Obsidian exchange and societies in the Balkans and the Aegean from the late 7th to 5th millennia BC

Marina Milić

A thesis submitted to University College London
for the degree of Doctor of Philosophy

Institute of Archaeology
University College London
31-34 Gordon Square
London, WC1H 0PY

April 2016

Declaration

I, Marina Milić, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

Obsidian has long been recognised as a proxy for tracing long-distance interaction and exchange. In this thesis, I use these lithics to examine the directionality, intensity and nature of interactions of the Neolithic communities that lived in western Anatolia, the Aegean and the Balkans between the late 7^{th} and the mid-5^{th} millennia BC. The study sites are located in the zones of circulation of material from three major obsidian sources: central Anatolian, Melian and Carpathian. More specifically, they are located in the peripheries of, and overlaps between, distributions zones in which obsidian was procured from long distance. The thesis investigates the modes and scales of interaction that are responsible for bringing obsidian to these sites and that can be measured through characterising obsidian consumption. The main approach is based on examination of interrelationships between raw material and technology in a number of assemblages. This is done by provenancing obsidian artefacts to sources by quantifying characteristic trace element patterns using data obtained with a portable X-Ray Fluorescence spectrometer. Techno-typological analysis of artefacts within the chaîne opératoire framework is used to understand the forms in which obsidian was exchanged and consumed at settlements. The results show that the interactions in these regions are not highly uniform. The amount of obsidian found in these assemblages is sufficiently small that it could not be counted as a primary raw material, and so in many cases it could be related to irregular or occasional events rather than formal exchange networks or long-term relationships. The thesis also seeks to develop our understanding of the varying motivations and mechanisms underlying the consumption of obsidian from its role in day-to-day practices to its use as a symbolic representation of long-distance contacts.

Table of Contents

List of Figures

List of Tables

Acknowledgments

I would like to thank many people who helped and supported this project and encouraged me to complete this often very challenging journey.

My gratitude firstly goes to my supervisors Andy Bevan, Cyprian Broodbank, and Todd Whitelaw, who joined my supervisory panel at a crucial time, for their intellectual and logistic support and invaluable feedback.

I am very grateful to the institutions that provided financial support for this research through grants: The Wenner-Gren Foundation (Wadsworth International Fellowship), the UCL Overseas Research Scholarship, The Open Society Foundation and a UCL Excellence grant.

My fieldwork was completed with the support of many scholars working in Turkey, Greece and Serbia.

In Turkey, I am indebted to: Mehmet Özdoğan, Necmi Karul, Mert Bertan Avci, Nurcan Kayacan, Mihriban Özbaşaran and Eylem Özdoğan, (Istanbul University); Ivan Gatsov and Petranka Nedelcheva (Bulgarian New University); Fokke Gerittsen (Nederland Institute in Turkey); Özlem Çevik and Burcin Erdoğu (University of Thrace, Edirne); Çiler Çiringiroğlu, Zafer Derin and Haluk Sağlamtimur (Ege University, Izmir); Turan Takoğlu (Çanakkale University); Denis Guilbeau (University Paris-X).

In Greece, I owe much gratitude to Kostas Kotsakis (Aristotle University, Thessaloniki) for support and advice during the fieldwork and writing phases of this thesis. I am very much indebted to Duška Urem-Kotsou (Democritus University of Thrace). I am also grateful to Areti Hondroyanni-Metoki (Ephorate of Antiquities, Kozani), Chaido Koukouli- Chrisantaki (Ephorate of Antiquities, Kavala), Maria Pappa (Ephorate of Antiquities, Thessaloniki), Christina Ziota (Ephorate of Antiquities, Florina); Giorgos Hourmouziadis, Aikaterini Papanthimou-Papaefthimiou, Marina Sofronidou and Elefteria Theodorudi (Aristotle University, Thessaloniki) and the students at Aristotle University, in particular Niki Saridaki, Yannis Papadias and Jenny Gkatzogia.

In Serbia, I am grateful to Miroslav Marić (Institute for Balkan Studies, Belgrade), Neda Mirković-Marić (University of Belgrade), Miljana Radivojević (UCL), Ben Roberts (Durham University) and Boban Tripković (University of Belgrade).

