117, 154; MAK 97/69

DIM 97/50, 52, 53

This coarse fabric group consists of angular to sub-rounder non-plastics which are set in a generally homogeneous, densely packed and mica-rich, optically active clay

matrix and form a bimodal grain size distribution. Voids represent *c.* 10-15%. The predominant inclusions comprise large quartz-biotite- and/or muscovite schist rock fragments along with muscovite and biotite mica laths, polycrystalline and monocrystalline quartz, phyllite rich in biotite mica, and rare serpentinite, black and brown opaque minerals, aggregates of quartz with epidote and dark reddish brown textural concentration features, and siltstones (in MAK 97/69). All samples, with the exception of DIM 97/50, exhibit inclusions with a strong schistose structure, while there is a notable preferred orientation of non-plastics, either diagonal or parallel to the vessel walls. Some of the coarse metamorphic fragments of this fabric group are also present in Fabric Group 12. MAK 97/69 exhibits a certain degree of heterogeneity in comparison to the other samples. Although it bears most of the general compositional and textural characteristics of the fabric group, it includes some dark reddish/brown textural concentration features, relatively evenly distributed across the section. In addition, the percentage of quartz increases in this sample (*pl.* 6.19).

Discussion

In this fabric group, again, four out of the seven samples are from Makrygialos (MAK 96/18, 96/117, 96/154 and MAK 97/69). Six of them are Incised, small closed jars (usually with white/pinkish paste as infilling to their incisions), one 'fruitstand' and one bowl. The only exception seems to be sample MAK 97/69, which belongs to the Black-topped ware.

This fabric group represents another significant piece of evidence for the long-distance movement of this category of Incised pottery. Fabric Group 13 comprises an alternative clay recipe used for the manufacture of this ware group, the other clay recipe being Fabric Group 12. Compositionally, the non-plastic inclusions of this group bear some similarities with the Mica schists-phyllites series of the Upper (?) Jurassic which appear in a small area to the West of Dimini and more extensively to the North and North-west (IGME 1986). In order to be able to confidently suggest a specific clay source, clay samples local to the Dimini area should be studied in future work.

14. Medium-fine to Semi-coarse

Samples: DIM 97/22, 23, 28, 29, 30, 31, 32, 33, 34, 37

This generally homogeneous fabric group exhibits a weakly to strongly bimodal grain size distribution of the angular to rounded inclusions, which are generally moderately (DIM 97/31, 33) to poorly sorted (DIM 97/32, 34) and set in a relatively densely packed, medium to coarse clay matrix. Voids comprise about 10%. The fabric consists largely of monocrystalline, polycrystalline quartz and plagioclase feldspar. The margins of some individual mineral grains are surrounded by micritic limestone, forming an 'oolith' like appearance, e.g., DIM 97/31, 32, 37. These inclusions might have derived from a marly, calcareous geological environment or in some cases they may be secondary calcite in a surrounding void. Also present are biotite and muscovite mica laths, very fine-grained volcanic rock fragments, coarse-grained metamorphic rocks that range from mylonitised polycrystalline quartz and different types of mica schists to clinozoisite/epidote-zoisite fragments, and, frequently, biotite and/or muscovite mica and polycrystalline quartz. Less frequent is the occurrence of carbonate rocks and crystalline limestone (marble?) together with rare serpentinite, chert, Tcfs, and discrete crystals of zoisite, clinopyroxene and amphibole (*pl.* 6.20).

Technological information

According to preservation conditions, some slips are partially visible, either on both external and internal surface (in open vessels), or only on one of them. In DIM 97/22, 97/30, 97/33 and 97/34 a reddish orange slip is preserved on the external and/or internal surface; its thickness ranges from approximately 0.02 mm to 0.1 mm and it contains small grains of monocrystalline quartz. In other cases both the black/dark brown and red/orange slips that constitute the painted decoration are well-preserved one on top of the other. Sample DIM 97/28 shows this on both surfaces of an open conical bowl. The black/dark brown slip used for the decorative motifs appears much thinner (hardly 0.02 mm) and compact than the red/orange slip covering the surface of the vessel (almost 0.04 mm) which incorporates small grains of monocrystalline quartz and biotite mica.

There is generally moderate to poor alignment of both voids and inclusions to the vessels margins. However, in some samples a moderate to strong alignment of the long axes of both aplastic inclusions and voids is observed, either parallel or diagonal to the vessels margins (DIM 97/23, 29, 31, 34).

Discussion

This fabric group was only found in samples from Dimini and is associated with the Black-on-Red ware. Six out of ten samples are open conical bowls and the rest are small closed jugs with vertical handles.

The non-plastic inclusions clearly demonstrate that their mineralogical composition is similar to that of Fabric Groups 6-8 whose origin is probably in the Dimini area. Samples DIM 97/31, 32, 37 contain a higher amount of calcareous material, where the frequency of metamorphic rock fragments and serpentinite is also higher.

15. Fine to Semi-fine, Non-calcareous

Samples: MAK 96/1, 11, 22, 25, 31, 36, 48, 49, 72, 78, 92, 130, 131, 132, 145, 146, 147, 158, 159, 160, 195, 210, 214, 225
MAK 97/4, 5, 9, 12, 14, 21, 26, 49, 65

Compositional and textural homogeneity characterises this fabric group. It consists mainly of well to very well sorted, angular to rounded inclusions, set in a densely packed, 'sandy' clay matrix that forms a unimodal to weakly bimodal grain size distribution. Voids comprise *c.* 5%. The groundmass varies from optically very active (MAK 97/14) to inactive (MAK 96/146, MAK 97/12). The non-plastics contain mainly monocrystalline quartz that is densely and evenly spread throughout the section, along with small laths of mica, predominantly muscovite and less biotite, and amphibole. Very small grains of ferromagnesian minerals, including clinopyroxene, are also present in both fractions. Fabric Group 15 also incorporates saussuritised feldspar, microcline, and intermediate igneous rock fragments. Rare limestone (micrite and sparite) and shelly limestone are also present and are more abundant in sections MAK 97/26, 49 (*pl.* 6.21).

Technological information

Here, there is a colour differentiation between the core and margins present in most samples. It ranges from greenish/greyish brown or dark grey core to yellowish/reddish orange margins. There are very few samples with no colour differentiation between core and margins; their colour is red/orange red and brownish

red, e.g., MAK 97/14, 49. This picture hints at different firing conditions in contrast to the homogeneous colour of the groundmass of the Brown-on-Cream associated with Fabric Group 1. In sample MAK 96/145 there is a rare example of both red slip and black/dark brown paint being preserved on the outside surface; the boundary between the two appears to be diffuse (the application of slips in the Brown-on-Cream ware is much more elaborate). The thickness of both layers together does not exceed 0.02 mm.

Discussion

This fabric group has been identified only within the Makrygialos assemblage. The dominant shape associated with it is open conical bowls, either shallow or deep and in one case pedestalled ('fruitstand'). All the wares made with this clay recipe represent fine, decorated pottery such as Black-on-Red, Polychrome, Black-topped, Brown Burnished, Black Burnished, Pattern Burnished, Red slipped Burnished and Brown-on-Cream II. The majority of samples in this group belong to Black-on-Red ware and their base clay appears to be generally non-calcareous. In addition, more than one ware group was made with this clay paste, in contrast to the Brown-on-Cream ware, of which approximately 95% of the samples were made with a single clay recipe which was processed, manufactured and fired in a rather standardised manner (*pl.* 6.22).

During the macroscopic fabric examination of the Makrygialos material it was difficult to separate the fabrics of Brown-on-Cream and Black-on-Red wares, as both categories were manufactured with very fine clays and lacked distinct inclusions. However, careful observation of the texture, colour, hardness and distribution of voids and inclusions made separation possible (see Appendix A). The microscopic separation and justification of the two fabrics (Fabric Group 1 associated with Brown-on-Cream and Fabric Group 15 associated with mainly Black-on-Red) was slightly easier, thanks to the process of the detailed petrographic descriptions. The compositional and textural differences between the two fabrics became clearer. Fabric Group 1, for instance, contains very fine, brown phyllite, which is not present in Fabric Group 15, whilst the Fabric Group 15 contains saussuritised feldspar, microcline and intermediate igneous rock fragments that are absent from Fabric Group 1. In addition, the optically inactive clay matrix of Fabric Group 1 differs strikingly from the rather 'sandy', generally optically active groundmass of Fabric Group 15 (*pl.* 6.23a and b respectively).

The fine nature of this fabric group in the absence of any distinct non-plastic

inclusions does not really permit any relaible conjectures as to provenance. Such a clay paste is not distinctive: similar geological deposits are common in the broader area of north and central Greece. It is important to stress, however, that base clay identical to that of Fabric Group 15 is associated with another fabric group present within the Makrygialos material, which is considered local to the area (Fabric Group 25). Therefore, by association, it is suggested here that Fabric Group 15 should be considered local to Makrygialos, something that may be supported by the fact that the same recipe was not found in any of the other comparative sites studied.

16. Semi-fine to Medium-coarse

Samples: MAK 96/5, 26, 32, 33, 111, 128, 149, 169, 178, 202
MAK 97/34, 41, 42, 50, 75

Fabric Group 16 appears similar to 15 but can be separated on grounds of texture and composition. Large grains of predominantly monocrystalline, polycrystalline quartz and feldspar are present more frequently, together with some carbonate rocks (micrite), acid igneous and metamorphic rock fragments (mainly muscovite and/or biotite mica schist) and well-preserved crystals of clinopyroxene. The percentage of muscovite mica laths is more frequent and in some cases they exhibit a strong alignment, diagonal to the vessel margins. Very rare intermediate igneous rock fragments are also present (e.g., MAK 96/33). Sample MAK 97/75 contains titanite (sphene) that predominantly occurs amongst the Makrygialos and Agrosykia A ceramic assemblages. The different size of the angular to rounded non-plastics points to a bimodal grain size distribution in contrast to the unimodal to weakly bimodal distribution of inclusions in Fabric Group 15. Further to this, the general texture of the groundmass in Fabric Group 16 differs as the percentage of voids increases to 10-15% (5% in Fabric Group 15) and the packing of inclusions appears less dense (*pls.* 6.24).

Discussion

All samples belonging to this fabric group were found in the Makrygialos assemblage and they are associated predominantly with Black-on-Red ware (also two Brown-on-Cream II, two Brown slipped and burnished and one Polychrome) and are open, conical bowls (except one carinated bowl and one storage(?) vessel). The range of wares manufactured with this particular clay recipe appears quite similar with that

observed in Fabric Group 15. This picture differs from the production pattern of the Brown-on-Cream ware. It is still, however, associated with decorated, semi-fine to medium-coarse pottery.

In strict compositional terms Fabric Groups 15 and 16 are not characterised by distinct mineralogical differences and, therefore, may have derived from the same geological environment. The fact that all samples were found within the Makrygialos material and bear no textural or obvious compositional similarities with the 'local' to Dimini, Agrosykia and Giannitsa Fabric Groups suggests that the clay source used may have been located in the immediate region.

17. Semi-fine to Medium-coarse with Carbonate Rocks

Samples: MAK 96/12, 53, 55, 57, 64, 65, 67, 68, 69, 70, 71, 99, 102, 114, 122, 142, 174, 182, 191, 221, 222; MAK 97/6, 23, 29, 33, 39, 56, 63, 70

The main reason for the separation of this fabric group from Fabric Group 16 is the presence of carbonate rocks, both micrite and sparite crystals (either plain or with small grains of monocrystalline quartz, mica laths and/or small ferromagnesian minerals) together with rare shell (e.g., MAK 96/68, MAK 97/56, 63). The presence of very few to few intermediate igneous rock fragments, i.e. andesite (MAK 96/174, 221, MAK 97/23) is also striking. Apart from these presences, the basic compositional, textural and technological characteristics of the two groups are generally similar (*pl.* 6.25).

There is some observable variation between members of this fabric group; for example, samples MAK 96/55, 64, 71, 102, 182 and MAK 97/29 appear much more calcareous, where the frequency of carbonate rocks, ostracods and shell fragments substantially increases. Their groundmass has an almost olive green to yellowish green colour and is less optically active than the rest of the samples. In addition, in MAK 97/70 microcline and 'fresh' plagioclase with polysynthetic twinning occur more often.

Discussion

The majority of this group consists of:

- Black Burnished pottery (ten samples), mainly associated with small and large

bowls, either carinated or with almost vertical walls; two of them are probably storage or cooking jars.

- Black-topped, carinated bowls (four samples).
- Incised II, fenestrated pedestal bowls (four samples).
- Red (three samples) and Brown (one sample) Slipped Burnished, Bichrome (two samples), Incised I (two samples), Brown Burnished (one sample) and, surprisingly, one Brown-on-Cream I.

The clay recipe of the latter sample resembles those considered to be 'local'. It cannot be associated with the main Fabric Group 1 of the 'typical' Brown-on-Cream, even though it is an open conical bowl and the decoration appears very similar to the Brown-on-Cream that are considered to have been 'imported' to Makrygialos.

18. Medium to Coarse with Carbonate Rocks

Samples: MAK 96/74, 80, 113, 144, 209
MAK 97/13, 64

This generally homogeneous fabric group consists of large, angular to rounded, poorly sorted non-plastic inclusions, set in a semi-fine, densely packed groundmass which exhibits a general high optical activity. They form a strongly bimodal grain size distribution. Voids represent *c.* 15%. Monocrystalline quartz and carbonate rocks predominate; the latter are mainly micrite and contain either small quartz grains or 'veins' of sparitic material. Also present are polycrystalline quartz, plagioclase feldspar (polysynthetic twinning), alkali feldspar (often with a cloudy appearance), muscovite and biotite mica laths, very few shell fragments, intermediate rock fragments (andesite), fine biotite or muscovite schist, sericite, rare ostracods, reddish brown siltstones, very rare to absent sandstone (with biotite mica 'veins') and titanite (*pl.* 6.26).

Technological information

The generally optically active, yellowish/greyish brown groundmass, with no colour differentiation between core and margins, suggests a relatively low firing temperature. Samples MAK 96/12, 113, 144 preserve partially a reddish brown slip either on both or (usually) on the outside surface of two Incised II and one Red Slipped and Burnished bowls. These slips often incorporate small mineral grains (monocrystalline quartz, micas etc).

Discussion

The wares and shapes involved in this fabric group are: three Brown Burnished, storage vessels, two Incised II, fenestrated pedestal bowls, one Red Slipped and Burnished storage vessel and one Black-topped, large carinated bowl. As is the case in Fabric Groups 15-17, here again a wide range of wares and shapes is associated with this particular clay paste, although all of them comprise decorated, generally fine pottery.

The compositional and textural characteristics of the groundmass resemble those of the three previous 'local' to Makrygialos fabric groups (especially Fabric Group 16). The same applies to the composition of non-plastic inclusions. What differs in this fabric group is the considerably larger size of the poorly sorted inclusions, which are set in a semi-fine clay matrix. The compositional and textural similarities with Fabric Groups 16-17 and the abundance of carbonate material, which probably derives from the brown Pleistocene Aeolian deposits surrounding Makrygialos, strongly suggest local provenance.

19. Medium to Coarse

Samples: MAK 96/19, 56, 118, 189, 194, 203, 213, 224

MAK 97/45, 53

The wares and shapes involved in this fabric group are very similar to those in the previous two. Generally, all the compositional and textural characteristics of this fabric group are very similar to those of Fabric Group 18. The only element that separates them is the absence of carbonate rocks in Fabric Group 19, which might be explained by a possible natural variation in the clay bed used by potters. By association, therefore, it could be argued that this material is also of local origin (*pl.* 6.27).

There are two samples, however, that exhibit a certain degree of variation; MAK 96/203 and MAK 97/45 appear much more micaceous than the rest of the samples, with a strong alignment of the long axes of inclusions, diagonal to the vessel margins. MAK 96/19 incorporates a large irregular void which is a good example of coil joins.

20. Coarse/very coarse, 'Local'

20a (coarse). Samples: MAK 96/8, 73, 107, 164, 168, 173, 186, 205, 212

20b (very coarse). Samples: MAK 96/2, 58, 60, 106, 150, 190

This fabric group is divided into coarse and very coarse sub-groups. Their compositional and textural characteristics appear similar, but they are separated by non-plastic grain-size, which is greater in sub-group 20b. Group 20 consists of angular to rounded non-plastic inclusions, set in a red to brown/yellowish brown, non-calcareous (with the exception of MAK 96/205), base clay with relatively high optical activity (except MAK 96/212). The inclusions form a strongly bimodal grain size distribution within each sub-group, whilst the voids comprise 10-15%. The upper grain size in sub-group 20a is 3.28 mm with a mode of 0.25mm whilst in sub-group 20b the upper size reaches 3.42 mm and the grain size mode increases to 0.40mm. Polycrystalline and monocrystalline quartz predominate along with (often saussuritised) feldspar, common white and/or biotite mica schist, plagioclase and/or microcline with polysynthetic and cross-hatched twinning respectively. The fabric group contains a few sedimentary rock fragments (e.g., chert in MAK 96/190 and micritic limestone); sample MAK 96/205 includes ostracods, which are absent in the other samples. It also comprises common to few clinopyroxene, very few to few amphiboles (mainly actinolite), and rare to very rare fine phyllite, and slate. Textural concentration features are also present; brown to dark brown, rounded to sub-rounded or dark grey/black, sub-rounded to sub-angular. They usually include small mineral grains and exhibit clear to diffuse boundaries. In MAK 96/2 there is a very good example of a large, dark brown feature with a 'snowball' texture, filled with angular quartz grains and mica laths (*pl.* 28).

Discussion

The wares and shapes involved in this fabric group (which incorporates two sub-groups) are:

- Undecorated, storage (?) vessels (five samples).
- Brown Slipped Burnished, one storage and one carinated bowl (two samples).
- Red Slipped Burnished bowl (one sample).
- White-on-Black (unusual), open bowls (two samples).
- Incised II, pedestalled bowl (one sample).
- Brown Burnished, storage vessels and a large bowl/cooking vessel? (four

samples).

It seems that the difference in the grain size of non-plastic inclusions might have been the result of natural variation within the same clay source used by the potters.

21. Coarse/very coarse, 'Local' with Carbonate Rocks

Samples: MAK 96/10, 37, 39, 40, 47, 52, 104, 148, 155, 179, 201, 204
MAK 97/28, 37, 47, 61, 68, 74

The compositional and textural characteristics of this fabric group resemble closely those of Fabric Group 20. The only difference between the two is the presence in this Group of a high percentage of carbonate rocks with clear to diffuse boundaries that are dispersed across the thin section in all samples. They normally contain small, angular quartz grains. In sample MAK 97/47, and more clearly in MAK 96/52 and MAK 97/74, the occurrence of clay concentrations containing marly, calcareous material is notable; in MAK 97/61 shell fragments are also present. This suggests the incomplete mixing of different clays (probably one 'sandy' and one more calcareous) (*pl.* 6.29).

22. Coarse Calcareous

Samples: MAK 96/141, MAK 97/31, 58

This coarse fabric group consists of rounded to angular, poorly sorted non-plastics that are set in a fine, heterogeneous in colour, highly calcareous and optically slightly active to inactive groundmass, which form a strongly bimodal grain-size distribution. Voids comprise *c.* 15% and often exhibit calcite lining. The inclusions consist of dominant micritic carbonate rocks, which usually contain mono- and polycrystalline quartz grains and their boundaries can be from clear to merging. Monocrystalline and polycrystalline quartz are common, along with textural concentration features in three categories: a) dark red, dense clay pellets with sharp boundaries, b) siltstones containing small quartz grains and c) concentrations of a highly calcareous, marly clay with angular quartz grains, whose reddish brown to olive green matrix can be optically inactive to glassy in some places; the boundaries of these clay features are diffuse. Also present are biotite mica laths (oxidised in some cases), high birefringent mineral grains (e.g., epidote), rare shell fragments and very rare to absent

quartz-biotite schist. At the same time, micritic limestone material is dispersed throughout the groundmass of all samples.