PXRF and obsidian calibration was conducted with the help of Marcos Martinón-Torres and Patrick Quinn (UCL), Thilo Rehren and Myrto Georgakopoulou (UCL Qatar), Colin Renfrew (Cambridge University) and Tristan Carter (McMaster University).

I want to especially thank Tristan Carter. I had the privilege to work with him on many projects in Turkey and Greece, and I learnt a great deal from him over the many years we worked together.

The staff at the Institute of Archaeology helped with many of the often daunting administrative issues over the years, in particular Lisa Daniel and Thom Rynsaard.

During my time in London I shared time with some great people and fellow doctoral students, in particular: Rose Bains, Peter Coe, Ruth Fillery-Travis, Rob Homsher, Francesco Iacono, Adi Keinan-Schoonbaert, Janice Li, Vana Orfanou and Carmen Ting.

I would also like to thank my friends Adi Keinan-Schoonbaert, Vana Orfanou, Helen Dawson, Anna Stellatou and Borja Legarra Herrero for the incredible help and hospitality at the time after I left London.

Many thanks to Vana Orfanou and Christina Tsoraki-Chan for their help with Greek translations.

I owe to a huge gratitude my family - my mum, dad and sister Lidija, for always being there for me. Writing up and the fieldwork would not be possible without the help of my mum and Mini Molloy who were taking care of my little bundle of distraction (Fillip Xander Molloy) throughout much of this work. Thanks to all the Molloys for keeping me sane (?) in the last year of my PhD.

Last but not least, I have to thank Barry Molloy for everything - for endless patience and encouragement, for all the advice, never-ending discussions about obsidian, tedious proof reading and a whole lot more!

This thesis is dedicated to my family,

(in order of appearance in my life)

Mum, Dad, Lidija, Barry, Fillip and Millan

Chapter 1. Introduction

1.1. Aims and setting of the study

This thesis aims to investigate and describe the nature, directionality and intensity of exchange connections between Neolithic communities of the late 7th, 6th and 5th millennia BC using the evidence provided through the study of obsidian artefacts. It considers obsidian acquisition and consumption in three case-study areas across the western part of Anatolia, the Aegean and the central and southern Balkans (Figure 1.1). Because obsidian can be accurately provenanced and was consumed across wide areas, it is particularly well suited to exploring exchange networks. Its study can thereby also provide clear evidence for peoples engaging in social and economic relationships with other regions and cultures through a variety of different activities. Obsidian was widely used by prehistoric societies worldwide and it has received considerable attention as an archaeological material since the late 19th century. A notable success in obsidian studies was achieved through the pioneering work of Renfrew, Dixon and Cann in the 1960s when trace elemental analyses, statistical modelling and concepts of trade and exchange were integrated as part of a unique multidisciplinary methodology. The further development of scientific methods in the past two decades has been useful for enabling very precise information to be obtained about obsidian sources and circulation and, in recent years, portable X-Ray Fluorescence (hereafter pXRF) spectrometers have become widely accessible for archaeologists. A key feature in the last five years or so has therefore been our growing ability to use this method to rapidly generate accurate data on-site such that more representative and larger samples can be obtained than before. This in turn better enables the kind of multi-site comparative approach that I will develop in the chapters that follow.

Perhaps because of the point-source and highly identifiable character of the material, spatial models for early trade and exchange studies in archaeology have often used obsidian as a key proxy for identifying the movements of prehistoric communities and their interactions. Apart from traceability, the physical properties of obsidian, sharpness and shiny appearance, make it distinctive amongst other raw materials and objects. As Robb noticed (2007, 200), while other Neolithic artefact types (e.g. rare colourful flints, polished stone and bone objects and *Spondylus* shell) were also moved over such large distances, none were transported in such a systematic, large-scale way. Furthermore, a unique feature of this material is that well-provenanced obsidian-working traditions are to be found in several different areas in the world, encouraging the comparative study of the long-distance exchange of obsidian within and between different societies worldwide. For example, in Europe and Asia Minor, there are several areas with multiple obsidian sources that were used in prehistory - the central Mediterranean, the Aegean, central and eastern Anatolian and central Europe.