Discussion

Samples of this coarse fabric group were found only in Makrygialos. Two of them are unusual ware (exhibiting a light yellow/creamy burnished surface) and one is undecorated. All of them are large storage vessels (pithoi).

This distinct fabric group is characterised by a high percentage of limestone (in the form of micritic carbonate rocks and shell fragments) not only as non-plastic inclusions, but also dispersed in abundance in the micromass. The brown Pleistocene Aeolian deposits surrounding Makrygialos are rich in carbonate material. It must be acknowledged that in AGR 97/31, the large, coarse inclusions are set in a very fine, calcareous, greenish brown to red, optically inactive groundmass that bears some similarities with the groundmass in Fabric Groups 1-3 and 6. In addition, the presence of common clay concentrations provides clear evidence of incomplete clay mixing, where one component seems to be a calcareous, marly clay. The manipulation of this clay recipe exhibits similarities with that of Fabric Groups 1-3 and 6 of Dimini. However, conclusions regarding provenance identification based on only one sample would not be justified.

23. Fine, Calcareous, with Shell

Samples: MAK 96/3, 9, 21, 62, 90, 136, 199; MAK 97/62

This fabric group consists of sub-angular to rounded, moderately to poorly sorted non-plastic inclusions, set in a fine, calcareous clay matrix that varies from relatively optically active to inactive. The colour in the homogeneous groundmass ranges from reddish brown and greyish/dark brown in PPL to orange/yellowish red and dark brown in XP (x40); no colour differentiation between the core and margins has been observed. The inclusions exhibit a strongly bimodal grain-size distribution whilst voids comprise *c.* 10-20%. They mainly consist of large and small shell fragments, monocrystalline quartz, microfossils (*Cyprideis* ostracods), foraminifera and Tcfs; few to absent polycrystalline quartz, fine mica schists, plagioclase, muscovite and biotite mica laths also occur (*pl.* 6.30).

Discussion

All samples included in this fabric group were found in Makrygialos and are Undecorated ware, storage vessels. The majority of the non-plastic inclusions in this fine fabric group are not distinct and, therefore, cannot offer reliable clues as to the origin of the clay source used. Before petrographic analysis of the material began, the dominant shell fragments that were present were assumed to have been crushed and added tempering material. However, the main type of textural concentration features, in this case clay concentrations, occurring in the fabric group provides clear evidence for an interpretation of the origin of the shell inclusions. These clay concentrations are usually discordant with the clay matrix (often a void – gap/line - surrounds and separates them from the host matrix). They consist of a fossiliferous, marly limestone that contains macrofossil shell, carbonate rocks (usually micrite) and *Cyprideis* ostracods. This information suggests incomplete clay mixing, where the major component of the paste was a fossiliferous, marly clay that naturally incorporated shells. Such clays originate in the older Upper Miocene – Lower Pliocene Sfendami-Alonia formations; they extend to the West and South-west of Makrygialos and comprise medium to coarse-grained sand, sandy loam, marly fossiliferous clays and marly limestones, along with *Cyprideis* ostracods and *Cardium* macrofossils (IGME 1982-83). This suggests that this particular clay can be considered as 'local' to Makrygialos. In the following Fabric Groups with shell, further examples of textural concentration features are provided which more firmly support this argument.

24. Semi-coarse, Calcareous with Shell

Samples: MAK 96/17, 44, 89, 94, 109, 129, 134, 137, 176, 217, 219
MAK 97/46, 72, 73

This fabric group is generally homogeneous, although certain samples exhibit some textural and colour variations. It consists of poorly sorted, angular to rounded inclusions that form a strongly bimodal grain size distribution. Voids represent *c.* 10-20%. The non-plastics are set in a semi-fine, calcareous groundmass; it is characterised by a general heterogeneity, especially in terms of colour, whilst the micromass is slightly optically active (MAK 97/73) to optically inactive (MAK 96/129). This implies that the pottery was relatively highly-fired (MAK 96/129, 219). In samples MAK 96/17 and 44, and MAK 97/72 there are some frequent inclusions of calcareous material

(marly limestone) spread throughout the thin section. Generally there is a preferred orientation of both non-plastic inclusions and voids either parallel (MAK 96/89) or diagonal to the vessels margins (MAK 96/109, MAK 97/73)(*pl.* 6.31). Especially in sample MAK 97/73 the voids are large, elongated and strongly orientated diagonally to the vessel's walls, where coils were joined together to form the upper body of a large carinated bowl. The non-plastic inclusions in this fabric group consist of dominant shell fragments of different sizes, comprising either micritic or sparitic limestone, along with mono and polycrystalline quartz, microcline, alkali and plagioclase feldspar, often saussuritised, microfossils (ostracods), amphibole and mainly muscovite mica laths. Few altered (?) igneous rock fragments (volcanic rocks and rare andesite) along with relatively fine metamorphic rocks (e.g., quartz-biotite/muscovite schist) or aggregates of epidote group minerals with or without feldspars and very rare titanite are also present (*pl.* 6.32).

Discussion

This fabric group provides convincing evidence to support the argument that the shell fragments are fossils that occur naturally in the clay source rather than crushed material that has been added to it. One of the types of textural concentration features present in this fabric group is clay concentrations. These mainly contain fossiliferous, marly limestone that incorporates whole fragments of macrofossil shell (e.g., in MAK 96/176 and especially MAK 96/109 where a large, curved shell encloses/becomes the outer boundary of one of these concentrations that has marl adhering) (*pls.* 6.33a and b). The presence of these features testifies to the technological process of clay mixing. In addition to this, in MAK 96/89 there is a swirl of clay, incompletely mixed with the calcareous base clay, containing angular to sub-angular grains of monocrystalline and polycrystalline quartz, microcline, plagioclase, pyroxene grains and fine mica schist (*pl.* 6.33c). This clay component resembles Fabric Groups 18-19, which are 'local' to Makrygialos. It is, therefore, clear that for the making of this particular clay recipe two different clays were involved: a marly, fossiliferous clay containing shell and a 'sandy' clay. Both of them are considered to be local to the Makrygialos area since they are compatible with the surrounding geological environment. More specifically, they are related to the older Sfendami-Alonia formations of the Upper Miocence – Lower Pliocene to the West of Makrygialos, which contain coarse-grained sand, sandy loams, marly fossiliferous limestone that incorporates microfossils (*Cyprideis* ostracods) and macrofossil shell (*Cardium*). The second, 'sandy' component of this paste probably

derives from the Pleistocene Aeolian deposits that surround the Makrygialos area (IGME 1982-83).

25. Fine, Non-calcareous(?) with Shell

Samples: MAK 96/24, 38, 96, 163, 185, 218, 223; MAK 97/59

Discussion

This recipe is associated with the manufacture of both decorated and undecorated pottery, but mainly Brown Burnished storage vessels, and Black Burnished bowls.

The composition and texture of the groundmass in this fabric group resembles that of Fabric Group 15, which is considered 'local' to Makrygialos. Based on the evidence provided from Fabric Groups 23 and 24, it can be argued with confidence that the production technology of this clay paste involved the mixing of a fine, 'sandy' (non-calcareous?) clay (also used in Makrygialos in the manufacture of decorated pottery) with a fossiliferous marly clay that contain macrofossil shell. Evidence of this mixing can be seen in samples MAK 96/163, MAK 96/218 and MAK 97/59 in the clay concentration features which contain whole fragments of fossil shell set in a marly, fossiliferous clay matrix (*pl.* 6.34).

26. Coarse with Shell

Samples: MAK 96/4, 14, 27, 28, 30, 50, 54, 63, 76, 77, 81, 82, 83, 84, 95, 97, 101, 119, 124, 125, 135, 138, 139, 140, 151, 152, 153, 157, 165, 166, 170, 171, 172, 175, 180, 196, 200, 207, 208, 226, 227, 229, 230

MAK 97/15, 22, 24, 30, 38, 44, 55, 57, 60, 71

MAK 96/77, 196, MAK 97/55, 44 (high-fired version of the same group)

This coarse fabric group consists of angular to rounded, poorly sorted non-plastic inclusions, which exhibit a strongly bimodal grain size distribution. Voids comprise *c.* 10-15%. The non-plastics are set in a generally homogeneous groundmass that appears less calcareous than that in Fabric Groups 23 and 24. They mainly consist of macrofossil shell (comprising mainly micrite and less sparite crystals), monocrystalline and polycrystalline quartz, alkali feldspar (microperthitic texture, often

saussuritised), microcline (cross-hatched twinning), micritic carbonate rocks, chert, Tcfs, and microfossils (ostracods, foraminimera) (*pls.* 6.35 and 6.36). They also contain medium to coarse-grained acid igneous rock fragments (microgranite/granite?) along with few andesite and other volcanic rock fragments. The metamorphic rock fragments, mainly quartz-biotite and quartz-muscovite schist, quartz-epidote (?)-and/or-muscovite schist, are very few. The presence of clinopyroxene and amphibole is rare with very rare to absent titanite.

Discussion

The vast majority of samples in this fabric group are associated with Undecorated and Brown Burnished storage vessels and some cooking pots.

The yellowish/greyish brown or red clay matrix with high optical activity and the absence of colour differentiation between core and margins probably suggest low firing temperatures. Here, the groundmass exhibits textural and compositional similarities with that of Fabric Group 20a. The presence of the same type of textural concentration features (clay concentrations) found in the previous Fabric Groups (23-25) confirms mixing of clays; one was probably the fossiliferous marly clay, containing shells, and the other a 'sandy' clay, also found as an independent clay recipe (Fabric Group 20a) which is considered 'local' to the Makrygialos area. Samples MAK 96/152, MAK 97/24 and MAK 97/30 are very good examples containing Tcfs that provide clear evidence of clay mixing (*pl.* 6.37).

It is suggested that the marly, calcareous with macrofossil shell component of this clay recipe possibly originates in Sfendami-Alonia Formations that extend to the West and South-west of Makrygialos (IGME 1982-83).

27. Very Coarse, with Shell

MAK 96/198

The single sample in this fabric group belongs to the Brown Burnished ware and is probably a cooking pot.

This fabric group is the coarsest version of the broad 'shell' fabric groups. The

presence of shell along with very coarse igneous and metamorphic inclusions suggests again the mixing of a marly, fossiliferous and a 'sandy' clay. The groundmass and composition of inclusions resembles the coarse version of Fabric Group 20 (20b), so it is possible that both clays originate in the Makrygialos area (see geological comments for previous 'shell' Fabric Groups) (*pl.* 6.38).

28. 'Local' Giannitsa B

Samples: GIAN 97/2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 17, 18; AGR 97/14

This fabric group comprises samples found only in Giannitsa B (except AGR 97/14). It consists of angular to rounded, poorly sorted, non-plastic inclusions that form a bimodal grain-size distribution. Voids represent *c.* 5%. The inclusions, set in a densely packed, optically relatively inactive groundmass, contain monocrystalline quartz, common polycrystalline quartz, mainly muscovite and less biotite mica laths, plagioclase with polysynthetic twinning, acid igneous rocks, some volcanic rocks, and Tcfs (dark reddish brown clay pellets and dark brown siltstones containing quartz and biotite mica laths, exhibiting in some cases 'snowball' texture); also present are rare chert, clinopyroxene, phyllite, biotite schist and micrite. The amount of carbonate rocks appears to be more frequent in GIAN 97/8.

Technological information

There is a marked variety in the colour of the groundmass. Samples GIAN 97/6, 15 and 17 have a dark grey brown to black clay matrix which probably suggests a reducing firing atmosphere. In the rest of the samples, a colour differentiation between core and margins of vessels is present; it varies from dark grey core and reddish/yellowish brown margins (GIAN 97/3, 5) to yellowish/greyish brown core and dark brown/black margins (GIAN 97/4, 14). Voids in GIAN 97/11, 12 must have been created by burned vegetable matter.

Discussion

There is a wide variety of wares associated with this particular clay recipe, including Brown-on-Cream and Black-on-Red open conical bowls, Black Burnished, carinated bowls and storage vessels, Black-topped carinated bowls and Red Slipped and Burnished bowls. The sample from Agrosykia corresponds to a Black-on-Red open

conical bowl.

The igneous and volcanic rock fragments present in this fabric group seem compatible with the Upper Jurassic Volcano-sedimentary series of Kasteneri, belonging to the Pro-Paeonian zone, to the North of Giannitsa and Agrosykia. In addition, in the same area, Pliocene and Upper Jurassic magmatic rocks are observed, including volcanic rocks (mainly trachytes and andesites) in the pink-coloured granite of Fanos. It is therefore suggested that this fabric group is considered local to Giannitsa.

29. 'Local' Agrosykia A

Samples: AGR 97/4, 6, 7, 9, 20, 21, 24, 28, 29, 30; GIAN 97/10

This very 'sandy' fabric group consists of angular to sub-rounded, poorly sorted inclusions, which exhibit a bimodal grain-size distribution. Voids represent *c.* 10%. The inclusions are set in a heterogeneous in colour, optically active groundmass. They contain predominantly monocrystalline quartz, less frequent polycrystalline quartz, microcline (cross-hatched twinning), plagioclase (polysynthetic twinning), and sericite. Also present are muscovite mica laths, less frequent carbonate rocks, rare phyllite rich in biotite mica, clinopyroxene, either as individual grains or aggregates with quartz, rare to absent shell fragments (AGR 97/9), titanite (AGR 97/24) and very rare to absent altered igneous rocks.

Technological information

There is a variety in the colour of the groundmass and the firing horizons of these samples. The optically active clay matrix can be from red and orange red (oxidising atmosphere) to greyish brown. In samples AGR 97/7, 9 and 21 half of the groundmass has a dark grey/black colour whilst the other half is reddish to yellowish brown. Such differences probably hint at poor control over the firing process.

The lack of textural concentration features, the general angularity and the even distribution of inclusions within each fraction may indicate the use of a single clay rather than clay mixing.

Discussion

This clay recipe is mainly associated with Brown Burnished, large, open storage vessels; also present are Black-on-Red, open conical bowls, Incised bowls, Black-topped and Red Slipped and Burnished, large, open bowls. The Giannitsa B sample belongs to the Black-on-Red ware.

This fabric group differs very clearly from Fabric Group 28, both in terms of texture, composition and technology of production. Its non-plastic inclusions, however, are not distinct enough to suggest a specific identification for the clay source. It is considered 'local' to Agrosykia.

30. Igneous and Volcanic Rock Fragments

Samples: AGR 97/3, 5

GIAN 97/16, 19, 20

This fabric group consists of large, angular to rounded, poorly sorted non-plastic inclusions, which form a strongly bimodal grain-size distribution. The percentage of voids is *c.* 10%. The inclusions, set in a densely packed, optically relatively active (except AGR 97/3) groundmass consist of monocrystalline quartz and feldspar, common andesite, polycrystalline quartz, weathered volcanic rock fragments (very cloudy appearance) which often occur with opaque minerals, fresh plagioclase (polysynthetic twinning), biotite mica laths, Tcfs, carbonate rocks (that contain plagioclase, quartz or mica laths), rare to absent amphiboles, quartz-biotite mica, sub-angular to rounded, prismatic individual crystals of clinopyroxene and opaque minerals.

Technological information

Sample GIAN 97/16 shows a colour differentiation between dark green core and greyish brown margins in both PPL and XP (x40). In the other samples the groundmass exhibits a red (AGR 97/3) to greyish brown colour. AGR 97/3 has an inactive to glassy, in some places clay, matrix and, thus, is considered to be the high-fired member of this group.

Discussion

Two of these samples are associated with Undecorated storage vessels, one is a

Red Slipped and Burnished bowl and the samples from Agrosykia belong to the Brown-on-Cream ware, open conical bowl, and Incised, open bowl.

The presence of common andesite in this fabric group seems compatible with the Pliocene and Upper Jurassic magmatic rocks, including volcanic rocks such as trachyte and andesite, to the North of Giannitsa.

31. Calcareous, 'Local' to Agrosykia

Samples: AGR 97/11, 13, 25

This fabric group mainly consists of monocrystalline quartz, carbonate rocks (micrite), polycrystalline quartz, alkali feldspar and muscovite mica; few to very few microcline, plagioclase feldspar and chert are also present; the occurrence of amphibole (hornblende) and shell fragments is very rare. The angular to rounded, poorly sorted inclusions are set in a generally calcareous and optically inactive groundmass, forming a strongly bimodal grain size distribution. The observed colour heterogeneity is due to poor control over the firing process. Non-plastics are not distinct to suggest a specific clay source location. The first sample (AGR 97/11) exhibits some variation in that it is less calcareous and more sandy than the others.

Unusual Fabrics

32. Grog-tempered

Samples: DIM 97/57, 71

This fabric group consists of angular to rounded, poorly sorted non-plastics, which form a strongly bimodal grain-size distribution. Voids comprise *c.* 15%. Some of the voids seem to have replaced burnt organic matter. The inclusions are set in a yellow, optically generally inactive groundmass; they mainly consist of dark brown/reddish brown textural concentration features. Some of them incorporate angular quartz grains, muscovite and less biotite mica laths and rare to absent small epidote grains or white mica schist. Amongst the Tcfs, the presence of angular to rounded grog fragments is striking; their identification was possible due to the fact that one of their boundaries was a sharp-edged, well-preserved dark brown slip (0.04 mm thickness), containing small quartz grains. The fabric of the grog inclusions is identical to the

actual clay matrix of Fabric Group 32 and thus their margins (expect the one formed by the slip) merge with the groundmass. Other inclusions also present include monocrystalline and less polycrystalline quartz (which in one case forms an aggregate with dark brown opaque mineral and a metamorphosed calcite grain), less frequent biotite and/or white mica schist, fine phyllite rich in biotite mica, and micritic limestone (*pl.* 6.39).

33. Micaceous

Samples: MAK 96/161, 167, 206

This fabric group consists of lath-like and angular to sub-rounded, moderately sorted inclusions, which exhibit a bimodal grain-size distribution. Voids comprise *c.* 15%. They are set in a generally homogeneous, dark red/reddish brown, slightly optically inactive groundmass, which exhibits no colour differentiation between core and margins. The inclusions predominantly consist of large, well-preserved muscovite mica laths whose long axes show a strong preferred orientation, parallel to the vessel wall. Also present are monocrystalline and polycrystalline quartz, alkali feldspar, often sericitised, and rare to absent chert and Tcfs (siltstones) (*pl.* 6.40).

Discussion

All samples in this fabric group were found within the Makrygialos material and belong to an unusual ware (Grooved(?)). Compositionally, this fabric group does not resemble any of those found and considered 'local' to Makrygialos. At the same time, it is not compatible with any other fabric group present in the other three comparative sites. It is, however, considered 'imported' to Makrygialos but specific source location cannot be suggested.

34. Serpentine/Limestone

Samples: DIM 97/69

This rare fabric group consists of angular to rounded, poorly sorted non-plastic inclusions that exhibit a strongly bimodal grain-size distribution. Voids comprise about 5%. The inclusions are set in a homogeneous, fine to semi-fine, densely packed, yellowish brown clay matrix that shows a slight colour differentiation between a greyish

brown core and reddish brown margins. Large, angular inclusions of serpentine predominate (often with dark brown/black opaques); also present are crystals of metamorphosed limestone, monocrystalline quartz, and small grains of clinozoisite (*pl.* 6.41a).

Discussion

This sample was found only in the Dimini material and is a Red Burnished storage vessel (pithos). Its inclusions are compatible with the Serpentinised peridotites-serpentinites deposits found to the North-west and South of Dimini, which mainly consist of serpentines (IGME 1986).

35. Volcanic Rocks

Sample: MAK 96/183

This fabric group consists of angular to rounded, poorly sorted non-plastics that form a strongly bimodal grain-size distribution. Voids represent *c.* 5%. The inclusions are set in a homogeneous, semi-fine and densely packed groundmass, which is optically inactive; they mainly consist of sub-rounded to rounded volcanic rock fragments (containing very fine plagioclase crystals and dark brown opaques), monocrystalline quartz, saussuritised feldspar, dark brown and reddish brown clay pellets, very rare chert, plagioclase with polysynthetic twinning and biotite mica (*pl.* 6.41b).

Discussion

This sample was found within the Makrygialos material and belongs to the Brown Slipped and Burnished ware, pedestal bowl.

36. Rounded Limestone

Sample: MAK 97/40

This fabric group consists of sub-rounded to well-rounded, poorly sorted inclusions that form a strongly bimodal grain-size distribution and contains about 10% voids. The inclusions are set in a reddish brown, densely packed groundmass, slightly optically active. They consist of well-rounded sand grains (mainly micrite and less frequent sparite, which contain small quartz grains and biotite mica laths); also present

are polycrystalline quartz, alkali feldspar, large, prismatic crystals of clinopyroxene, very rare phyllite, andesite and aggregates of zoisite/clinozoisite with quartz (*pl.* 6.42a).

Discussion

This sample was found amongst the Makrygialos material; it is an Undecorated storage vessel.

The groundmass of this fabric group exhibits similarities with Fabric Group 15, considered 'local' to Makrygialos, and the composition and texture of non-plastics (especially carbonate rocks and clinopyroxenes) is very similar with other coarse, 'local' to Makrygialos fabric groups; the carbonate rocks are also compatible with the geology of the area surrounding the site, e.g., the Pleistocene brown Aeolian deposits, rich in carbonate material (IGME 1982-1983).

37. Chert/Serpentine

Sample: MAK 97/51

This fabric group consists of angular to rounded, poorly sorted inclusions that form a bimodal grain size distribution and incorporate about 10% voids. The non-plastics are set in a dark greyish/greenish brown, calcareous groundmass, which is heterogeneous in terms of colour (differentiation between core and margins) and optically inactive to nearly vitrified. The inclusions mainly comprise sub-rounded to rounded, fine-grained chert and serpentine or serpentinised schists. Also present are mylonitised polycrystalline quartz (often with black opaques), oxidised biotite schist and/or oxidised biotite mica laths, monocrystalline and polycrystalline quartz, dark brown and red to orange, dense clay pellets (*pl.* 6.42b)

38. Limestone/Serpentine/Phyllite

Samples: MAK 96/105

This fabric group is distinguished by its striking mixture of lithologies. It consists of sub-rounded to well-rounded, poorly sorted non-plastic inclusions that form a strongly bimodal grain-size distribution and contain *c.* 15% voids. The inclusions are set in a densely packed, optically relatively active groundmass. Limestone, in different

forms, predominates not only as a non-plastic but also as evenly dispersed across the clay matrix. Micritic carbonate rocks and equally frequent sparite are present, either individually or as aggregates with polycrystalline quartz; often the same inclusions are contained within 'pockets' formed by micritic limestone matter (a well-defined margin). Also present are calcite (in some cases metamorphosed?) grains, rounded serpentine, chert, monocrystalline and polycrystalline quartz, few to very few muscovite mica schist, red and brown textural concentration features, rare phyllite, shell fragments, and a unique fragment of either bone or tooth (*pl.* 6.43a).

39. Phyllite/Schist/Altered Igneous Rock Fragments

Samples: MAK 96/110, 112

DIM 97/62

This very coarse fabric group consists of large, sub-angular to rounded, poorly sorted non-plastic inclusions that form a strongly bimodal grain-size distribution. Voids represent *c.* 10%. They are set in a densely packed, red-firing, relatively optically active groundmass. They mainly consist of large, coarse rock fragments that include metamorphic rocks and individual mineral grains, all interlocked in thick 'veins' of oxidised biotite mica or clay. These rocks and minerals comprise quartz, sericite, biotite schist, epidote-biotite schist, and individual prismatic grains of epidote/clinozoisite with very high relief. The appearance of these rock fragments in PPL is very cloudy. Also present are amphibolite (?), phyllite rich in biotite mica with small black opaque minerals, biotite schist, quartz-epidote and/or quartz-zoisite schist, polycrystalline and monocrystalline quartz, serpentinite with a 'mesh' structure and altered (?) igneous rock fragments almost covered with a 'net' of orange/red matter (*pl.* 6.44).

They are all Undecorated storage vessels. Lack of any compatibility with the local geology of the Makrygialos area suggests that this pottery is imported to Makrygialos, probably from the Dimini area.

40. Mudstones(?)/Siltstones/Phyllite Fabric Group

Sample: MAK 96/75

This unusual fabric group consists of sub-angular to rounded, poorly sorted non-

plastic inclusions, set in a dark brown, densely packed and optically inactive groundmass. They consist mainly of dark brown mudstones(?)/siltstones, fine phyllite, polycrystalline and monocrystalline quartz and rare quartz-biotite schist.

The sample is a Red Burnished bowl. This particular clay recipe is not associated with any of the fabric groups considered 'local' to Makrygialos.

6.4 Conclusions

6.4.1 Pottery Production within Makrygialos

As stated in the introductory chapter, there are two focal points of this thesis: a) the system of pottery production within the Makrygialos settlement and b) the circulation of pottery over long distances; for the latter comparative samples were taken from the contemporary sites of Dimini, in Thessaly and Agrosykia A and Giannitsa B, in western Macedonia.

In Chapter 3 it is argued that the practice of pottery production could be traced in two different ways: a) by examination of manufacturing technology and b) by assessment of the organisation of production. These parameters will be looked at in the following sections.

6.4.2 Manufacturing Technology

Fabrics: from the detailed petrographic analysis of the Makrygialos material a rather interesting picture has emerged. Considering the large amount of this pottery assemblage, it can be argued that the range of fabric groups occurring within this settlement is not particularly broad. During macroscopic examination, the number of major fabrics identified did not exceed four (Groups I, II, III and IV) with some sub-divisions, especially within the last two. There were of course quite a few paste variations and 'unusual fabrics' but such categories represented only minimal quantities within the total assemblage. With the completion of the petrographic analysis these macroscopic groupings were proved to be valid, in general terms, thus linking very clearly the two stages of the pottery analysis process. During the microscopic examination the picture did not change dramatically. There are about nine major clay

recipes, representing a considerable quantity of pottery and found only within the Makrygialos material, plus some small sub-groups/variations that are closely linked with the main fabric groups. At the same time, there are a number of 'unusual' fabrics each of which consists of a couple to few samples that bear distinct compositional and textural characteristics. Finally, certain samples that, during the macroscopic analysis of the Makrygialos material and before the collection of comparative samples, were considered 'unusual', were in the end classified together with fine or coarse fabrics taken from Dimini and are, therefore, treated as 'imported' to Makrygialos.

If the technology of production is set as a single criterion in an attempt to form discrete ceramic categories, then it is surely possible to readily distinguish between classes of pottery that were manufactured either with different or with differently manipulated raw materials. Within Makrygialos, Fabric Group 1, for instance, forms a very distinct group, which is manufactured with a very fine, calcareous clay that is not associated with any other main clay recipe found in the assemblage. The interpretation of the textural concentration features present undoubtedly suggests the mixing of different fine clays (perhaps calcareous and non-calcareous). These Tcfs are compositionally and texturally very similar in samples not only from Makrygialos but also from the other comparative sites under investigation, which possibly implies manufacture by one producer or centre of production. The recipe appears very consistent and this standardisation extends to other technological characteristics. The optically inactive dark/greenish brown groundmass hints at a high firing temperature and the lack of colour differentiation between the core and margins of vessels suggests a constant atmosphere and a high degree of control over firing conditions. These characteristics are present in all analysed samples. Fabric Group 1 is also present in the other three comparative sites; in Dimini, the frequency of this recipe is higher than the equivalent in Makrygialos, whilst in Agrosykia and Giannitsa it is represented in minimal quantities. In Dimini, the clay recipe associated with Fabric Group 1 is also mixed with crushed tempering material (e.g., angular metamorphic rock fragments) for the production of a number of different wares (alongside Brown-on-Cream). This does not apply to the other sites.

Fabric Group 15 is the second distinct clay recipe within the Makrygialos material. The manufacturing technology of this category is different. No evidence of clay mixing was observed under the polarising microscope (absence of the Tcfs present

in Fabric Group 1 or any other feature that could be interpreted accordingly). The fine nature of the clay and the even, weakly bimodal distribution of non-diagnostic inclusions across the section may signify either the use of a fine, natural sediment or the refinement, through levigation of a coarse soil. The generally optically active groundmass in this category suggests a lower firing temperature in comparison to Fabric Group 1, and the colour differentiation between the dark grey core and red margins in the majority of samples shows poor control over the firing process.

Groups 16-19 and 20-22, found only within the Makrygialos material, represent different clay pastes, especially compared to the fine, calcareous Fabric Group 1. Fabric Group 16 was not easily distinguished from Group 15 (see relevant fabric characterisation). Fabrics 16-19 should perhaps be discussed as two different pairs: 16-17 and 18-19. Compositionally, these two pairs do not exhibit any apparent differences; they basically contain a very similar suite of minerals and rocks. What separates Groups16-17 from 18-19 is the grain size of non-plastic inclusions and their distribution across the thin section. The size of the non-plastics in Groups 18-19 increases considerably and their distribution appears much more uneven. It is fair to acknowledge that this division may not be 'real' but due to a natural variation occurring within the same clay source, used by the same or different potters or 'households'. Within each pair of fabric groups, the presence or absence of carbonate rocks is the element that separates them, e.g., Groups 17 and 18 contain a substantial amount of micritic limestone which is absent from Groups 16 and 19.

Fabric Groups 20 and 21 exhibit a quite similar pattern. The main compositional and textural characteristics of these two fabric groups are very similar, except for the absence (in Fabric Group 20) and presence (in Fabric Group 21) of a substantial amount of carbonate rock. Apart from this compositional difference, the firing conditions also appear different. Fabric Groups 20 and 21 were predominantly made of yellowish/reddish brown-firing clays that, due to the possibly low firing temperature, maintain an optically active groundmass. The strongly bimodal distribution of inclusions combined with their angular shape may suggest crushed and added material rather than clay mixing, even though some dark brown Tcfs are also present.

There is another range of fabric groups within the Makrygialos assemblage that

comprises rather distinct clay recipe/s. Groups 23-27 have a common characteristic: the presence of shell fragments in different quantities and in relation to different base clays. Analysis of these fabric groups under the polarising microscope provided positive evidence to argue that the dominant shell inclusions are actually macrofossils, naturally occurring in the deposits of a marly, fossiliferous clay and not crushed and added material as thought during the macroscopic analysis. Textural concentration features (clay concentrations), containing fossil shell, ostracods and foraminifera set in a marly matrix, confirmed the potters' technological choice to mix different clays, one of which was rich in shell and calcareous material. The other clays involved in the production of these fabric groups closely resemble fabric groups also found independently within the Makrygialos material (for instance, Groups 15, and 20a and b). In terms of quantity, Fabric Groups 23-27 comprise the vast majority of the Makrygialos ceramic assemblage. Considering the temporal parameter (estimated to around 300 years for the later Late Neolithic), it seems that the use of this particular 'shelly clay' represents a technological tradition that lasted for many generations. Of the five 'shell fabrics', Fabric Group 26 (coarse with shells, whose groundmass resembles Fabric Group 20a) contains the larger number of samples; this, generally, reflects its actual frequency within the total ceramic assemblage. As said earlier, however, this main group co-exists with four more, also containing shell. Fabric Groups 23 and 24 (fine and coarser version) are characterised by a very calcareous, fine groundmass, which might represent the actual/natural clay before processing with any other raw material. In contrast, the groundmass in Fabric Group 25 exhibits many similarities with that in Fabric Group 15 whilst the only sample of Fabric Group 27 resembles the clay matrix of Fabric Group 20b (its coarse version). It cannot be said with confidence whether these variations represent different, conscious technological choices made by contemporary potters/'households' or they occur due to the temporal parameter (more than one potter or 'household' involved from different generations who exploited certain clay beds based on their availability at a certain point in time).

Forming: during macroscopic examination, a sufficient number of sherds provided clear evidence of the techniques used by ancient potters in the manufacture of this large ceramic assemblage. According to this information, the majority of the Makrygialos pottery must have been manufactured with coils and/or slabs. The presence of coils, in particular, were identified due to easily observable variations in the thickness of walls (especially in large vessels) or due to surface marks, where coils were

not subsequently covered by dragging or applying an extra thin clay layer to finish off the surface. There is normally a rather consistent relation between technique used and shape of vessel, i.e., smaller shapes such as open, shallow and deep bowls (either conical or carinated), small and medium size jugs and jars were built with coils. Large storage jars were, for obvious reasons, built with slabs, whilst the less frequently occurring small cups and miniature vessels were manufactured by dragging and pinching the clay. Having collected this information, it was easier to interpret and confirm certain technological features observed in thin sections under the polarising microscope. In many instances, there is a strong, preferred orientation of both voids and/or inclusions usually diagonal to the vessels' margins creating distinct areas in different parts of the section. This element has been interpreted as evidence of coiling.

Shapes: both macro- and microscopic analysis of the Makrygialos assemblage revealed some significant associations between the variables shape, fabric and/or ware. This relation is remarkable in Fabric Group 1 (and the associated Groups 2-3); they all belong to the Brown-on-Cream ware, were found in all comparative sites, and were all associated with open, shallow, conical bowls with flat bases. Dimini additionally incorporates open, pedestal bowls ('fruitstands'). Slightly different is the picture for the Black-on-Red ware in Makrygialos; indeed, the majority of this category is associated with open, shallow, but also deep, conical bowls, all with flat bases. 'Fruitstands' and jugs with a vertical, strip-like handle are also present. This relative variation in shapes applies to the clay recipe as well. For instance, Fabric Groups 15 and 16, predominantly related to the Black-on-Red ware, are also used for the manufacture of Black-topped and Black Burnished, small and large carinated bowls. This close association between shape and fabric becomes more consistent in the 'shell' fabric groups. The majority of these appear in meaningful relation with storage vessels (jars and pithoi) and cooking pots (deep bowls), although the latter function category is not reliably established within the assemblage unless there are traces of burning in the outer and/or inner surface of the vessel.

Decoration and firing: both these important parameters of the production process have not been properly investigated in the present study. Based on observation under the polarising microscope, only general comments on estimated low or high firing temperatures and atmosphere, inferred from colour differentiation in the firing horizon of vessels and optical activity of the groundmass, were possible. The same applies to

the comments on presence or absence and description of slips observed on the vessels' surfaces. It is acknowledged that further research is required in the future in this area and it is suggested that SEM would be a suitable technique to answer the relevant questions.

6.4.3 Provenance Identification

6.4.3.1 Fabric Groups 'Imported' to Makrygialos

Fabric Groups 1-3 (associated with the Brown-on-Cream ware): it has been argued that, based on the observed textural similarities and the standardised production technology, Fabric Groups 1-3 are considered to be the output of one centre/location of production. Due to the fact that their clay recipe is not found in any other fine or coarse fabric groups 'local' to the sites of Makrygialos, Agrosykia A and Giannitsa B but, in contrast, re-appear in the coarse fabrics of Dimini, this site (Dimini and/or its immediate area) is a possible 'candidate' as the location of production.

The petrographic evidence reinforces this argument. Of these three fabric groups, Fabric Group 1 represents the most frequent. Fabric Groups 2 and 3 comprise only a few samples. In strict petrographic terms, Fabric Group 1 does not contain distinct inclusions that could facilitate provenance ascription. It is, however, closely related to Fabric Groups 2 and 3. The difference with the last two is that, although their plastic component appears identical with that in Fabric Group 1, their non-plastic inclusions are much coarser and offer helpful clues towards clay source identification. Fabric Group 2 contains red and dark brown textural concentration features (siltstones), the composition and texture of which resembles similar mineral and rock fragments present in Fabric Group 1, but of a much smaller size. In addition, Fabric Group 3 is considered the coarser version of Fabric Group 1, so that these observed similarities could be more securely studied and confirmed. More importantly, the suite of minerals and rocks identified in the Tcfs of Fabric Group 2 (schist, phyllite, amphibole, minerals of the epidote group (especially zoisite)) are also found in the coarse metamorphic fabrics from Dimini (Fabric Group 6-8 and especially 12) and are compatible with the amphibole-epidote-chlorite schist and the gneiss-schist formations of the Eohellenic Tectonic Nappe, to the North, South and West of Dimini (IGME 1986). By indirect association, therefore, it is cautiously suggested that the clay source used for the manufacture of the painted Brown-on-Cream ware, found in all comparative sites, may

be located in the aforementioned areas around Dimini, in Thessaly.

Fabric Groups 12 and 13 (associated with Incised I, Black-on-Red and Black-topped): the petrographic evidence provided by these two fabric groups is also important; samples belonging here are found only amongst the Makrygialos and Dimini materials. The represented wares within the Makrygialos material are Incised I, Black-on-Red and Black-topped vessels. Compositionally, they seem to be identical with the rest of the samples taken from Dimini. The suite of minerals and rocks present here seem compatible with the amphibole-epidote-chlorite schist deposits that extend to the North of Dimini and, therefore, the Makrygialos samples are considered to have been imported from that area.

Fabric Group 39: this small fabric group consists of three samples, one of which was found in Dimini and the other two in Makrygialos. They exhibit very close similarities both in terms of texture and composition. This could have important implications as all samples represent undecorated coarse pottery (pithoi), associated with large storage vessels, circulating over long distance. The occurrence of minerals of the epidote group combined with phyllite and biotite mica schists may be compatible with the Mica schists-phyllites deposits of the Upper(?) Jurassic to the North and North-west of Dimini and the Amphibole-epidote-chlorite schists, mainly lying to the North of the same area. It is therefore suggested that these vessels were transported to Makrygialos.

6.4.3.2 Fabric Groups 'Local' to Makrygialos

Fabric Group 15 (associated mainly with Black-on-Red but also a wider range of wares): although this fabric group was made from a fine base clay and therefore does not include any distinct, (for the purposes of provenance identification), non-plastics, a clear separation was made from the fine Fabric Group 1, which is considered 'imported', (see relevant section) based on a number of technological characteristics and the texture of the groundmass; thus, Fabric Group 15 is considered 'local' to the Makrygialos area. This is also supported by the fact that a very similar base clay is associated with another very distinct 'local' to Makrygialos fabric group, which belongs to the broad 'shell' category, Fabric Group 25, with its sub-divisions.

Fabric Groups 16-19: local to Makrygialos but different from Fabric Group 15. All four of them are variations (sub-groups) of the same main group.

Fabric Groups 20-21: local to Makrygialos but much coarser than the previous ones.

Fabric Group 22: most of these samples were classified as 'unusual' during macroscopic examination. Under the polarising microscope, they seem to be associated with the calcareous fabric groups from Dimini, even though they are much coarser.

Fabric Groups 23-27: a distinct fabric category with sub-groups within the Makrygialos material. This category represents the majority of the total ceramic assemblage. It has been proved microscopically that these fabric groups are the products of clay mixing between one particular calcareous clay, which includes macrofossil shells, and a combination of different clay recipes also available locally and also found associated with other local Fabric Groups, e.g., 15, 20-21.

6.4.4 Organisation of Production

In Chapter 3 it has been discussed whether an assessment of the organisation of production within a settlement is possible based on either direct or indirect evidence. In Makrygialos, in the excavated sector H in particular, remains of ovens ('Kataskeues') were found between 'houses' surrounded by postholes, along with the so-called 'megaron', in a relatively small area towards the east boundary of the Phase II settlement. In close proximity, to the West, two relatively small, shallow pits containing marine *Cardium* shells and very fine clay were discovered. This context certainly points to household activities involving food and perhaps materials processing. It would not be justifiable, however, to argue that such evidence is sufficient enough to suggest the presence of kilns and intra-site, large-scale pottery production. Also, pebbles with smoothed edges and well-rounded sherds of different size, possibly used as tools, are present amongst the material remains of this phase but their function cannot be reliably associated only with ceramic manufacture.