Over the course of this research, I have visited archaeological projects throughout the study area and conducted first-hand analysis of a wide variety of excavated assemblages. This has involved quantifying the absolute and, where practicable, relative quantities of obsidian within broader chipped stone assemblages from excavated Neolithic sites. In the maps (e.g. Figure 1.1.) used throughout the thesis, the percentages of obsidian in relation to other lithics from study assemblages are calculated (all data is provided in Data 1 on CD). This was done alongside other sites in Anatolia, the Aegean and the Balkans for which the information about obsidian percentage has been collected via existing publications. However, it is important to note that these quantities represent only a part of the original quantity of material that was in use. These were the pieces that ended up being discarded or deposited in the excavated areas of sites, and we cannot assume that not all obsidian consumed by the residents ended up being deposited at (or recovered from) the site. The material deposited on-site, therefore, is not unequivocally a representative sample of the material consumed by the occupants, given the off-site activities that are not documented during excavations. Furthermore, the recovery methods (excavation and the use of sieving) adopted at different sites were far too variable to be truly comparable.

In particular, the focus of this research will be on studying obsidian assemblages from as many sites as possible in those areas thought to be on the margins of well-known obsidian distributions, supplemented by careful reconsideration of the published data from better-know core areas, in order to develop a macro-regional picture of the exchange and interaction that this type of material culture can effectively provide. In addressing this large geographical scale of analysis, there are inevitably limitations in the fidelity of analysis for assemblages at each site studied, which is typically a result of the stage of research and publication of the relevant project teams. Where practicable, I take account of depositional practices affecting the character of assemblages analysed.

The main methodology used here involves a combination of techno-typological and provenance characterisations of assemblages. The first method examines the forms in which obsidian was obtained and consumed. Then, using pXRF technology, I was also able to quantify key trace elements that could be used to attribute artefacts to particular obsidian sources. In this way, the pieces of obsidian examined have been characterised using distinct criteria that provided information about their biographies or lifecycles as objects. This approach has enabled a range of relationships between sites and obsidian sources to be plotted spatially using GIS. In this way, we can identify the direction(s) of the interactions, while quantities, knapping techniques and forms of obsidian artefacts can then be used to explore in more detail the intensity and the nature of the contacts alongside a characterisation of diversity in local practices of manufacture and consumption.

The criteria I have used for targeting three case-study regions in this thesis are discussed in Chapter 5. These three source areas are located in central Anatolia, the Cycladic island of Melos and the northern arc of the Carpathian Mountains. Close to these sources, obsidian is a regularly used raw material, while in the outer areas, acquiring obsidian involving the mobility of people and/or wider groups of things in which the movement of obsidian may often have been a secondary outcome. My intention in this work, therefore, is to compare and contrast the consumption of obsidian starting at the scale of a single site and extending up to inter-site relations that form geographical micro-regions, and from there to assess regional-level interactions. However, those communities on the margin of one distribution zone could also receive obsidian from another source (Figure 1.1), and the evaluation of relative access to two or more exchange networks in a given site and region further elucidates the modes of interaction existing between communities and individuals.

A key contribution of this thesis will be to characterise the exchange of different obsidian types (based on source) alongside their production and consumption. Through pXRF and technologically informed sampling, this project explores: a) the frequency of obsidian relative to other raw materials; b) the frequency of different obsidian types in overlapping areas, i.e. when more than one source is represented; c) the *chaîne opératoire* of each obsidian type; d) obsidian consumption at neighbouring and contemporary settlements; and e) the procurement and consumption of obsidian from a micro to macro regional basis.

1.2. Geographical and temporal scope

In total, 1498 pieces from 20 assemblages have been studied in person for this research, of which 974 were characterised for possible provenance through my fieldwork using a pXRF.

These primary data collection efforts spanned modern day national borders, permit-granting institutions and research projects and were carried out in 2010-2012 fieldwork seasons. A further 16 sites were thoroughly re-investigated via published catalogues and existing commentaries. The sites selected for close attention are located in: the eastern and north-eastern Aegean (western Anatolia), the Marmara region (north-western Anatolia), Greek Macedonia, and the central Balkans. As far as practicable, I analysed obsidian from all known sites that were available for study. As mentioned above, the sites given particular attention were those that are assumed to come from marginal procurement zones, and especially those thought to be receiving obsidian from more than one distinct source regions. More specifically, in the eastern and north-eastern Aegean and the Marmara region communities consumed obsidian from Melian and central Anatolian sources, while in Macedonia, an overlap of Melian and Carpathian sources was expected. The significance is that these communities did not consume the same amount of obsidian from each source, at the same time, or indeed for the same purpose, thus implying that different mechanisms of exchange were in place.