Analysis of the final products of ceramic production in Makrygialos may shed some light on the issue of the intra-site organisation of production. The picture that

emerges through this examination is quite complex; the main clues are summarised bel ow:

- The presence of distinctly definable fabrics that comprise quite different raw materials and clay recipes.
- The co-existence of 'local' and 'imported' ceramic categories.
- Local production of predominantly utilitarian pottery in large quantities involving a relatively restricted number of wares and clay recipes, although some variations do occur.
- Storage and cooking vessels, locally produced, comprise the majority of the total assemblage with smaller quantities of eating/drinking vessels, both locally made and imported.
- Pots of the same shape and decoration made from different clay recipes.
- Pots of different shape and decoration made from the same clay paste (especially in the case of eating/drinking vessels).
- The production technology of the 'locally' made pottery exhibits a certain degree of consistency and homogeneity.
- The production technology of the 'imported' pottery is highly standardised and strictly ware and fabric specific (especially in Makrygialos, Agrosykia A and Giannitsa B)

Broadly, the combined macroscopic and petrographic analysis reveals the following association:

- Storage/cooking vessels ⇒ undecorated coarse, burnished ⇒ locally produced (in very rare cases imported).
- Eating/drinking vessels ⇒ decorated ⇒ locally produced (in very rare cases imported).
- Eating/drinking vessels ⇒ painted ⇒ imported and locally produced.

These points undoubtedly suggest that pottery production within this settlement was organised on different levels:

Pottery imported to Makrygialos; this represents a relatively small percentage of the total ceramic assemblage, compared to Dimini, but certainly a large percentage compared to Agrosykia and Giannitsa; it is principally associated with the painted

Brown-on-Cream ware. The production technology of this category, which is fabric and shape specific, is highly standardised and, according to conventional definitions that are established in the literature, the output of 'specialised production'. A minimal amount of Incised I, Black-on-Red and Undecorated storage vessels are also considered imported to this site. During the early stages of macroscopic examination of the Makrygialos material, along with the Brown-on-Cream (I) another similar ware was also defined as Brown-on-Cream (II). The shape and decoration of these vessels are exactly the same. The final aesthetic result, however, is different and it is a difference visually apparent to anyone. In addition, their firing technology is distinct (colour differentiation between dark grey core with many voids and chocolate brown margins). During petrographic analysis it became apparent that the Brown-on-Cream I and II were produced with different clays. The base clay of the latter ware, which is represented by minimal quantities, is also used for the manufacture of a range of wares that are considered 'local' to Makrygialos, e.g., Black-on-Red, Black Burnished, Black-topped, Polychrome. This information may indicate an unsuccessful attempt by local potters to reproduce the 'imported' Brown-on-Cream ware vessels, whilst having obtained and secured the 'original' ones. If this hypothesis is correct, it hints at the importance of the Brown-on-Cream I and its possible social and even symbolic dimension which was maintained through the complex chain of exchanges that these pots were subjected to until the moment they 'arrived' in Makrygialos. This point is also supported by the fact that many sherds belonging to this ware bear repair holes, which suggest that they were so valuable they were kept and passed down from generation to generation (this also happens with very rare Incised I and some of the locally made Black-on-Red).

Pottery locally produced near Makrygialos; this covers the great majority of the Makrygialos ceramic assemblage and is associated with one or more locations of production, possibly situated outside but not far away from the settlement. The production output comprises fine and coarse pottery which exhibits a certain degree of technological competence. Fine and medium-coarse fabric groups are consistently related to painted (Black-on-Red) and decorated wares (Incised I and II, Polychrome, Black-topped, Black Burnished, Red and Brown Slipped and Burnished) and generally small shapes (conical, carinated, fenestrated and/or pedestal bowls or small jugs). On the other hand, coarse to very coarse fabric groups are associated with the Brown Burnished and Undecorated wares and, mainly, storage and/or cooking vessels. This interesting picture may refer to certain groups or individuals that acquired the

technological knowledge of making pots and, furthermore, deliberately chose to produce pottery in very distinct ways. Such variations in the technological choices that the potters made could be interpreted in several ways, e.g., they could suggest different groups of potters who operated simultaneously or different raw material sources used over time. It must be stressed, however, that there is one fabric group, the 'shell fabric', which predominates, as discussed earlier. Although mixed to produce different recipes, it remains the basis for the manufacture of the majority of the Makrygialos pottery. More importantly, the same clay recipe has been used for the manufacture of the majority of the pottery from Phase I, which is dated to 5,400/5,300 BC whilst Phase II is estimated to have finished in *c.* 4,500 BC (Andreou *et al.* 1996: 538). In addition, this paste was not used for the manufacture of similar or any other wares within the comparative materials studied here and, to the writer's knowledge, there is no other known contemporary settlement in northern Greece that used it. Such indications may imply a very strong ceramic tradition that lasted for a long period of time or even set territorial and/or social boundaries.

Pottery locally produced within Makrygialos; this category incorporates relatively small amounts of pottery. It mainly corresponds to variations and small sub-groups of the major clay recipes present in Makrygialos. No significant association between certain fabric groups and wares or shapes were readily observed and their manufacturing technology (as identified macro- and microscopically) appears quite crude and random. Such categories of pottery might have been the products of individual 'households' in order to cover everyday needs.

In Chapter 6 the results of the petrographic analysis of the Makrygialos material and the three comparative, contemporary sites have been presented and discussed. In Chapter 7 the implications of these findings for the debate on the organisation of Greek Neolithic society as a whole will be examined.

CHAPTER 7
FINAL DISCUSSION

7.1 Introduction

The purpose of this chapter is to bring together and discuss the implications of all the key elements that have arisen from the macroscopic and petrographic examination of the Makrygialos Phase II ceramic material. The next step is to point out the essential concepts linked to pottery that can help to incorporate this newly emerging picture into more general discussions of the Greek Neolithic and, as a final step, to explore how these concepts inform (and to what extent confirm or question) previously established ideas.

7.2 The Technology of Production

Observed correlations pertaining to certain stages of the production process reveal consistent and significant relations between the attributes fabric, ware and shape of the vessels. These relations are more apparent in some ceramic categories than in others, and are supported by both the macroscopic and microscopic analysis of pottery.

Preferences for certain raw materials, which are differently manipulated between and within sites, are expressed through the occurrence of distinct clay recipes, as revealed by petrographic analysis. Thus, ancient potters – individuals or groups – chose to exploit different clay sources and different processing methods in order to produce distinct categories of pottery. For example, Fabric Group 1 is strictly associated with a very fine recipe, the production of which results from clay mixing of at least one highly calcareous clay, probably signifying the exploitation of one particular source over a long period of time. This clay recipe occurs abundantly within the Dimini material, in considerably smaller quantity in Makrygialos and is represented by only a few sherds at Agrosykia A and Giannitsa B. The exclusive use of this particular fine calcareous clay, in the manufacture of the Brown-on-Cream ware can be accounted for in functional terms as it results in the production of a light, creamy clay body that will produce a background for the dark brown manganese pigment. In that way, the desired aesthetic contrast with the painted decoration was achieved.

At Makrygialos, Agrosykia A and Giannitsa B the clay paste represented by Fabric Group 1 is linked only with open, conical bowls with flat bases (and very rarely with small 'kalathoi' in Makrygialos). Dimini's repertoire appears slightly broader, also incorporating 'fruitstands', as well as bowls and 'kalathoi'. The picture becomes even more intriguing when it is considered that the firing temperature and atmosphere of this category of pottery appear very similar in all settlements under investigation. The pots were probably fired at high temperatures (judging from the optically inactive to glassy groundmass) and in a constant, well-controlled atmosphere, as testified by the highly homogeneous clay matrix, which displays no colour differentiation between core and margins. Interestingly, the aforementioned clay recipe is not used for the production of any other ware and shape considered 'local' to either Makrygialos or Agrosykia and Giannitsa. At Makrygialos only, rare variations of principally the same base clay are found associated again with Brown-on-Cream open conical bowls (Fabric Groups 2 and 3), identical clays have also been found amongst the Dimini ceramic assemblage.

The pattern and technology of production of the second important painted ware, Black-on-Red ware, are very different. This ware is present at all sampled sites and its clay sources and the processing of its raw materials are entirely different from those used for the Brown-on-Cream ware. More importantly, they vary from site to site. Specifically, four discrete clay pastes, possibly deriving from four related clay sources 'local' to each site, are involved in the production of the Black-on-Red pottery. Fabric Groups 14 and 15 represent this ware in the Dimini and Makrygialos settlements respectively and, although they both relate to similar vessel shapes, there is a variation in the fabric-ware association between the two sites. At Makrygialos, even though the majority of Black-on-Red is made with the clay comprising Fabric Group 15, there are simultaneously a number of other decorated wares produced with the same clay. In Dimini, however, the recipe represented by Fabric Group 14 is only used in the production of Black-on-Red vessels. It seems that in both settlements, potters chose to produce this fine ware not by mixing different clays, but rather by using a single clay. This was either derived from a fine sediment (in the case of Makrygialos), or resulted from levigation of coarse clays (in the case of Dimini). Additionally, both materials may have been fired at a much lower temperature than the Brown-on-Cream pottery, although there is an observed variation concerning the firing horizons of vessels within each site. Colour homogeneity characterises the 'biscuit' of the Dimini Black-on-Red, whilst in the equivalent ware in Makrygialos, there is a consistent colour differentiation

between the dark grey core and the red margins of the vessels.

Although Fabric Groups 14 and 15 correspond to substantial quantities of pottery, probably being the main clay recipes, at the same time this ware is also manufactured with a number of different clays, occurring less frequently. In Makrygialos, for example, some Black-on-Red vessels are manufactured with a clay represented by Fabric Group 16 and a rare exception is associated with the distinct Fabric Group 12. Interestingly, the latter group is found predominantly in the Dimini material, where this particular clay recipe is used for the production of Incised (I), Black-on-Red, Polychrome and Black Burnished wares. But, within Dimini another apparently popular paste, represented by the coarse Fabric Group 8, is used for the production of the Black-on-Red along with a number of other decorated vessels. In contrast, no such associations were detected between Agrosykia and Giannitsa and the other two sites. Agrosykia and Giannitsa each produced Black-on-Red pottery by using compositionally and technologically distinct clays, which were simultaneously exploited for the production of other decorated wares, e.g., a few Brown-on-Cream, Black Burnished and Black-topped wares in Giannitsa and mainly Brown Burnished, Incised and Black-topped wares in Agrosykia. Despite the differences in the production of Black-on-Red vessels in each of these two sites, this category of pottery is again associated with the same shape, i.e., the open, conical bowl with a flat base.

The clay choices in the production of the Incised ware (Incised I in Makrygialos) are entirely different to the painted wares. Although this category involves relatively small, thin-walled vessels, the clay pastes used, especially in Dimini, are generally coarse (Fabric Groups 12 and 13) or medium-coarse in Makrygialos (Fabric Groups 17 and 18). In both settlements, the very same clay recipes are employed in the production of a wider range of wares. At Makrygialos, however, there is an observed variation in the surface treatment and firing technology between Incised vessels belonging to Fabric Groups 12-13, and those belonging to Fabric Groups 17-18. Elaborate surfaces, well burnished and homogeneous in colour that are also linked with larger shapes, are associated with vessels of the former groups. Careless treatment (rarely burnished and often smoothed or rough surfaces) and orange red or dark grey firing 'clouds' on the vessels' external walls characterise samples belonging to the latter groups; shapes also appear smaller. At Makrygialos, along with the Incised I, a second category of Incised (II) vessels occur. This is not present at any of the other three comparative sites, and

represents pots that are generally coarser (Fabric Groups 17-20), larger (fenestrated, pedestal bowls and jars), and fired at varied temperatures. Their function, however, incorporates both non-utilitarian and utilitarian vessels.

Focusing on Makrygialos, one can easily observe that for the manufacture of decorated pottery, producers (individuals or groups) used a variety of semi-fine to medium-coarse clays (Fabric Groups 17-22). None of these recipes is particularly related to one specific ware, although the shapes produced are predominantly small and medium size, but there is an apparent flexibility in the way materials and processing methods were employed; such choices cannot be fully justified in functional or purely technological terms. There is a distinct production pattern, however, concerning the correlation between the fabrics characterised by the presence of macrofossil shells and two particular wares and shapes: Brown Burnished and Undecorated wares, associated largely with storage and also cooking vessels. With very rare exceptions, the majority of this particular type of pottery at Makrygialos is relatively low fired.

In putting together some of the most striking key elements that the analysis of pottery provides, the emerging picture is intriguing and rather complex. It reveals several co-existing mechanisms of production of this class of material culture, which can be inferred from the occurrence of a range of distinct and mostly consistent ceramic categories, alongside more varied ones. Such mechanisms, developed on a micro-scale level, have been largely overlooked in previous studies.

Close examination of all the categories of pottery involved in this study demonstrates different degrees of control over and knowledge of certain stages of the production process, which can vary not only within the Makrygialos assemblage, but also from site to site. This could have been the result of a number of factors. It may, for example, imply different degrees of technological skill and know-how, acquired through short or long term practical experience and regular engagement in the pottery making process. This, in turn, may suggest the involvement of different groups or individuals, who acquired different levels of skill, and/or maintained restricted access to particular sources for the production of each distinct ceramic category. Alternatively, the potters' choices of materials and techniques may signify cultural choices and the existence of ceramic traditions in their attempt to define their individual or group identity within the social environment to which they belonged. Therefore, the ways

they chose to produce pots were not dominated by technological or environmental constraints but rather declared their understanding of what a certain type of vessel should look like. In some cases, temporal variation may be the cause of certain observed attributes.

It is not easy to isolate with confidence which of the above considerations was responsible for the resulting picture, mainly due to the fact that more than one parameter may have been involved at the same time. The case of the Brown-on-Cream ware, for example, represents a ceramic category that stands out for its morphological, technological and compositional consistency, in all the comparative sites studied. The densely painted surfaces (both internal and external), with repeated motifs that are arranged in a rather standardised manner, are carefully finished and well burnished. The high labour investment and technical skill are evident beyond any doubt and constitute this type of pottery as highly 'visible'. More importantly, there is a high degree of observed homogeneity in: a) the clay sources exploited, b) the manipulation of the raw materials used, c) the shape (form, wall-thickness, rim diameter) and manufacturing technique employed, and d) the firing technology. All these variables strongly imply skilful producers who probably maintained technological know-how and control over all stages of the production process. The standardised manner in which painted decoration and shapes were achieved and reproduced in considerable quantities may suggest high investment of time but also frequent practice. It is, therefore, possible that the Brown-on-Cream vessels, present at all comparative sites, were manufactured in the same location. There is one element worth mentioning that further stresses the special character of the Brown-on-Cream ware. Quite frequently, pottery sherds bear repair holes along breakage points; this is mainly observed within the Makrygialos ceramic assemblage. Such repair holes perhaps signify the importance of this category of vessels probably due to their social value, which did not allow the pots to be easily replaced, but they were repaired and perhaps transferred from generation to generation.

In contrast, textural, compositional, and decoration attributes are more varied in the Black-on-Red ware. This pottery seems to have been manufactured by different individuals or groups of potters in each of the studied settlements. Although in all four cases the majority of the ware is made of fine clays, each of them is distinct compositionally and fired in variable temperatures and atmosphere. The petrographic evidence also suggests that potters at each site exploited local clays. Morphologically

all these vessels appear similar, although different degrees of craftsmanship can be identified in the finished products of each site. They are decorated with generally comparable motifs and correspond to similar shapes, even though the distance between the three Macedonian sites and Dimini, in Thessaly, is up to 220 km. This clearly shows that producers and consumers of the four communities had a common perception as to how Black-on-Red pottery was supposed to look. On the one hand, this also implies regular contact and interaction, and on the other, it declares their deliberate choice to manufacture the same pottery in distinct ways, which may have set them apart symbolically.

Further to this, the proportion of the Black-on-Red ware in each settlement is substantially higher in comparison to the Brown-on-Cream. Under certain circumstances this aspect may signify more restricted consumption of the Brown-on-Cream pottery. Interestingly, at Makrygialos, the intra-site distribution of both aforementioned painted wares appears to be restricted to two specific contexts across the site, i.e., in Pit 24 (one of the 'basements') to the South of the Phase II settlement, and in the north boundary, where the deepest deposits were accumulated. In addition, both wares were found together deposited in the same contexts. This significant piece of information may suggest social competition between individuals/groups, who maintained these highly elaborated vessels and those who were excluded. In support of this picture, the contrast with the even distribution of large amounts of utilitarian pottery (mainly Undecorated and Brown Burnished storage and cooking vessels) in all contexts across the site is striking. These elements may suggest spatial rather than hierarchical differentiation within the site. Inequalities could also be marked in the form of acquired technological knowledge and access to the means of production on the producers' part, in relation to consumers in the rest of the community. This form of differentiation was not necessarily linked with economic power and privileges for the potters, but rather the negotiation of their social status in the community in which they lived. Alternatively, the evidence could indicate communal use of the particular types of pottery by all the inhabitants only on important social occasions. Surely, a conclusive statement cannot be reached at this stage without detailed contextual analysis and without complementary evidence supplied by other important categories of material culture to test these initial observations arising from the analysis of the ceramic assemblage and to shed some light on the character of the Makrygialos settlement.

The long-term exploitation of a fossiliferous, marly clay source, rich in macrofossil (*Cardium*) shells and microfossils (ostracods and foraminifera), close to Makrygialos is of note. Significant consistencies are observed in the way this particular source of raw material was combined with different, locally available clays. The mixing of the 'shelly', fossiliferous clay with a range of semi-fine to very coarse 'sandy' clays resulted in the production of distinct recipes, whose main compositional constituent is macrofossil shell (corresponding to Fabric Groups 23-27). In functional terms, the occurrence of this type of inclusions mixed with quartz-rich clays can be justified, to a certain extent. The majority of this pottery is consistently related to large, medium to thick-walled storage and, less frequently, cooking vessels, either Brown Burnished or Undecorated. At the same time, however, much finer versions of the same 'shelly' calcareous clay component (e.g., Fabric Groups 23 and 25) are also associated with both Undecorated and Brown Burnished storage vessels but also with Black Burnished bowls and other decorated wares and smaller shapes. The dominance of the clay recipes rich in macrofossil shell characterises the ceramic assemblage of the Makrygialos settlement. Furthermore, the same clay recipe also comprises the majority of the Makrygialos Phase I component. This means that potters were exploiting the same clay sources during the course of the entire Late Neolithic period. These particular clay choices are taken to signify the existence of a long-term ceramic tradition only related to the producers and consumers of Makrygialos, probably in order to identify themselves within their social environment by setting boundaries and, thus, by declaring their differences with short- and long-distant neighbours.

7.3 The Organisation of Production

Spatial organisation: it has been pointed out in Chapter 6 that at Makrygialos (Phase II) there is insufficient, direct evidence to suggest that pots were being manufactured and fired in-site, in a large-scale production process. However, a single concentration of fine, raw clay and marine shells, deposited in two shallow pits that were found in close proximity to ovens (in sector H), is noted. These indications may suggest limited production by certain individuals for everyday needs and are largely associated with what are considered 'variations' from the predominant fabric groups. Nevertheless, the petrographic evidence permits identification of some of the locations of the possible clay sources used in the production of distinct categories of pottery. It is clear, though, that each site exploited the available local raw materials, whilst at the

same time consuming smaller quantities of products of non-local origin.

Concentration of production: if one considers the above mentioned point in combination with the available geological information and the observed associations between vessel types and fabrics, it can clearly be argued that certain types of pots were being produced at different locations at a distance from their findspot. This implies that there was at least one location of production from which categories of pots were regularly distributed over long distances.

Scale of production: in terms of the geographical extent of the production process, it seems that potters preferred to use clay sources available in the immediate region rather than to obtain raw materials from distant sources. As far as the production output is concerned, it is acknowledged that at this stage there is no specific estimate of the number of vessels produced per year. Nonetheless, the quantity of pottery found in Makrygialos Phase II (approximately 18 tonnes), especially compared to outputs from other known, published contemporary sites in northern Greece, is substantial, even taking into account the time span involved (around 300 years). It seems possible that pottery production, especially in Makrygialos and Dimini, was carried out on a scale beyond the everyday needs of the family unit. Thus, one could cautiously put forward the idea that consumers, in these settlements, may have outnumbered producers.

Specialisation: it is without doubt that certain types of pottery within the Makrygialos assemblage, e.g., the Brown-on-Cream, represent different levels of skill, technological knowledge and possibly access to resources. It has been argued earlier that this particular category is characterised by standardisation of many of the parameters of the production process (i.e., exploitation of the same sources, clay recipe, ware, shape, firing technology). In addition, the majority of this material suggests that its producers were much fewer than the consumers and that the former acquired knowledge and skills that were not accessible to others. In conventional terms, and based on the recent definition of specialisation by Perlès and Vitelli, the aforementioned indications may be read as positive evidence of specialised production.

However, at this point it is necessary to remind the reader of the statement made in the introductory chapter that the main concern of this thesis is to explore the complexity of certain aspects of the organisation of the production and circulation of

pottery during this period in its own right. This means that the new evidence will not be viewed in evolutionary terms and interpreted in comparison to the development of certain phenomena (such as specialisation) during the different sub-phases of the Late Neolithic or later chronological periods, e.g., the Bronze Age. This perspective has dominated the work of previous researchers and has inhibited the study of issues such as specialisation and the emergence of inequalities within the specific socio-economic and ideological context of the period that triggered and reproduced them. In addition, it has already been pointed out in Chapter 3 that the emphasis of previous researchers on the need to define specialisation has derived from their engagement with a theoretical archaeological tradition with a strong economic orientation. This orientation links the development of economic specialisation with the progressive evolution of social complexity from earlier to later periods. But, as stated earlier, this is not the standpoint of the present thesis. The writer argues that if one accepts that it is archaeologically possible, and therefore relevant, to define specialisation, then this should be accomplished not only through study of the organisation of production, but also through understanding of consumption and the intra- and inter-site circulation patterns of a given material. Thus, it would be over-simplistic and unjustified at this stage to argue in favour of specialised pottery production, since we have not yet arrived at any safe conclusions regarding all the above-mentioned crucial parameters. This argument is supported by the fact that extensive ethnographic work has demonstrated that definitions of specialisation can vary widely from one context to another, and that even factors like product standardisation may not be conclusive evidence of specialisation.

7.4 The Circulation of Pottery

The majority of the pottery found not only at Makrygialos, but also at the other comparative sites was produced and consumed locally. Petrographic analysis, however, proves that at the same time there were restricted categories of pots that were imported to some of these sites. Considerable quantities of imported pottery predominantly concern the Brown-on-Cream ware, which was probably manufactured in the area near Dimini, in Thessaly, and was transported to Makrygialos and, in lower quantities to Agrosykia and Giannitsa. A few more wares were imported only to Makrygialos and concern the rare Incised I, Black-on-Red, and Undecorated storage vessels. This evidence contradicts the dominant idea that pottery circulated only over short or medium distances, apparently no more than *c.* 70 km (Perlès 1992: 146; Schneider *et al.*

1991: 48). The analysis of this material provides positive evidence to suggest that pots were circulating over a distance of up to 220 km at least since the Late Neolithic period.

It is difficult to define the exact exchange mechanism that operated and by whom it was controlled (e.g., whether the producers were also the distributors of these vessels). Perlès' alternative suggestion for the possible existence of not only reciprocal but also more 'neutral' exchanges between distant communities, which did not establish close links and ties, is of interest. However, she excluded ceramics from such types of exchange, due to the prevailing paradigm that pottery did not circulate over long distances.

7.5 The Implications for Understanding the Late Neolithic in Northern Greece

1) Study of this ceramic assemblage has illustrated the importance of analysing material culture remains on a micro-scale level. The new evidence has revealed diverse patterns and a high degree of complexity in the organisation of production of Late Neolithic material that would not have been observed if a different methodological approach had been undertaken.

2) This new picture questions certain aspects regarding the validity of the 'household' model of self-sufficiency, simplicity and egalitarianism for the Late Neolithic period.

3) Evidence for the long-distance circulation of pottery and the nature of 'exchange' contradicts the previously held ideas pertaining to ceramics.

4) Perlès has identified separate systems of exchange corresponding to distinct modes of production for three major categories of objects: stone tools, pottery and rare 'exotic goods' and ornaments. She insists on a striking contrast between the system of production and circulation of stone tools with that of pottery. Although the study of the stone tools from Makrygialos is not yet completed, initial results in contrast reveal a picture compatible to that suggested here.

The implications of these findings are potentially of great importance for future interpretations of the Late Neolithic in northern Greece, and should be studied in detail in combination with data from all the other different categories of excavated material culture. More detailed suggestions for further work are presented in section 8.2.

CHAPTER 8
CONCLUSIONS AND FURTHER WORK

8.1 General Conclusions

Overall, this thesis has succeeded in providing answers to its archaeological questions on technology and provenance. In some cases, detailed answers are not possible, due to the nature and limitations of the available evidence. Therefore, from the detailed macroscopic and microscopic analysis of the Makrygialos (Phase II) pottery and its comparative examination with the contemporary settlements of Dimini and Agrosykia A and Giannitsa B, a number of conclusions pertaining to both levels of observation and interpretation have been drawn:

- The Makrygialos ceramic assemblage consists of distinct, consistent fabric categories that constitute different raw materials and clay recipes.
- Both local and imported wares co-exist within the assemblage and are also found within the same depositional contexts.
- There is an apparent, restricted intra-site distribution of the imported and locally produced painted wares.
- There is an observed even intra-site distribution of coarse, undecorated pottery in all contexts across the settlement.
- Utilitarian pottery, produced in large quantities, is associated with locally manufactured wares, and involves a relatively restricted number of clay pastes.
- Storage and cooking vessels, largely locally produced, predominate and outnumber the essentially limited quantities of display/drinking/eating vessels.
- The interplay of and meaningful associations between the variables ware-fabric-shape reveal that pots of the same shape and decoration are associated with different clay recipes and *vice versa*.
- Morphological, compositional and technological standardisation characterises the production of the painted Brown-on-Cream ware.
- Simultaneously, the production technology of the locally manufactured pottery exhibits a considerable degree of consistency and homogeneity, although variations do occur.

- Distinct categories of pottery were produced by different producers who acquired different degrees of technological knowledge and skill, which might signify social rather than simply economic inequalities.
- Certain ceramic categories present in the assemblage, e.g., mainly Brown-on-Cream and minimal quantities of Incised I, Black-on-Red and Undecorated storage vessels, were produced at a different place (probably in the region around Dimini, in Thessaly), and were transported to Makrygialos, and, in minimal quantities, to Agrosykia A and Giannitsa B.
- Such evidence supporting the long-distance circulation of pottery (up to 220 km) contradicts previously established ideas, and may hint at not only reciprocal but also more 'neutral' exchanges of pots, akin to commodity transactions.
- The emerging picture reinforces recent assumptions about the complex and dynamic nature of Late Neolithic society. However, it questions to a certain extent established ideas regarding the self-sufficiency and assumed simplicity of the organisation of Greek Neolithic society as a whole.

8.2 Further Work

This thesis aimed to answer some important archaeological questions. Although a thesis is necessarily constrained by time and resources, this target has been reached successfully. Equally crucial issues, however, have not been touched upon, either because they were beyond the scope of this research or because the available evidence did not permit. They still await careful consideration and more detailed, integrated theoretical and scientific approaches in the future. What follows is a list of suggestions for future work on particular and more general aspects of the Makrygialos Phase II ceramic assemblage that the writer considers necessary:

- Extensive collection of modern clay samples from possible clay sources not only in the geological environment surrounding Makrygialos but also from those in the vicinity of the other three comparative sites. There should be an emphasis on south-eastern Thessaly, as this region is considered a possible location of production of the imported wares. This will facilitate the association of certain types of inclusions, the identification of which has been problematic, with more specific and limited geological areas.

- Additional employment of a number of analytical techniques in order to clarify issues concerning the technology of production and provenance ascription. For example, SEM is needed for the study and determination of firing temperatures and atmospheres along with the use and application of slips and pigments for vessel surface treatment and decoration. NAA is already in progress, but needs to be expanded to incorporate larger numbers of representative clay and ancient pottery samples for parallel examination with the petrographic results.
- It is crucial that the production and circulation of this pottery assemblage be studied within the largely overlooked but vital context of vessel use and deposition. Only by fully integrating all these aspects will the character and content of the relationship between the production, movement and consumption of pottery in northern Greece be better understood.

Finally, the clues that analysis of this ceramic material provides must be examined in the light of the evidence for the production, movement and consumption of the other categories of material culture from Makrygialos Phase II. Only under these circumstances will a more comprehensive contextual understanding of the character of the Makrygialos settlement in particular, and that of Late Neolithic society in northern Greece in general, be attained.

BIBLIOGRAPHY

Adams, W. Y. 1988. Archaeological classification: theory versus practice, *Antiquity* 61: 40–56.

Adams, W. Y. and E. W. Adams 1991. *Archaeological Typology and Practical Reality. A Dialectic Approach to Artefact Classification and Sorting.* Cambridge: Cambridge University Press.

Adams, A. E., Mackenzie, W. S. and C. Guildford 1984. *Atlas of Sedimentary Rocks Under the Microscope.* London: Longman.

Alram-Stern, E. 1996. *Die ägäische Frühzeit, 1: Das Neolithikum in Griechenland.* Vienna: Österreichische Akademie der Wissenschaften.

Anagnostou, I., Thomaidou, S., Stratouli, G., Sofronidou, M., and K. Touloumis 1997. Anaskafi Dispiliou Kastorias. To hronologiko provlima, *To Arhaiologiko Ergo sti Makedonia kai Thraki (AEMTH) 7*: 13-15 (In Greek).

Andreou, S. and K. Kotsakis 1986. Diastaseis tou horou stin Kentriki Makedonia: Apotyposi tis endokoinotikis kai diakoinotikis horoorganosis. In: *Amitos. Timitikos tomos gia ton kathigiti M. Androniko* A. Thessaloniki: Aristotle University of Thessaloniki, pp. 57–88 (In Greek).

Andreou, S., Fotiadis, M. and K. Kotsakis 1996. Review of Aegean Prehistory V: the Neolithic and Bronze Age of northern Greece, *American Journal of Archaeology* 100: 537–597.

Armit, I. and B. Finlayson 1995. Social strategies and economic change. Pottery in context. In: W. K. Barnett and J. W. Hoopes (eds), *The Emergence of Pottery: Technology and Innovation in Ancient Societies.* Washington DC: Smithsonian Institution Press, pp. 267–275.

Arnold, D.E. 1980. Localised exchange: an ethnoarchaeological perspective. In: R. E. Fry (ed.), *Models and Methods in Regional Exchange*. SAA Papers No. 1. Washington DC: Society for American Archaeology, pp. 147–150.

Arnold, D. E. 1981. A model for the identification of non-local ceramic distribution: a view from the present. In: H. Howard and E. L. Morris (eds), *Production and Distribution: A Ceramic Viewpoint.* BAR (Int. Series) 120. Oxford: British Archaeological Reports, pp. 31–44.

Arnold, D. E. 1985. *Ceramic Theory and Cultural Process.* Cambridge: Cambridge University Press.

Arnold, D. E. 1991. Ethnoarchaeology and investigations of ceramic production and exchange: can we go beyond cautionary tales? In: R. L. Bishop and F. W. Lange (eds), *The Ceramic Legacy of Anna O. Shepard.* Niwot, Colorado: University Press of Colorado, pp. 321–345.

Arnold, D. E. 2000. Does the standardization of ceramic pastes really mean specialization? *Journal of Archaeological Method and Theory* 7 (4): 333–375.

Aslanis, I. 1990. Oi oxuroseis stous oikismous tou Borioelladikou horou kata ti Halkolithiki periodo kai i periptosi tou Diminiou, *Melethmata* 10: 19–64 (In Greek).

Aslanis, I. 1992. *H proistoria tis Makedonias I. H Neolithiki Epohi.* Athens: Ethniko Idryma Ereunon (In Greek).

Aslanis, I. 1997. Die Dimini-Keramik in Westmakedonien, Griechenland. Zeugnis kultureller Ausstrahlung, Spuren von Handelsbeziehungen oder Ergebnis einer Kolonisation? In: *Hronos, Beiträge zur Prähistorischen Archäologie zwischen Nord- und Südosteuropa.* Verlag Marie Leidorf GmbH, Espelkamp, pp. 83–89.

Bailey, D. W. 2000. *Balkan Prehistory. Exclusion, Incorporation and Identity.* London and New York: Routledge.

Barley, N. 1994. *Smashing Pots. Feats of Clay from Africa.* London: British Museum Press.

Barrett, J. C. 1991. Bronze Age pottery and the problem of classification. In: J. Barrett, R. Bradley and M. Hall (eds), *Papers on the Prehistoric Archaeology of Cranborne Chase.* Monograph 11. Oxford: Oxbow, pp. 201–230.

Barrett, J. C. 1997. Stone age ideologies, *Analecta Praehistorica Leidensia* 29: 121–129.

Beck, C. and G. T. Jones 1989. Bias and archaeological classification, *American Antiquity* 54 (2): 244–262.

Besios, M. and M. Pappa 1994. Neolithikos oikismos Makrygialou 1993, *To Arhaiologiko Ergo sti Makedonia kai Thraki (AEMTH)* 7: 215–222 (In Greek).

Besios, M. and M. Pappa (in press). Neolithikos oikismos Makrygialou 1994, *To Arhaiologiko Ergo sti Makedonia kai Thraki (AEMTH)* 8 (In Greek).

Besios, M. and M. Pappa 1995. *Pidna.* Thessaloniki: Pieriki Anaptixiaki (In Greek).

Besios, M. and M. Pappa 1998. O Neolithikos oikismos sto Makrygialos Pierias (1990-1995), *Arhaiologika Analekta ex Athinon* 23–28: 13–30 (In Greek)

Binford, L. R. 1975. Sampling, judgment, and the archaeological record. In: J. W. Mueller (ed.), *Sampling in Archaeology.* Tuscon: The University of Arizona Press, pp. 251–257.

Binford, L. R. 1982. Meaning, inference and the material record. In: C. Renfrew and S. Shennan (eds), *Ranking, Resource and Exchange. Aspects of the Archaeology of Early European Society.* Cambridge: Cambridge University Press, pp. 160–163.

Binford, L. R. 1987. Data, relativism and archaeological science, *Man* 22: 391–404.

Bintliff, J. 1976. The plain of western Macedonia and the Neolithic site of Nea Nikomedeia, *Proceedings of the Prehistoric Society* 42: 241–262.

Bishop, R. L. and F. W. Lange (eds) 1991. *The Ceramic Legacy of Anna O. Shepard.* Niwot, Colorado: University Press of Colorado.

Björk, C. 1995. *Early Pottery in Greece. A Technological and Functional Analysis of the Evidence from Neolithic Achilleion, Thessaly.* Studies in Mediterranean Archaeology, Vol. 115. Jonsered: Paul Åströms Förlag.

Bradley R. and M. Edmonds 1993. *Interpreting the Axe Trade: Production and Exchange in Neolithic Britain.* Cambridge: Cambridge University Press.

Braun, D. P. 1983. Pots as tools. In: J. A. Moore and A. S. Keene (eds), *Archaeological Hammers and Theories.* London and New York: Academic Press, pp. 107–134.

Braun, D. P. 1991. Why decorate a pot? Midwestern household pottery, 200 BC–AD 600, *Journal of Anthropological Archaeology* 10: 360–397.

Bronitsky, G. 1986. The use of materials science techniques in the study of pottery construction and use. In: M. B. Schiffer (ed.), *Advances in Archaeological Method and Theory, Vol. 9.* Orlando and London: Academic Press, pp. 209–276.

Bronitsky, G. (ed.) 1989. *Pottery Technology. Ideas and Approaches.* Boulder and London: Westview Press.

Broodbank, C. 1992. The Neolithic labyrinth: social change at Knossos before the Bronze Age, *Journal of Mediterranean Archaeology* 5 (1): 39–75.

Broodbank, C. 1993. Ulysses without sails: trade, distance, knowledge and power in the early Cyclades, *World Archaeology* 24 (3): 315–331.

Brumfiel, E. M. and T. K. Earle 1987. Specialization , exchange and complex societies: an introduction. In: E. M. Brumfiel and T. K. Earle (eds), *Specialization, Exchange, and Complex Societies.* Cambridge: Cambridge University Press, pp. 1–9.

Buko, A. 1995. Clays for ancient pottery production: some current problems of analysis, *KVHAA Konferenser* 34: 29–36.

Bullock, P. N., Federoff, A. J., Stoops, G. and T. Tursina 1985. *The Handbook of Soil Thin Section Description.* Wolverhampton: Wayne Research.

Burton, J. H and A. W. Simon 1996. A pot is not a rock: a reply to Neff, Glascock, Bishop, and Blackman, *American Antiquity* 61 (2): 405–413.

Chapman, J. C. 1981. *The Vinca Culture of South-East Europe, Vols I and II.* BAR (Int. Series) 117. Oxford: British Archaeological Reports.

Chapman, J. C. 1988. Ceramic production and social differentiation: the Dalmatian Neolithic and the western Mediterranean, *Journal of Mediterranean Archaeology* 1 (1): 3–25.

Chapman, J. C. 1991. The creation of social arenas in the Neolithic and Copper Age of South-East Europe: the case of Varna. In: P. Garwood, D. Jennings, R. Skeates and J. Toms (eds), *Sacred and Profane.* Oxford: Oxford University Committee for Archaeology, pp. 152–171.

Chapman, J. C. and P. Dolukhanov 1993. Cultural transformations and interactions in Eastern Europe: theory and terminology. In: J. Chapman and P. Dolukhanov (eds), *Cultural Transformations and Interactions in Eastern Europe.* Aldershot: Avebury, pp. 1–36.

Cherry, J.F. 1990. The first colonization of the Mediterranean islands: a review of recent research, Journal of Mediterranean Archaeology 3(2): 145-221.

Chrysostomou, Pan. 1992. O neolithikos oikismos ton Giannitson B, *To Arhaiologiko Ergo sti Makedonia kai Thraki (AEMTH)* 3: 119–134 (text in Greek).

Chrysostomou, Pan. 1997a. H neolithiki katoikisi sti voreia paraktia zoni tou allote Thermaikou Kolpou (Eparhia Giannitson), *To Arhaiologiko Ergo sti Makedonia kai Thraki (AEMTH)* 10_A: 159–171 (In Greek).

Chrysostomou, Pan. 1997b. O neolithikos oikismos Giannitson B. Nea anaskafika dedomena (1992–93), *To Arhaiologiko Ergo sti Makedonia kai Thraki (AEMTH)* 7: 135–146 (In Greek).

Chrysostomou, P. & Pan. Chrysostomou 1993. Neolithikes ereunes sta Giannitsa kai stin periohi tous, *To Arhaiologiko Ergo sti Makedonia kai Thraki (AEMTH)* 4: 169–183 (In Greek).

Clark, J. E. and J. Parry 1990. Craft specialization and cultural complexity, *Research in Economic Anthropology* 12: 289–346.

Clarke, D. L. 1978. *Analytical Archaeology (2nd edition)*. London: Methuen.

Cogswell, J., Neff, H. and M. D. Glascock 1996. The effect of firing temperature on the elemental characterization of pottery, *Journal of Archaeological Science* 23: 283–287.

Cogswell, J., Neff, H. and M. D. Glascock 1998. Analysis of shell-tempered pottery replicates: implications for provenance studies, *American Antiquity* 63 (1): 63–72.

Collins, P. and P. Halstead 1999. Faunal remains and animal exploitation at Late Neolithic Makriyalos: preliminary results. In: P. Halstead (ed.), *Neolithic Society in Greece*. Sheffield Studies in Aegean Archaeology 2. Sheffield: Sheffield Academic Press, pp. 139–141.