My characterisation of assemblages from such marginal distribution zones in the eastern Aegean and north-western Anatolia in particular, provides an unusual and usefully comparative view of obsidian supply on the margins, and with this in mind, more effort was placed on these areas than on sites in the core supply zones with higher numbers of obsidian pieces from single sources. Prior to this study, the quantities of obsidian present at any given site, as well as the provenance of that obsidian was not well known in many of the study regions considered here. For example, eastern Aegean sites remained relatively unexplored until very recently and only a few obsidian assemblages had been provenanced. Prior to one or two recent studies (Bergner *et al.* 2009; Herling *et al.* 2008; Perlès *et al.* 2011) and my own research as described here, the character of obsidian circulation in western and north-western Anatolian sites had been largely unrecognised. This is the case with the north-eastern distribution of Melian obsidian and also the western spread of central Anatolian obsidian, towards the Aegean. Obsidian provenancing work has enabled me to clarify the distribution boundaries and the results are explored in detail in Chapters 6, 7 and 8.

The temporal framework of this thesis includes Neolithic material spanning the late 7th, 6th and the first half of the 5th millennia BC (ca. 6400-4500 BC). These absolute dates correspond to a sequence of very complex relative chronologies (Figure 1.2.) and terminologies in the study areas: Anatolian Late Neolithic (LN), Early Chalcolithic (EC) and Middle Chalcolithic (MC); Aegean Early Neolithic (EN), Middle Neolithic (MN), Late Neolithic I and II (LN I and LN II) and Final Neolithic (FN); central Balkan Early Neolithic and Middle Neolithic (Starčevo culture) and Late Neolithic and Eneolithic (EE) Vinča culture (early Vinča (A and B) and late Vinča (C and D) cultures).

Details of the chronological relationships will be discussed in Chapter 5, though here it can be concisely stated that sites in the eastern and north-eastern Aegean and the Marmara region belong predominantly to the late 7th / early 6th millennia BC. The sites located in Turkey that have been examined here belong to the Late Neolithic / Early Chalcolithic periods (LN / EC). This terminology is taken from Turkish prehistoric chronology and corresponds to Early Neolithic and Middle Neolithic in Aegean and Balkan terminologies. The study sites in Macedonia and the central Balkans (Serbia) are predominantly dated to mid-6th to mid-5th millennia BC and this is related to Late Neolithic period in Greek and Balkan terminology.

In summary, my overall study area encompasses a range of Neolithic communities surrounding the Aegean basin, but dominated by:

a) EN (LN/EC) in the eastern and north-eastern Aegean and north-western Anatolia for the overlap of Aegean and Anatolian obsidian.
b) LN in the southern Balkans for the overlap of Aegean and Carpathian obsidian.

This slight mismatch for each region is due to the availability of well-excavated assemblages. Indeed, reframing this bias as a potential analytical strength, we also stand to gain much from such staggered chronology, as we can thereby hope to understand historic transformations associated with the adaptation of early farming communities to new territories in the EN and development of more complex social relations and value systems due to increased residential stability in the LN period.

In the case of the LN/EC eastern and north-eastern Aegean and north-western Anatolia, there are now a large number of excavations being undertaken and these projects kindly provided access to their obsidian assemblages, which allowed for the creation of a very promising dataset for exploring long-distance exchange and inter-settlement relations. In the same area, there is currently a dearth of sites that belong to the later Neolithic periods from the mid-6th millennium BC. Çilingiroğlu (2010, 16) noted that “[I]t is unfortunate that in Central-West Anatolia it is not possible to discuss further evolution of impressed wares beyond 5700/5600 cal. BC because all the excavated sites so far were abandoned more or less simultaneously before the mid-6th millennium cal." In the central and southern Balkans, on the other hand, the use of obsidian is common in the Early and Middle Neolithic periods, however, the exchange of obsidian in the Late Neolithic (mid-6th – mid-5th millennia BC) was the most extensive and this is the period in which both Melian and Carpathian raw materials reach their widest distributions.