Conkey, M. W. 1990. Experimenting with style in archaeology: some historical and theoretical issues. In: M. Conkey and C. A. Hastorf (eds), *The Uses of Style in Archaeology*. Cambridge: Cambridge University Press, pp. 5–17.

Conkey, M. W and C. A. Hastorf (eds) 1990. *The Uses of Style in Archaeology*. Cambridge: Cambridge University Press.

Costin, C. L. 1991. Craft specialization: issues in defining, documenting, and explaining the organization of production. In: M. B. Schiffer (ed.), *Advances in Archaeological Method and Theory, Vol. 3.* New York: Academic Press, pp. 1–56.

Cox, K. G., Price, N. B. and B. Harte 1988. *An Introduction to the Practical Study of Crystals, Minerals and Rocks (revised 1st edition).* London: McGraw-Hill.

Cullen, T. 1985. Social implications of ceramic style in the Neolithic Peloponnese. In: W. D. Kingery (ed.), *Ancient Technology to Modern Science, Vol. I.* Columbus, Ohio: American Ceramic Society, pp. 77–100.

Davis, J. L. 1992. Review of Aegean Prehistory I: the islands of the Aegean, American Journal of Archaeology 96(4): 699–756.

Day, P. M. 1988a. Ceramic analysis and pottery systems: the case of Minoan Crete. In: R. E. Jones and H. W. Catling (eds), *New Aspects of Archaeological Science in Greece, Proceedings of a Meeting held at the British School at Athens, January 1987.* Athens (British School at Athens): Fitch Laboratory Occasional Paper 3, pp. 39–45.

Day, P. M. 1989. Technology and ethnography in petrographic studies of ceramics. In: Y. Maniatis (ed.), *Archaeometry, Proceedings of the 25th International Symposium.* Amsterdam and Oxford: Elsevier, pp.139–147.

Day, P. M. 1991. *A Petrographic Approach to the Study of Pottery in Neopalatial East Crete.* Unpublished PhD thesis, University of Cambridge.

Day, P. M. 1995. Pottery production and consumption in the Sitia Bay area during the New Palace period. In: M. Tsipopoulou and L. Vagnetti, *Achladia. Scavi e ricerche della Missione Greco-Italiana in Creta Orientale (1991–1993).* Rome: CNR/GEI, pp.148–175.

Day, P. M., Wilson, D. E. and E. Kiriatzi 1997. Reassessing specialization in Prepalatial Cretan ceramic production. In: R. Laffineur and P. Betancourt (eds), *TEXNH. Craftsmen, Craftswomen and Craftsmanship in the Aegean Bronze Age.* Aegaeum 16. Liège: University of Liège, pp. 275–289.

Day, P. M and D. E. Wilson 1998. Consuming power: Kamares ware in Protopalatial Knossos, *Antiquity* 72: 350–358.

Day, P. M., Kiriatzi, E., Tsolakidou, A. and V. Kilikoglou 1999. Group therapy in Crete. A comparison between analyses by NAA and thin section petrography of Early Minoan pottery, *Journal of Archaeological Science* 26: 1025–1036.

De Atley, S. P. and R. L. Bishop 1991. Toward an integrated interface for archaeology and archaeometry. In: R. L. Bishop and F. W. Lange (eds), *The Ceramic Legacy of Anna O. Shepard.* Niwot, Colorado: University Press of Colorado, pp.358–380.

Demoule, J.-P., Gallis, K. and L. Manolakakis 1988. Transition entre les cultures neolithiques de Sesklo et de Dimini: les categories ceramiques, *Bulletin de Correspondance Hellénique* 112: 2–58.

Demoule, J-P. and C. Perlès 1993. The Greek Neolithic: a new review, *Journal of World Prehistory* 7 (4): 355–415.

Dimitriadis, S. and K. Skourtopoulou (in press). Characterization of lithic materials by petrographic and SEM techniques: towards suggestions on chipped stone tool provenance from Neolithic sites of northern Greece. In: *Proceedings of the 3rd Symposium on Archaeometry of the Greek Society for Archaeometry, Athens, November 6–10, 1996.*

Dunnell, R. C. 1971. Comment. Sabloff and Smith's 'The importance of both analytic and taxonomic classification in the type-variety system', *American Antiquity* 36 (1): 115–118.

Earle, T. K. 1982. Prehistoric economics and the archaeology of exchange. In: J. E. Ericson and T. K. Earle (eds), *Contexts for Prehistoric Exchange*. New York: Academic Press, pp. 1–11.

Ericson, J. E and T. K. Earle (eds) 1982. *Contexts for Prehistoric Exchange*. New York: Academic Press.

Evans, R. K. 1978. Early craft specialisation: an example from the Balkan Chalcolithic. In: C. L. Redman, W. T. Langhorne, Jr., M. J. Berman, N. M. Versaggi, E. V. Curtin, and J. C. Wanser (eds), *Social Archaeology. Beyond Subsistence and Dating.* New York and London: Academic Press, pp. 113–129.

Feathers, J. K. 1989. Comments. Effects of temper on strength of ceramics: response to Bronitsky and Hamer, *American Antiquity* 54 (3): 579–588.

Feinman, G. M. 1999. Rethinking our assumptions: economic specialization at the household scale in ancient Ejutla, Oaxaca, Mexico. In: J. M. Skibo and G. M. Feinman (eds), *Pottery and People. A Dynamic Interaction.* Salt Lake City: The University of Utah Press, pp. 81–98.

Feinman, G. M., Upham, S. and K. G. Lightfoot 1981. The production step measure: an ordinal index of labour input in ceramic manufacture, *American Antiquity* 46: 871–884.

Fletcher, R. 1991. The messages of material behaviour: a preliminary discussion of non-verbal meaning. In: I. Hodder (ed.), *The Meanings of Things: Material Culture and Symbolic Expression.* London: HarperCollins Academic, pp. 33–40.

Forbes, H. 1989. Of grandfathers and grand theories: the hierarchised ordering of responses to hazard in a Greek rural community. In: P. Halstead and J. O'Shea (eds), *Bad Year Economics: Cultural Responses to Risk and Uncertainty.* Cambridge: Cambridge University Press, pp. 87–97.

Foster, G. M. 1965. The sociology of pottery: questions and hypotheses arising from contemporary Mexican work. In: F. R. Matson (ed.), *Ceramics and Man.* London: Methuen, pp. 43–61.

Franklin, U. M. and V. Vitali 1985. The environmental stability of ancient ceramics, *Archaeometry* 27 (1): 3–15.

Freestone, I. C. 1991. Extending ceramic petrology. In: A. Middleton and I. Freestone (eds), *Recent Developments in Ceramic Petrology.* British Museum Occasional Paper No. 81. London: British Museum, pp. 399–410.

Freestone, I. C. and D. Gaimster (eds) 1997. *Pottery in the Making. World Ceramic Traditions.* London: British Museum Press.

Friedman, J. and M. Rowlands (eds) 1977. *The Evolution of Social Systems.* London: Duckworth.

Gamble, C. 1981. Social control and the economy. In: A. Sheridan and G. Bailey (eds), *Economic Archaeology.* BAR (Int. Series) 96. Oxford: British Archaeological Reports, pp. 215–229.

Gardner, E. 1976. The technology of the ceramics. In: M. Gimbutas (ed.), *Neolithic Macedonia As Reflected by Excavations at Anza, Southeast Yugoslavia.* Monumenta Archaeologica 1. Los Angeles: Institute of Archaeology, University of California, pp. 159–176.

Gardner, E. 1978. *The Pottery Technology of the Neolithic Period in Southeastern Europe.* PhD thesis, University of California.

Gifford, J.C. 1960. The type-variety method of ceramic classification as an indicator of cultural phenomena, American Antiquity 25(3): 341-347.

Gimbutas, M. (ed.) 1976. *Neolithic Macedonia As Reflected by Excavation at Anza, Southeast Yugoslavia.* Monumenta Archaeologica 1. Los Angeles: Institute of Archaeology, University of California.

Gimbutas, M., Winn, S. and D. Shimabuku 1989. *Achilleion: A Neolithic Settlement in Thessaly, Greece.* Monumenta Archaeologica 14. Los Angeles: Institute of Archaeology, University of California.

Gledhill, J. and M. J. Rowlands 1982. Materialism and socio-economic process in multi-linear evolution. In: C. Renfrew and S. Shennan (eds), *Ranking, Resource and Exchange. Aspects of the Archaeology of Early European Society.* Cambridge: Cambridge University Press, pp. 144–149.

Gosselain, O. P. 1992. Technology and style: potters and pottery among the Bafia of Cameroon, *Man* 27 (3): 559–586.

Grammenos, D. V. 1996. Neolithic settlements in Macedonia and Thrace. In: G. A. Papathanassopoulos (ed.), *Neolithic Culture in Greece.* Athens: NP Goulandris Foundation Museum of Cycladic Art, pp. 41–45 (In Greek).

Grammenos, D. V., Pappa, M., Ourem-Kotsou, D., Skourtopoulou, K., Yiannouli, E., Maragou, Ch., Valamoti, S-M., Siridis, G., and E. Marki 1992. Anaskafi neolithikou oikismou Thermis B kai Byzantinis engatastasis para ton proistoriko oikismo Thermi A. Anaskafiki periodos 1989, *Makedonika* 28: 381–499 (In Greek).

Graves, M. W. 1991. Pottery production and distribution among the Kalinga: a study of household and regional organization and differentiation. In: W. A. Longacre (ed.), *Ceramic Ethnoarchaeology.* Tuscon: The University of Arizona Press, pp. 112–143.

Hagstrum, M. B. 1985. Measuring prehistoric ceramic craft specialization: a test case in the American Southwest, *Journal of Field Archaeology* 12: 65–75.

Halstead, P. L. 1981a. Counting sheep in Neolithic and Bronze Age Greece. In: I. Hodder, G. Isaac and N. Hammond (eds), *Patterns of the Past. Studies in Honour of David Clarke.* Cambridge: Cambridge University Press, pp. 307–339.

Halstead, P. L. 1981b. From determinism to uncertainty: social storage and the rise of the Minoan Palace. In: A. Sheridan and G. Bailey (eds), *Economic Archaeology.* BAR (Int. Series) 96. Oxford: British Archaeological Reports, pp. 187–213.

Halstead, P. L. 1984. *Strategies for Survival: An Ecological Approach to Social and Economic Change in the Early Farming Communities of Thessaly, Northern Greece.* PhD thesis, University of Cambridge.

Halstead, P. L. 1989. The economy has a normal surplus: economic stability and social change among early farming communities of Thessaly, Greece. In: P. Halstead and J. O'Shea (eds), *Bad Year Economics: Cultural Responses to Risk and Uncertainty.* Cambridge: Cambridge University Press, pp. 68–80.

Halstead, P. L. 1992a. Dimini and the 'DMP': faunal remains and animal exploitation in late Neolithic Thessaly, *The Annual of the British School at Athens* 87: 29–59.

Halstead, P. L. 1992b. From reciprocity to redistribution: modelling the exchange of livestock in Neolithic Greece, *Anthropozoologica* 16: 19–30.

Halstead, P. L. 1993. *Spondylus* shell ornaments from Late Neolithic Dimini, Greece: specialised manufacture or unequal accumulation?, *Antiquity* 67: 603–609.

Halstead, P. L. 1994. The North-South divide: regional paths to complexity in prehistoric Greece. In: C. Mathers and S. Stoddart (eds), *Development and Decline in the Mediterranean Bronze Age.* Sheffield Archaeological Monographs 8. Sheffield: J. R. Collis Publications, pp. 195–219.

Halstead, P. L. 1995. From sharing to hoarding: the Neolithic foundations of Aegean Bronze Age society? In: R. Laffineur and W.-D. Niemeier (eds), *Politeia. Society and State in the Aegean Bronze Age.* Aegaeum 12. Liège: University of Liège, pp. 11–20.

Halstead, P. L. (ed.) 1999a. *Neolithic Society in Greece.* Sheffield Studies in Aegean Archaeology 2. Sheffield: Sheffield Academic Press.

Halstead, P. L. 1999b. Neighbours from hell? The household in Neolithic Greece. In: P. Halstead (ed.), *Neolithic Society in Greece.* Sheffield Studies in Aegean Archaeology 2. Sheffield: Sheffield Academic Press, pp. 77–95.

Halstead, P. L. and J. O'Shea 1982. A friend in need is a friend indeed: social storage and the origins of social ranking. In: C. Renfrew and S. Shennan (eds), *Ranking, Resource and Exchange. Aspects of the Archaeology of Early European Society.* Cambridge: Cambridge University Press, pp. 92–99.

Halstead, P. L. and J. O'Shea 1989. Introduction: cultural responses to risk and uncertainty. In: P. Halstead and J. O'Shea (eds), *Bad Year Economics: Cultural Responses to Risk and Uncertainty.* Cambridge: Cambridge University Press, pp. 1–7.

Hantman, J. L. and S. Plog 1982. The relationship of stylistic similarity to patterns of material exchange. In: J. E. Ericson and T.K. Earle (eds), *Contexts of Prehistoric Exchange.* New York: Academic Press, pp. 237–263.

Harbottle, G. 1982. Chemical characterization in archaeology. In: J. E. Ericson and T. K. Earle (eds), *Contexts for Prehistoric Exchange.* New York: Academic Press, pp. 13–51.

Hauptmann, H. 1981. *Die deutschen Ausgrabungen auf der Otzaki-Magoula in Thessalien III: Das späte Neolithikum und das Chalkolithikum.* BAM 21. Bonn: Rudolf Habelt.

Hayden, B. 1995. The emergence of prestige technologies and pottery. In: W. K. Barnett and W. Hoopes (eds), *The Emergence of Pottery. Technology and Innovation in Ancient Societies.* Washington DC: Smithsonian Institution Press, pp. 257–265.

Heimann, R. B. 1982. Firing technologies and their possible assessment by modern analytical methods. In: J. S. Olin and A. D. Franklin (eds), *Archaeological Ceramics.* Washington DC: Smithsonian Institution Press, pp. 89–96.

Heurtley, W. A. 1939. *Prehistoric Macedonia. An Archaeological Reconnaissance of Greek Macedonia (West of the Struma) in the Neolithic, Bronze, and Early Iron Ages.* Cambridge: Cambridge University Press.

Hill, J. N. and R. K. Evans 1972. A model for classification and typology. In: D. L. Clarke (ed.), *Models in Archaeology.* London: Methuen, pp. 231–273.

Hodder, I. 1980. Trade and exchange: definitions, identification and function. In: R. E. Fry (ed.), *Models and Methods in Regional Exchange.* SAA Papers No. 1. Washington DC: Society for American Archaeology, pp. 151–156.

Hodder, I. 1981. Pottery production and use: a theoretical discussion. In: H. Howard and E. L. Morris (eds), *Production and Distribution: A Ceramic Viewpoint.* BAR (Int. Series) 120. Oxford: British Archaeological Reports, pp. 215–228.

Hodder, I. 1982a. The identification and interpretation of ranking in prehistory: a contextual perspective. In: C. Renfrew and S. Shennan (eds), *Ranking, Resource and Exchange. Aspects of the Archaeology of Early European Society.* Cambridge: Cambridge University Press, pp. 150–154.

Hodder, I. 1982b. Toward a contextual approach to prehistoric exchange. In: J. E. Ericson and T. K. Earle (eds), *Contexts for Prehistoric Exchange.* New York: Academic Press, pp. 199–211.

Hodder, I. 1982c. *Symbols in Action. Ethnoarchaeological Studies of Material Culture.* Cambridge: Cambridge University Press.

Hodder, I. 1988. Material culture texts and social change: a theoretical discussion and some archaeological examples, *Proceedings of the Prehistoric Society* 54: 67–75.

Hodder, I. 1991a. Archaeological theory in contemporary European societies: the emergence of competing traditions. In: I. Hodder (ed.), *Archaeological Theory in Europe.* London and New York: Routledge, pp. 1–24.

Hodder, I. 1991b. *Reading the Past. Current Approaches to Interpretation in Archaeology (2nd edition).* Cambridge: Cambridge University Press.

Hodder, I. 1991c. Post-modernism, post-structuralism and post-processual archaeology. In: I. Hodder (ed.), *The Meanings of Things: Material Culture and Symbolic Expression.* London: HarperCollins Academic, pp. 65–78.

Hodder, I. 1991d. The decoration of containers: an ethnographic and historical study. In: W. A. Longacre (ed.), *Ceramic Ethnoarchaeology.* Tuscon: The University of Arizona Press, pp. 71–93.

Hodder, I. 1992. *Theory and Practice in Archaeology.* London and New York: Routledge.

Hourmouziadis, G. 1978. Ena Eikideumeno Ergastirio Kerameikis sto Neolithiko Dimini, *Arhaiologika Analekta eks Athinon* 10: 207–226 (In Greek).

Hourmouziadis, G. 1979. *To Neolithiko Dimini.* Volos: Etairia Thessalikon Ereunon (In Greek).

Hourmouziadis, G. 1980. Eisagogi sto Neolithiko tropo paragogis (a' meros), *Anthropologika* 1: 118–129 (In Greek).

Hourmouziadis, G. 1981. Eisagogi sto Neolithiko tropo paragogis (b' meros), *Anthropologika* 2: 39–49 (In Greek).

Johnson, M. 1999. *Archaeological Theory. An Introduction.* Oxford: Blackwell Publishers.

Jones, R. E. 1986. *Greek and Cypriot Pottery. A Review of Scientific Studies.* London (The British School at Athens): Fitch Laboratory Occasional Paper 1.

Kaiser, T. 1984. *Vinca Ceramics: Economic and Technological Aspects of Late Neolithic Pottery Production in Southeast Europe.* Unpublished PhD thesis, University of California.

Kaiser, T. 1990. Ceramic technology. In: R. Tringham and D. Krstic', *Selevac: A Neolithic Village in Yugoslavia.* Monumenta Archaeologica 15. Los Angeles: Institute of Archaeology, University of California, pp. 255–287.

Kaiser, T. and B. Voytek 1983. Sedentism and economic change in the Balkan Neolithic, *Journal of Anthropological Archaeology* 2: 323–353.

Kaiser, T. and W. Lucius 1989. Thermal expansion measurement and the estimation of prehistoric pottery firing temperatures. In: G. Bronitsky (ed.), *Pottery Technology. Ideas and Approaches.* Boulder and London: Westview Press, pp. 83–100.

Kalogirou, A. 1994. *Production and Consumption of Pottery in Kitrini Limini, West Macedonia, Greece, 4500–3500 B.C.* Unpublished PhD thesis, University of Indiana.

Kalogirou, A. 1997. Pottery production and craft specialization in Neolithic Greece. In: R. Laffineur and P. Betancourt (eds), *TEXNH. Craftsmen, Craftswomen and*

Craftsmanship in the Aegean Bronze Age. Aegaeum 16. Liège: University of Liège, pp. 11–17.

Kamilli, D. C. and A. Steinberg 1985. New approaches to mineral analysis of ancient ceramics. In: G. Rapp and J. A. Gifford (eds), *Archaeological Geology.* New Haven, Connecticut and London: Yale University Press, pp. 313–330.

Karimali, E. 1994. *The Neolithic Mode of Production and Exchange Reconsidered: Lithic Production and Exchange Patterns in Thessaly, Greece, During the Transitional Late Neolithic-Bronze Age Period.* Unpublished PhD thesis, University of Boston.

Keighley, J. M. 1986. The pottery of Phases I and II. In: C. Renfrew, M. Gimbutas and E. S. Elster (eds), *Excavations at Sitagroi. A Prehistoric Village in Northeast Greece, Vol. 1.* Los Angeles: Institute of Archaeology, University of California, pp. 346–369.

Kelly, R. L. 1992. Mobility/sedentism: concepts, archaeological measures, and effects, *Annual Review of Anthropology* 21: 43–66.

Kemp, R. A. 1985. *Soil Micromorphology and the Quartenrary.* Cambridge: Quarternary Research Association Technical Guide No 2.

Kempe, D. R. C. and J. A. Templeman 1983. Techniques. In: D. R. C. Kempe and A. R. Harvey (eds), *The Petrology of Archaeological Artefacts.* Oxford: Clarendon Press, pp. 26–52.

Kerr, P. F. 1977. *Optical Mineralogy (4^{th} edition).* New York: McGraw-Hill.

Kilikoglou, V., Maniatis, Y. and A. P. Grimanis 1988. The effect of purification and firing of clays on trace element provenance studies, *Archaeometry* 30 (1): 37–46.

Kilikoglou, V., Vekinis, G., Maniatis, Y. and P. M. Day 1998. Mechanical performance of quartz-tempered ceramics: part I, strength and toughness, *Archaeometry* 40: 261–279.

Kingery, W. D. 1984. Interactions of ceramic technology with society. In: P. M. Rice (ed.), *Pots and Potters. Current Approaches in Ceramic Archaeology.* Monograph XXIV. Los Angeles: Institute of Archaeology, University of California, pp. 171–178.

Kiriatzi, E. 1996. H meleti tis tehnologias os deiktis anthropinis sumberiforas: Paratiriseis stin kataskeuh kerameikis tis Ysteris Epohis Halkou apo tin Toumba Thassalonikis, *Praktika Sunedriou "Arhaia Makedonia"* 6: 585-597 (In Greek).

Kiriatzi, E. 2000. *Keramiki Texnologia kai Paragwgh. H Keramiki ths Ysterhs Epoxhs tou Xalkou apo thn Toumba Thessalonikis.* Unpublished PhD thesis, Aristotle University of Thessaloniki (In Greek).

Knapp, A. B. and T. Stech (eds) 1985. *Prehistoric Production and Exchange: The Aegean and Eastern Mediterranean.* Monograph XXV. Los Angeles: Institute of Archaeology, University of California.

Knapp, A. B. and J. F. Cherry 1994. *Provenience Studies and Bronze Age Cyprus. Production, Exchange and Politico-Economic Change.* Monographs in World Archaeology No. 21. Madison, Wisconsin: Prehistory Press.

Kokkinidou D. and M. Nikolaidou 1999. Neolithic enclosures in Greek Macedonia: violent and non-violent aspects of territorial demarcation. In: J. Carmen and A. Harding (eds), *Ancient Warfare. Archaeological Perspectives.* Stroud: Sutton publishing, pp. 89–99.

Kotsakis, K. 1983. *Kerameiki Tehnologia kai kerameiki diaforopoiisi. Provlimata tis graptis kerameikis tis Mesis Neolithikis Epohis tou Sesklou.* Unpublished PhD thesis, Aristotle University of Thessaloniki.

Kotsakis, K. 1991. The powerful past: theoretical trends in Greek archaeology. In: I. Hodder (ed.), *Archaeological Theory in Europe.* London and New York: Routledge, pp. 65–90.

Kotsakis, K. 1992. O neolithikos tropos paragogis. Ithagenis h apoikos. In: *Diethnes Synedrio gia tin Arhaia Thessalia. Mnimi D. R. Theohari.* Athens: TAPA, pp. 120–135.

Kotsakis, K. 1994. The use of habitational space in Neolithic Sesklo. In: *La Thessalie: Quinze Années de Recherches Archéologique, 1975-1990.* Athens: Ministry of Culture, pp. 125-130.

Kotsakis, K. 1996a. Exchanges and relations. In: G. A. Papathanassopoulos (ed.), *Neolithic Culture in Greece.* Athens: NP Goulandris Foundation Museum of Cycladic Art, pp. 168–170.

Kotsakis, K. 1996b. Pottery technology. In: G. A. Papathanassopoulos (ed.), *Neolithic Culture in Greece.* Athens: NP Goulandris Foundation Museum of Cycladic Art, pp. 107–107.

Kotsakis, K. 1996c. The coastal settlements of Thessaly. In: G. A. Papathanassopoulos (ed.), *Neolithic Culture in Greece.* Athens: NP Goulandris Foundation Museum of Cycladic Art, pp. 49–57.

Kotsakis, K. 1998. The past is ours: images of Greek Macedonia. In: L. Meskell (ed), *Archaeology Under Fire. Nationalism, Politics and Heritage in the Eastern Mediterranean and Middle East.* London and New York: Routledge, pp. 44–67.

Kotsakis, K. 1999. What tells can tell: social space and settlement in the Greek Neolithic. In: P. Halstead (ed.), *Neolithic Society in Greece.* Sheffield Studies in Aegean Archaeology 2. Sheffield: Sheffield Academic Press, pp. 66–76.

Krahtopoulou, A. 2000. Holocene alluvial history of northern Pieria, Macedonia, Greece. In: P. Halstead and C. Frederick (eds), *Landscape and Land Use in Postglacial Greece.* Sheffield Studies in Aegean Archaeology 3. Sheffield: Sheffield Academic Press, pp. 15–27.

Krahtopoulou, A. 2001. *Late Quaternary Alluvial History of Northern Pieria, Macedonia, Greece.* Unpublished PhD thesis. The University of Sheffield.

Lemonnier, P. 1986. The study of material culture today: toward an anthropology of technical systems, Journal of Anthropological Archaeology 5: 147–186.

Lemonnier, P. 1992. *Elements for an Anthropology of Technology.* Anthropological Papers No. 88. Ann Arbor, Michigan: Museum of Anthropology, University of Michigan.

Lemonnier, P. 1993 (ed.) 1993. *Technological Choices: Transformation in Material Culture since the Neolithic.* London and New York: Routledge

Liritzis, Y., Orfanides-Georgiadis L. and N. Efstratiou 1991. Neolithic Thessaly and the Sporades: remarks on cultural contacts between Sesklo, Dimini and Agios Petros based on trace element analysis and archaeological evidence, *Oxford Journal of Archaeology* 10 (3): 307–313.

London, G. A. 1991. Standardization and variation in the work of craft specialists. In: W. A. Longacre (ed.), *Ceramic Ethnoarchaeology.* Tuscon: The University of Arizona Press, pp. 182–204.

Longacre, W. A. 1991. Ceramic ethnoarchaeology: an introduction. In: W. A. Longacre (ed.), *Ceramic Ethnoarchaeology.* Tuscon: The University of Arizona Press, pp. 1–10.

Longacre, W. 1995. Why did they invent pottery anyway? In: W. K. Barnett and W. Hoopes (eds), *The Emergence of Pottery. Technology and Innovation In Ancient Societies.* Washington DC: Smithsonian Institution Press, pp. 277–180.

Longacre, W. 1999. Standardization and specialization: what's the link?. In: J. M. Skibo and G. M. Feinman (eds), *Pottery and People. A Dynamic Interaction.* Salt Lake City: The University of Utah Press, pp. 44–58.

Mackenzie, W. S. and C. Guildford 1980. *Atlas of Rock-Forming Minerals in Thin Section.* London: Longman.

Mackenzie, W. S., Donaldson, C. H. and C. Guildford 1982. *Atlas of Igneous Rocks and Their Textures.* Harlow: Longman.

Mackenzie, W. S. and A. E. Adams 1994. *A Colour Atlas of Rocks and Minerals in Thin Section.* London: Manson Publishing.

MacSween, A. 1995. Fabric analysis of Coarse Ware assemblages: examples from three sites in the Northern Isles of Scotland, *KVHAA Konferenser* 34: 127–138.

Maniatis, Y. and M. S. Tite 1981. Technological examination of Neolithic-Bronze Age pottery from Central and Southeast Europe and from the Near East, *Journal of Archaeological Science* 8: 59–76.

Maniatis, Y., Perdikatsis, V. and K. Kotsakis 1988. Assessment of in-site variability of pottery from Sesklo, Thessaly, *Archaeometry* 30 (2): 264–274.

Manson, J. L. 1995. Starcevo pottery and Neolithic developments in the Central Balkans. In: W.K. Barnett and J. W. Hoopes (eds), *The Emergence of Pottery. Technology and Innovation in Ancient Societies.* Washington DC: Smithsonian Institution Press, pp. 65–77.

Marquardt, W. H. 1978. Advances in archaeological seriation. In: M. B. Schiffer (ed.), *Advances in Archaeological Method and Theory, Vol. 1.* New York and London: Academic Press, pp.257–314.

Marquardt, W. H. 1992. Dialectical archaeology. In: M. B. Schiffer (ed.), *Advances in Archaeological Method and Theory, Vol. 4.* New York and London: Academic Press, pp. 101–139.

Matson, F. R. 1982. Archaeological ceramics and the physical sciences: problem, definition and results. In: J. S. Olin and A. D. Franklin (eds), *Archaeological Ceramics.* Washington DC: Smithsonian Institution Press, pp. 19–27.

Matson, F. R. 1984. Ceramics and Man reconsidered with some thoughts for the future. In: S. E. Van der Leeuw and A. C. Pritchard (eds), *The Many Dimensions of Pottery.* Amsterdam: Universiteit van Amsterdam, pp.27–49.

Matson, F. R. 1989. Shell-tempered pottery and the Fort Ancient potter. In: G. Bronitsky (ed.), *Pottery Technology. Ideas and Approaches.* Boulder and London: Westview Press, pp. 15–31.

Matthew, A. J., Woods, A. J. and C. Oliver 1991. Spots before the eyes: new composition charts for visual percentage. In: A. Middleton and I. Freestone (eds), *Recent Developments in Ceramic Petrology.* British Museum Occasional Paper No. 81. London: British Museum, pp. 211–263.

Middleton, A. P., Freestone, I. C. and M. N. Leese 1985. Textural analysis of ceramic thin sections: evaluation of grain sampling procedures, *Archaeometry* 27 (1): 64–74.

Middleton, A. P., Leese, M. N. and M. R. Cowell 1991. Computer-assisted approaches to the grouping of ceramic fabrics. In: A. Middleton and I. Freestone (eds), *Recent Developments in Ceramic Petrology.* British Museum Occasional Paper No. 81. London: British Museum, pp. 265–275.

Miller, D. 1981. The relationship between ceramic production and distribution in a central Indian village. In: H. Howard and E. L. Morris (eds), *Production and Distribution: A Ceramic Viewpoint.* BAR (Int. Series) 120. Oxford: British Archaeological Reports, pp. 221–228.

Miller, D. 1982. Explanation and social theory in archaeological practice. In: C. Renfrew, M. J. Rowlands and B. A. Segraves (eds), *Theory and Explanation in Archaeology: The Southampton Conference.* New York and London: Academic Press, pp. 83–95.

Miller, D. 1985. *Artefacts as Categories. A Study of Ceramic Variability in Central India.* Cambridge: Cambridge University Press.

Millett, M. 1979. How much pottery?. In: M. Millett (ed.), *Pottery and the Archaeologist.* Institute of Archaeology Occasional Publication No. 4. London: Institute of Archaeology, University of London, pp. 77–80.

Milojcic, V. 1960. *Hauptergebnisse der deutschen Ausgrabungen in Thessalien, 1953–1958.* Bonn: Rudolf Habelt.

Mueller, J. W. (ed.) 1975. *Sampling in Archaeology.* Tuscon: The University of Arizona Press.

Mylonas, G. E. 1929. *Excavations at Olynthus: Part I, The Neolithic Settlement.* Baltimore: The John Hopkins Press.

Neff, H. 1992. Ceramics and evolution. In: M. B. Schiffer (ed.), *Advances in Archaeological Method and Theory, Vol. 4.* New York and London: Academic Press, pp. 141–193.

Neff, H., Bishop, R. L. and E. V. Sayre 1988. A simulation approach to the problem of tempering in compositional studies of archaeological ceramics, *Journal of Archaeological Science* 15: 159–172.

Neff, H. Bishop, R. L. and E. V. Sayre 1989. More observations on the problem of tempering in compositional studies of archaeological ceramics, *Journal of Archaeological Science* 16: 57–69.

Nelson, M. C. 1991. The study of technological organization. In: M. B. Schiffer (ed.), *Advances in Archaeological Method and Theory, Vol. 3.* New York: Academic Press, pp. 57–100.

Olin, J. S. and A. D. Franklin (eds.) 1982. *Archaeological Ceramics.* Washington DC: Smithsonian Institution Press.

Orton, C., Tyers, P. and A. Vince 1993. *Pottery in Archaeology.* Cambridge: Cambridge University Press.

O'Shea, J. 1981. Coping with scarcity: exchange and social storage. In: A. Sheridan and G. Bailey (eds), *Economic Archaeology.* BAR (Int. Series) 96. Oxford: British Archaeological Reports, pp. 167–183.

O'Shea, J. and P. Halstead 1989. Conclusions: bad year economics. In: P. Halstead and J. O'Shea (eds), *Bad Year Economics: Cultural Responses to Risk and Uncertainty.* Cambridge: Cambridge University Press, pp. 123–126.

Otto, B. 1985. Die verzierte Keramik der Sesklo und Dimini Kultur Thessaliens. Mainz: Philipp von Zabern.

Papadopoulos, S. 1997. *H Neoteri Neolithiki kai h Proimi Epohi tou Halkou stin Anatoliki Makedonia.* Unpublished PhD thesis, Aristotle University of Thessaloniki (In Greek).

Papathanassopoulos, G. A. (ed.) 1996. *Neolithic Culture in Greece.* Athens: NP Goulandris Foundation Museum of Cycladic Art.

Pappa, M. 1997. Neolithikos oikismos Makrygialou Pierias: prota apotelesmata tis meletis, *To Arhaiologiko Ergo sti Makedonia kai Thraki (AEMTH) 10$_A$.*: 259–277 (In Greek).

Pappa, M. and M. Besios 1999a. The Makriyalos Project: rescue excavations at the Neolithic site of Makriyalos, Pieria, northern Greece. In: P. Halstead (ed.), *Neolithic Society in Greece.* Sheffield Studies in Aegean Archaeology 2. Sheffield: Sheffield Academic Press, pp. 108–120.

Pappa, M. and M. Besios 1999b. The Neolithic settlement at Makriyalos, northern Greece: preliminary report on the 1993–1995 excavations, *Journal of Field Archaeology* 26 (2): 177–195.

Parkes, P. A. 1986. *Current Scientific Techniques in Archaeology.* London and Sydney: Croom Helm.

Peacock, D. P. S. 1977. Ceramics in Roman and Medieval archaeology. In: D. P. S. Peacock (ed.), *Pottery and Early Commerce. Characterization and Trade in Roman and Late Ceramics.* London: Academic Press, pp. 21–33.

Perlès, C. 1990. L' outillage de pierre taillée néolithique en Grèce: approvisionnement et exploitation des matières premières, *Bulletin de Correspondance Hellénique* 114 (1): 1–42.

Perlès, C. 1992. Systems of exchange and organisation of production in Neolithic Greece, *Journal of Mediterranean Archaeology* 5 (2): 115–164.

Perlès, C. and K. D. Vitelli 1994. Technologie et fonction des premières productions céramiques de Grèce. In: *Terre Cuite et Société. La Céramique, Document Technique, Economique, Culturel.* XIVe Rencontres Internationales d' Archéologie et d' Histoire d' Antibes. Juan-les-Pins: Editions APCDA, pp. 225–242.

Perlès, C. and K. D. Vitelli 1999. Craft specialisation in the Neolithic of Greece. In: P. Halstead (ed.), *Neolithic Society in Greece.* Sheffield Studies in Aegean Archaeology 2. Sheffield: Sheffield Academic Press, pp. 96–107.

Pfaffenberger, B. 1988. Fetisished objects and humanised nature: towards an anthropology of technology, *Man* 23: 236–252.

Plog, S. 1978. Social interaction and stylistic similarity: a re-analysis. In: M. B. Schiffer (ed.), *Advances in Archaeological Method and Theory, Vol. 1.* New York and London, pp. 143–182.

Plog, S. 1980. *Stylistic Variation in Prehistoric Ceramics.* Cambridge: Cambridge University Press.

Pollard, A. M. and C. Heron 1996. *Archaeological Chemistry.* Cambridge: The Royal Society of Chemistry.

Pritchard, A. C. and S. E. Van der Leeuw 1984. Introduction: the many dimensions of pottery. In: S. E. Van der Leeuw and A. C. Pritchard (eds), *The Many Dimensions of Pottery. Ceramics in Archaeology and Anthropology.* Amsterdam: Universiteit van Amsterdam, pp. 3–23.

Read, D. W. 1974. Some comments on typologies in archaeology and an outline of a methodology, *American Antiquity* 39 (2): 216–242.

Renfrew, A. C. 1972. *The Emergence of Civilisation: The Cyclades and the Aegean in the Third Millennium BC.* London: Methuen.

Renfrew, C. 1973. Trade and craft specialization. In: D. R. Theocharis (ed.), *Neolithic Greece.* Athens: National Bank of Greece, pp.179–191.

Renfrew, C. 1984. Trade as action at distance. In: C. Renfrew (ed.), *Approaches to Social Archaeology.* Cambridge MA: Harvard University Press, pp. 86–134.

Renfrew, C. 1993. Trade beyond the material. In: C. Scarre and F. Healy (eds), *Trade and Exchange in Prehistoric Europe: Proceedings of a Conference Held at the University of Bristol, April 1992.* Oxbow Monograph 33. Oxford: Oxbow, pp. 5–16.

Renfrew, C., M Gimbutas and E. S. Elster (eds) 1986. *Excavations at Sitagroi. A Prehistoric Village in Northeast Greece, Vol. 1.* Monumenta Archaeologica 13. Los Angeles: Institute of Archaeology, University of California.

Rice, P. M. 1976. Comment: rethinking the ware concept, *American Antiquity* 41 (4): 538–543.

Rice, P.M. 1977. Whiteware pottery production in the Valley of Guatemala: specialization and resource utilisation, Journal of Field Archaeology 4: 221–233.

Rice, P. M. 1981. Evolution of specialised pottery production: a trial model, *Current Anthropology* 22 (3): 219–240.

Rice, P. M. 1982. Pottery production, pottery classification, and the role of physicochemical analyses. In: J. S. Olin and A. D. Franklin (eds), *Archaeological Ceramics.* Washington DC: Smithsonian Institution Press, pp. 47–56.

Rice, P. M. 1984a. Change and conservatism in pottery-producing systems. In: S. E. Van der Leeuw and A. C. Pritchard (eds), *The Many Dimensions of Pottery. Ceramics in Archaeology and Anthropology.* Amsterdam: Universiteit van Amsterdam, pp. 233–288.

Rice, P. M. 1984b. The archaeological study of specialised pottery production: some aspects of method and theory. In: P. M. Rice (ed.), *Pots and Potters. Current Approaches in Ceramic Archaeology.* Monograph XXIV. Los Angeles: Institute of Archaeology, University of California, pp. 45–54.

Rice, P. M. 1987a. *Pottery Analysis. A Sourcebook.* Chicago: The University of Chicago Press.

Rice, P. M. 1987b. Economic change in the lowland Maya Late Classic period. In: E. M. Brumfiel and T. K. Earle (eds), *Specialization, Exchange and Complex Societies.* Cambridge: Cambridge University Press, pp. 76–85.

Rice, P. M. 1991. Specialization, standardization, and diversity: a retrospective. In: R. L. Bishop and F. W. Lange (eds), *The Ceramic Legacy of Anna O. Shepard.* Niwot, Colorado: University Press of Colorado, pp. 257–279.

Rice, P. M. 1999. On the origins of pottery, *Journal of Archaeological Method and Theory* 6 (1): 1–54.

Richards, J. D. and N. S. Ryan (eds) 1985. *Data Processing in Archaeology.* Cambridge: Cambridge University Press.

Ridley, C. and K. A. Wardle 1979. Rescue excavations at Servia 1971–1973: a preliminary report, *The Annual of the British School at Athens* 74: 187–230.

Riley, J. A. 1983. The contribution of ceramic petrology to our understanding of Minoan society. In: O. Krzyszkowska and L. Nixon (eds), *'Minoan Society'. Proceedings of Cambridge Colloquium 1981.* Bristol: Bristol Classic Press, pp. 283–293.