1.3. Thesis overview

This thesis has nine chapters and begins with an overview of Neolithic societies and existing theoretical perspectives on exchange in Chapter 2, where I will provide the wider research context behind my study. Three main issues will be dealt with here: the background to the Neolithic period in each study area, models of cultural and economic interaction in the Neolithic and the role that obsidian characterisation has played in studies of trade and exchange. In the first section, I introduce the archaeology of the study regions, starting with our current understanding of what the process of Neolithisation means and following on from this to assess the settling of groups in Anatolia, the Aegean and the Balkans in the Neolithic. This section addresses settlement patterns and building technologies, social organisation, craft specialisation and activities related to exchange and interaction. Neolithic societies engaged in exchanges of materials and technologies for various reasons and to fulfil both practical and symbolic needs. Such exchanges may have involved entire communities, groups and/or lone individuals and might involve either short or long journeys. How we might characterise this interaction is considered in relation to traditional exchange models and more recent approaches that emphasise interaction at different scales. The exchange of obsidian is an essentially Neolithic phenomenon, with later periods in most areas exhibiting far less sustained investment in moving this lithic resource around (at least in part due the advent of metallurgy). The third part of the chapter illustrates how obsidian has previously been used in studies of exchange mechanisms, and I place particular emphasis on the models that were applied in the three source regions of this research. Finally, obsidian is considered as an artefact that signifies various social practices. I will discuss how obsidian was linked to the manufacture of functional knapped tools, but also utilised for its aesthetic properties which may themselves have motivated inter-personal contacts and prestige-building strategies.

The history of research in the three different volcanic settings present in my study regions is discussed in Chapter 3, along with a summary of the evidence for the distribution of obsidian from each source in relation to the different time-frames considered by this study. It is significant that three such source regions occur in significantly different environmental settings (Figure 1.1), and I discuss the implications for different kinds of material accessibility. The central Anatolian complex hosts a number of outcrops, located inland on the Anatolian plateau and surrounded by a vast plain, and my emphasis here is on the history of exploitation at two major sources, Göllü Dağ and Nenezi Dağ. The Aegean sources of Adamas and Demenegaki are situated comparatively close together on the small island of Melos, in the western Cyclades, which makes them particularly suited for assessing maritime mobility, as discussed in Chapters 3, 7 and 9. The third source area is a part of the Carpathian Mountains on the edges of the Great Hungarian Plain in central Europe. This means that three different types of movement took place through landscapes, from obsidian sources to settlements, involving overland journeys, maritime stretches and riverine routes. Chapter 3 also defines the reasons for focussing on the areas where there is an overlap of obsidian distributions from more than one source area.

Chapter 4 describes the main analytical methods applied to each site's obsidian assemblages. These include trace element characterisation, techno-typological study and contextual analysis (wherever the latter is practical given constraints of publication and access). I outline the way the chosen methodological strategy has developed and justify the choice of analytical equipment. This includes discussion of the more destructive and expensive approaches commonly used in the past and comment to the effect that these rarely allowed valid datasets to be generated. The underlying goal of an investigation of this kind is to collect sufficient samples via portable instrumentation that can be used at sites and museums with considerably fewer administrative limitations and which in turn can enable the examination of far larger numbers of pieces than has previously been possible. Building on the advantages of mass-sampling from many assemblages, it was my intention in this thesis to analyse as many artefacts as practicable, particularly in the marginal, overlap zones of different source-area distributions.

The final part of Chapter 4 considers the methodology used for studying the techno-typological aspects of knapped stone tools. Its purpose is to explain how the technology used for artefact manufacture and the form in which each artefact is exchanged can reveal wider exchange mechanisms. The criteria and terminology used are defined via the *chaîne opératoire* approach to identify each step in an artefacts' production and consumption cycle.