Riley, J. A. 1984. Pottery analysis and the reconstruction of ancient exchange systems. In: S. E. Van der Leeuw and A. C. Pritchard (eds), *The Many Dimensions of Pottery. Ceramics in Archaeology and Anthropology.* Amsterdam: Universiteit van Amsterdam, pp. 57–73.

Rodiri, V. 1985. Epifaneiaki kerameiki neolithikon theseon tis Thessalias: Katanomi sto horo, *Anthropologika* 8: 53–74 (In Greek).

Roux, V. and D. Corbetta 1989. *The Potter's Wheel. Craft Specialization and Technical Competence.* New Dehli: Oxford and IBH Publishing Co.

Rowlands, M. J. 1982. Processual archaeology as historical social science. In: C. Renfrew, M. J. Rowlands and B. A. Segraves (eds), *Theory and Explanation in Archaeology: The Southampton Conference.* New York and London: Academic Press, pp. 155–174.

Rowntree, D. 1981. *Statistics Without Tears. A Primer for Non-Mathematicians.* Harmondsworth: Penguin Books.

Runnels, C. N. 1983. Trade and communication in prehistoric Greece, *Ekistics* 302: 417–420.

Runnels, C. N. and T. H. Van Andel 1988. Trade and the origins of agriculture in the Eastern Mediterranean, *Journal of Mediterranean Archaeology* 1 (1): 83–109.

Rye, O. S. 1976. Keeping your temper under control: materials and the manufacture of Papuan pottery, *Archaeology and Physical Anthropology in Oceania* 11 (2): 106–137.

Rye, O. S. 1981. *Pottery Technology. Principles and Reconstruction.* Washington: Taraxacum.

Sabloff, J. A. 1991. Toward a future archaeological ceramic science: brief observations from a conference. In: R. L. Bishop and F. W. Lange (eds), *The Ceramic Legacy of Anna O. Shepard.* Niwot, Colorado: University Press of Colorado, pp. 394–399.

Sabloff, J. A. and R. E. Smith 1969. The importance of both analytic and taxonomic classification in the type-variety system, *American Antiquity* 34 (3): 278–285.

Sahlins, M. 1972. *Stone Age Economics.* London: Tavistock.

Schneider, G., Knoll, K., Gallis, K. and J-P. Demoule 1990. Production and distribution of coarse and fine pottery in Neolithic Thessaly, Greece. In: E. Pernicka and G. A. Wagner (eds), *Archaeometry '90. Proceedings of the 27th Symposium on Archaeometry.* Basel: Birkhauser, pp. 513–522.

Schneider, G., Knoll, H. Gallis, K. and J.-P. Demoule 1991. Transition entre les cultures Néolithiques de Sesklo and de Dimini: recherches minéralogiques, chimiques et technologiques sur les céramiques et les argiles, *Bulletin de Correspondance Hellenique* 115: 2–51.

Schneider, G., Knoll, H., Gallis, K. and J-P. Demoule 1994. Production and circulation of Neolithic Thessalian pottery: chemical and mineralogical analyses. In: *Thessalia: Dekapente hronia arhaiologikis ereunas, 1975–1990. Apotelesmata kai prooptikes. Praktika Sunedriou, 17-22/4/1990.* Athens, Ministry of Culture, pp. 61–70.

Schiffer, M. B. 1972. Archaeological context and systemic context, *American Antiquity* 37 (2): 156–165.

Schiffer, M. B. 1992. *Technological Perspectives on Behavioral Change.* Tuscon: The University of Arizona Press.

Seferiades, M. 1983. Dikili Tash: introduction a la prehistoire de la Macedoine Orientale, *Bulletin de Correspondance Hellenique* 107: 634–677.

Shanks, M. and C. Tilley 1987. Material culture. In: M. Shanks and C. Tilley, *Social Theory and Archaeology.* Cambridge: Polity Press, pp. 79–117.

Shanks, M. and C. Tilley 1989. Archaeology into the 1990s, *Norwegian Archaeological Review* 22: 1–12.

Shanks, M. and C. Tilley 1992. *Re-Constructing Archaeology. Theory and Practice (2nd edition).* London: Routledge.

Shennan, S. 1988. *Quantifying Archaeology.* Edinburgh: Edinburgh University Press.

Shepard, A. O. 1965. Rio Grande glaze-paint pottery : a test of petrographic analysis. In: F. R. Matson (ed.), *Ceramics and Man.* London: Methuen, pp. 62–87.

Shepard, A. O. 1985. *Ceramics for the Archaeologist.* Washington DC: Carnegie Institution of Washington.

Sillar, B. and M. S. Tite 2000. The challenge of 'technological choices' for materials science approaches in archaeology, *Archaeometry* 42 (1): 2–20.

Sinopoli, C. M. 1991. *Approaches to Archaeological Ceramics.* New York and London: Plenum Press.

Skourtopoulou, K. 1998. Technical behaviour and the identification of social patterning: a preliminary discussion of some new evidence from the Late Neolithic of northern Greece. In: S. Milliken and M. Vidale (eds), *Craft Specialization: Operational Sequences and Beyond. Papers from the EAA Third Annual Meeting at Ravenna 1997, Vol. IV.* BAR (Int. Series) 720. Oxford: Archaeopress, pp. 9–16.

Skourtopoulou, K. 1999. The chipped stone from Makriyalos: a preliminary report. In: P. Halstead (ed.), *Neolithic Society in Greece.* Sheffield Studies in Aegean Archaeology 2. Sheffield: Sheffield Academic Press, pp. 121–127.

Skibo, J. M. 1992. Theory and experiment in the study of technological change. In: M. B. Schiffer (ed.), *Technological Perspectives on Behavioral Change.* Tuscon: The University of Arizona Press, pp.44–76.

Stark, M. T. 1991. Ceramic Production and Community Specialisation: a Kalinga Ethnoarchaeological Study, *World Archaeology* 23 (No 1): 64-78.

Stark, M. T. 1993. *Pottery Economics: A Kalinga Ethnoarchaeological Study.* PhD thesis, The University of Arizona.

Stark, M. T 1998 (ed.). *The Archaeology of Social Boundaries.* Washington DC: Smithsonian Institution Press.

Steponaitis, V. P. 1983. *Ceramics, Chronology, and Community Patterns: an Archaeological Study at Moundville.* London: Academic Press.

Talalay, L. E. 1993. *Deities, Dolls, and Devices. Neolithic Figurines from Franchthi Cave, Greece.* Excavations at Franchthi Cave, Greece, Fasc. 9. Bloomington and Indianapolis: Indiana University Press.

Theocharis, D. R. 1968. Anaskafai en Sesklw, *Praktika ths en Athinais Arxaiologikis Etaireias:* 24–30 (In Greek).

Theocharis, D. R. (ed.) 1973. *Neolithic Greece.* Athens: National Bank of Greece.

Theocharis, D. R. and A. Romiopoulou 1961. Anaskafai Dikili Tash (Ellhnikos Tomeus), *Praktika tis Arhaiologikis Etaireias*: 81–87 (In Greek).

Tilley, C. 1981. Economy and society: what relationship? In: A. Sheridan and G. Bailey (eds), *Economic Archaeology.* BAR (Int. Series) 96. Oxford: British Archaeological Reports, pp. 131–148.

Tilley, C. 1990b. Claude Levi-Strauss: structuralism and beyond. In: C. Tilley (ed.) *Reading Material Culture.* Oxford: Blackwell Publishers, pp. 3–81.

Tilley, C. 1991. Interpreting material culture. In: I. Hodder (ed.), *The Meanings of Things: Material Culture and Symbolic Expression.* London: HarperCollins Academic, pp. 185–194.

Tite, M. S. 1969. Determination of the firing temperature of ancient ceramics by measurement of thermal expansion: a reassessment, *Archaeometry* 11: 131–143.

Tite, M. S. 1972. *Methods of Physical Examination in Archaeology.* London: Seminar Press.

Tite, M. S. 1995. Firing temperature determinations – how and why?, *KVHAA Konferenser* 34: 37–42.

Tite, M. S., Freestone, I. C., Meeks, N. D. and M. Bimson 1982. The use of scanning electron microscopy in the technological examination of ancient ceramics. In: J. S. Olin and A. D. Franklin (eds), *Archaeological Ceramics.* Washington DC: Smithsonian Institution Press, pp. 109–120.

Tomkins, P. and P. M. Day 2001. Production and exchange of the earliest ceramic vessels in the Aegean: a view from Early Neolithic Knossos, Crete, *Antiquity* 75: 259–260.

Torrence, R. 1986. Production and Exchange of Stone Tools. Cambridge: Cambridge University Press.

Triantaphyllou, S. 1999. Prehistoric Makriyalos: a story from the fragments. In: P. Halstead (ed.), *Neolithic Society in Greece.* Sheffield Studies in Aegean Archaeology 2. Sheffield: Sheffield Academic Press, pp. 128–135.

Trigger, B. G. 1989. *A History of Archaeological Thought.* Cambridge: Cambridge University Press.

Tringham, R. and D. Krstic' 1990. *Selevac: A Neolithic Village in Yugoslavia,* Monumenta Archaeologica 15. Los Angeles: Institute of Archaeology, University of California.

Tsountas, C. 1908. *Ai Proistorikai Akropoleis Diminiou kai Sesklou.* Athens: Athens Archaeological Society.

Topping, P. G. and A. B. Mackenzie 1988. A test of the use of neutron activation analysis for clay source characterization, *Archaeometry* 30 (1): 92–101.

Valamoti, S. M. 1999. Charred plant remains from Makriyalos: preliminary observations. In: P. Halstead (ed.), *Neolithic Society in Greece.* Sheffield Studies in Aegean Archaeology 2. Sheffield: Sheffield Academic Press, pp. 136–138.

Van der Leeuw, S. E. (ed.) 1981a. *Archaeological Approaches to the Study of Complexity.* Amsterdam: Amsterdam: Universiteit van Amsterdam.

Van der Leeuw, S. E. 1981b. Ceramic exchange and manufacture: a 'flow structure' approach. In: H. Howard and E. L. Morris (eds), *Production and Distribution: A Ceramic Viewpoint.* BAR (Int. Series) 120. Oxford: British Archaeological Reports, pp. 361–386.

Van der Leeuw, S. E. 1982. How objective can we become? Some reflections on the nature of the relationship between the archaeologist, his data, and his interpretations. In:

C. Renfrew and M. J. Rowlands (eds), *Theory and Explanation in Archaeology: The Southampton Conference*. New York and London: Academic Press, pp. 431–464.

Van der Leeuw, S. E. 1984a. Pottery manufacture: some complications for the study of trade. In: P. M. Rice (ed.), *Pots and Potters. Current Approaches in Ceramic Archaeology.* Monograph XXIV. Los Angeles: Institute of Archaeology, University of California, pp. 55–69.

Van der Leeuw, S. E. 1984b. Dust to dust: a transformational view of the ceramic cycle. In: S. E. Van der Leeuw and A. C. Prichard (eds), *The Many Dimensions of Pottery. Ceramics in Archaeology and Anthropology.* Amsterdam: Universiteit van Amsterdam, pp. 709–773.

Van der Leeuw, S. E. 1991. Variation, variability, and explanation in pottery studies. In: W. A. Longacre (ed.), *Ceramic Ethnoarchaeology.* Tuscon: The University of Arizona Press, pp. 11–39.

Van der Leeuw, S. E., Papousek, D. A and A. Coudart 1991. Technical traditions and unquestioned assumptions: the case of pottery in Michoacan, *Techniques et Culture* 17–18: 145–173.

Vitelli, K. D. 1974. *The Greek Neolithic Patterned Urfirnis Ware from Franchthi Cave and Lerna.* Unpublished PhD thesis, University of Pennsylvania.

Vitelli, K. D. 1984. Greek Neolithic pottery by experiment. In: P. M. Rice (ed.), *Pots and Potters. Current Approaches in Ceramic Archaeology.* Monograph XXIV. Los Angeles: Institute of Archaeology, University of California, pp. 113–131.

Vitelli, K. D. 1989. Were pots first made for foods? Doubts from Franchthi, *World Archaeology* 21 (1): 17–29.

Vitelli, K. D. 1993a. Power to the potters. Comment on Perlès' 'Systems of exchange and organization of production in Neolithic Greece", *Journal of Mediterranean Archaeology* 6 (2): 247–257.

Vitelli, K. D. 1993b. *Franchthi Neolithic Pottery. Volume 1: Classification and Ceramic Phases 1 and 2.* Excavations at Franchthi Cave, Greece, Fasc. 8. Bloomington and Indianapolis: Indiana University Press.

Vitelli, K. D. 1994. Experimental approaches to Thessalian Neolithic ceramics: gray ware and ceramic colour. In: *Thessalia: Dekapente hronia arhaiologikis ereunas, 1975–1990. Apotelesmata kai prooptikes.* Athens: Ministry of Culture, pp. 143–148.

Vitelli, K. D. 1995. Pots, potters and the shaping of the Greek Neolithic society. In: W. K. Barnett and J. W. Hoopes (eds), *The Emergence of Pottery. Technology and Innovation in Ancient Societies.* Washington DC: Smithsonian Institution Press, pp. 55–63.

Vitelli, K. D. 1999. *Franchthi Neolithic Pottery. Volume 2: The Later Neolithic Ceramic Phases 3 to 5.* Excavations at Franchthi Cave, Greece, Fasc. 10. Bloomington and Indianapolis: Indiana University Press.

Wace, A. J. B. and M. S. Thompson 1912. *Prehistoric Thessaly.* Cambridge: Cambridge University Press.

Washburn, D. K. 1983. Symmetry analysis of ceramic design: two tests of the method on Neolithic material from Greece and the Aegean. In: D. K. Washburn (ed.), *Structure and Cognition in Art.* Cambridge: Cambridge University Press, pp. 138–164.

Weisshaar, H-J. 1989. *Die Deutschen Ausgrabungen auf der Peukakia-Magoula in Thessalien.* Bonn: R. Habelt GMBH.

Whallon, R. 1972. A new approach to pottery typology, *American Antiquity* 37 (1): 13–33.

Wheat, J. B. 1991. Ceramic classification: Bradfield and Shepard, types and varieties. In: R. L. Bishop and F. W. Lange (eds), *The Ceramic Legacy of Anna O. Shepard.* Niwot, Colorado: University Press of Colorado, pp. 120–131.

Whitbread, I. K. 1986a. *The Application of Ceramic Petrology to the Study of Ancient Greek Transport Amphorae, With Special Reference to Corinthian Amphora Production.* Unpublished PhD thesis, University of Southampton.

Whitbread, I. K. 1986b. The characterization of argillaceous inclusions in ceramic thin sections, *Archaeometry* 28 (1): 79–88.

Whitbread, I. K. 1989. A proposal for the systematic description of thin sections towards the study of ancient ceramic technology. In: Y. Maniatis (ed.), *Archaeometry: Proceedings of the 25th International Symposium.* Amsterdam and Oxford: Elsevier, pp. 127–138.

Whitbread, I. K. 1991. Image and data processing in ceramic petrology. In: A. Middleton and I. Freestone (eds), *Recent Developments in Ceramic Petrology.* British Museum Occasional Paper No. 81. London: British Museum, pp. 369–388.

Whitbread, I. K. 1995a. We are what we study: problems in communication and collaboration between ceramologists and archaeological scientists, *KVHAA Konferenser* 34: 91–100.

Whitbread, I. K. 1995b. *Greek Transport Amphorae. A Petrological and Archaeological Study.* Fitch Laboratory Occasional Paper 4. London: British School at Athens.

Whitbread, I. K. 1996. Detection and interpretation of preferred orientation in ceramic thin sections, *Proceedings of the 2nd Symposium of the Hellenic Archaeometrical Society* (26–28 March 1993). Thessaloniki: Hellenic Archaeometrical Society, pp. 413-425.

Whitelaw, T. M. 1992. Lost in the labyrinth?. Comments on Broodbank's 'Social change at Knossos before the Bronze Age', *Journal of Mediterranean Archaeology* 5 (2): 225–238.

Whittle, A. 1996. *Europe in the Neolithic. The Creation of New Worlds.* Cambridge: Cambridge University Press.

Whittle, A. 1997. Moving on and moving around: Neolithic settlement mobility. In: P. Topping (ed.), *Neolithic Landscapes.* Neolithic Studies Group Seminar Papers 2. Oxford: Oxbow Books, pp. 15–22.

Widemann, F. 1982. Why is archaeometry so boring for archaeologists?. In: J. S. Olin and A. D. Franklin (eds), *Archaeological Ceramics.* Washington DC: Smithsonian Institution Press, pp. 29–36.

Wijnen, M. 1982. Analysis of the Early Neolithic pottery from Sesklo. In: M. N. Wijnen *The Early Neolithic I Settlement at Sesklo: An Early Farming Community in Thessaly, Greece.* Leiden: University of Leiden Press, pp. 21–37.

Wijnen, M. 1994. Neolithic pottery from Sesklo. Technological aspects. In: J.-Cl. Decourt, B. Helly and K. Gallis (eds), *La Thessalie: 15 Années de Recherches (1975–1990). Bilan et Perspectives.* Athens: Tameio Arhaiologikon poron kai apallotrioseon, pp.149–154.

Williams, D. F. 1978. A petrological examination of pottery from Thera. In: C. Doumas (ed.), *Thera and the Aegean World I. Papers Presented at the Second International Scientific Congress, Santorini, Greece, August 1978.* London: Thera and the Aegean World.

Williams, D. F. 1983. Petrology of ceramics. In: D. R. C. Kempe and A. P. Harvey (eds), *The Petrology of Archaeological Artefacts.* Oxford: Clarendon Press, pp. 301–329.

Wilson, D. E. and P. M. Day 1994. Ceramic regionalism in Prepalatial central Crete: the Messara imports at EM I to EM II_A Knossos, *Annual of the British School at Athens* 89: 1–86.

Wilson, D. E. and P. M. Day 1999. EM II B ware groups at Knossos: the 1907-8 South Front Tests, *Annual of the British School at Athens* 94: 1-62.

Wobst, H. M. 1977. Stylistic behaviour and information exchange. In: C. E. Cleland (ed.), *For the Director: Research Essays in Honour of James B. Griffin.* Ann Arbour: University of Michigan, pp. 317–342.

Woods, A. J. 1982. Smoke gets in your eyes: patterns, variables and temperature measurement in open firings, *Bulletin of the Experimental Firing* 1: 11–25.

Woods, A. J. 1986. Form, fabric, and function: some observations on the cooking pot in antiquity. In: W. D. Kingery (ed.), *Technology and Style II.* Columbus, Ohio: American Ceramic Society, pp. 157–172.

Yardley, B. W. D., Mackenzie, W. S. and C. Guildford 1990. *Atlas of Metamorphic Rocks and Their Textures.* Harlow: Longman.

Yiouni, P. 1996a. H sumvoli ton Arhaiometrikon ereunon sti meleti tis Neolithikis Kerameikis, *Proceedings of the 2nd Symposium on the Hellenic Archaeometrical Society (26–28 March 1993).* Thessaloniki: Hellenic Archaeometrical Society, pp. 135-148.

Yiouni, P. 1996b. The Early Neolithic pottery: technology. Analysis and comparison with other Neolithic ceramic materials. In: K. A. Wardle (ed.), *Nea Nikomedeia I: the Excavation of an Early Neolithic Village in Northern Greece 1961–1964.* Supplementary Volume No. 25. London: The British School at Athens, pp. 55-212.

Zangger, E. 1991. Prehistoric coastal environments in Greece: the vanished landscapes of Dimini Bay and Lake Lerna, *Journal of Field Archaeology* 18 (1): 1–15.

Ziota, C., Kalogirou, A., Fotiadis, M. and A. Hondrogianni 1993. Kitrini Limni, tessera hronia ereunas, *To Arhaiologiko Ergo sti Makedonia kai Thraki (AEMTH) 4*: 93-103.