Important further methodological issues are discussed in Chapter 5, which is separated into two sections. The first part addresses the question of sampling strategies on a sliding scale from the selection of study regions, to the selection of sites and then to the treatment of artefacts. In particular, this chapter provides information on the 20 sites that were studied intensively and in person for the purpose of this PhD and also includes published data from other sites that are relevant to this research (this includes a number of sites in Serbia that I had previously analysed, as discussed in Chapter 8). It addresses key issues relating to the absolute and relative chronologies of the region and it assesses the difficulties in correlating these varying systems. The second part of this chapter is an overview of the archaeology of the sites and material culture associated with them. I define the idea of considering both *inner* and *outer* zones of an obsidian distribution that to some extent correlate with Renfrew's *supply* and *contact* zones, but begin with fewer assumptions about modes of exchange (Renfrew *et al.* 1968b). The intention is to explain the nature of the large obsidian assemblages close to the sources and the way peoples there used obsidian that was widely accessible. The purpose is to understand the progression of how obsidian is manufactured and used in the vicinity of the sources and then at sites of varying distances moving farther away until we reach the limits of the known distributions.

Chapter 5 thereby offers an introduction to three data chapters which contain the results from the characterisation and techno-typological studies of individual assemblages. Chapters 6, 7 and 8 duly provide the results gathered from the three obsidian regions: central Anatolia, Melos and the Carpathians respectively. The reason to choose these regions is that while they have distributions that are neighbouring and sometimes overlap, the communities that used obsidian from these sources are also interlinked through various cultural and historical processes. Each chapter is structured in a way first to describe the obsidian assemblages from one or two key sites located in the core and intermediate areas from the sources and then for the rest of the sampled study sites individually.

Chapter 6 discusses the distribution and consumption of obsidian from the central Anatolian Göllü Dağ and Nenezi Dağ sources. The main emphasis here is on the LN/EC sites in the Marmara region, as this is an area that contains central Anatolian obsidian as the most frequent type. The results from the provenancing also showed that this type of obsidian occurs in the regions of the eastern and north-eastern Aegean. The focus of the following Chapter 7 is on EN and LN sites that have Melian Adamas and Demenegaki as their main obsidian type. This chapter includes the results from both assemblages. The EN (LN/EC) discussion contains details of results from the study of material from the eastern and north-eastern Aegean sites largely supplied from Melian sources. In the section that deals with LN material, the emphasis is on the north-western Aegean sites in Macedonia, representing the peripheral zone of distribution of Melian obsidian. Chapter 8 then returns to the occurrences of Carpathian obsidian in Macedonia and then expands to consider contemporary communities that lived in the central and northern parts of the Balkans, where Carpathian obsidian is also documented.

Chapter 9 synthesises the results of the research overall by period and micro-region. It places an analytical emphasis on understanding the appearance of different obsidian types, both at a single site and within a group of sites, and suggests different mechanisms by which obsidian was procured and consumed. It also reconsiders the ability of existing datasets to address the core questions of the thesis, the practical implications of the chosen methodologies for this dissertation, and the archaeological interpretation of how patterns in obsidian distribution reveal social practices and wider processes in the Neolithic. For example, it reconsiders how obsidian evidence continues to modify our understanding of the processes of Neolithisation and adopting of agriculture in western and north-western parts of Anatolia and the Aegean.

A final section (Chapter 10) summarises the outcomes and potential for further research that has emerged through this work on obsidian in marginal regions. It also considers the practical constraints affecting the material and information available for this study and through this I highlight a range of promising opportunities for future research.

1.4. Summary

As noted above, obsidian has long been recognised as an attractive geological and archaeological material for research, particularly in studies of exchange and interaction between distinct regions. This thesis offers new results on provenancing and close study of obsidian from a range of sites that have been studied for the first time herein, and these are located in the regions (Anatolia, the Aegean and the Balkans), that traditionally have received much attention for those seeking to understand the roles and outcomes of movement and interaction in the Neolithic period. My methodology combines novel technology (pXRF) that has enabled the analysis of far greater numbers of artefacts in a single study than has previously been possible in this wider region. This is complemented with more established techno-typological study of chipped stone tools within a multi-disciplinary framework that aims to provide new insights about the modes of exchange and consumption of obsidian. The use of material from marginal areas of known obsidian distributions is of crucial importance, informing our understanding in novel ways about short and long-range interactions among Neolithic societies across hundreds of kilometres.

Chapter 2. Current Perspectives on Neolithic Society, Regional Interaction and Obsidian Exchange

2.1. Introduction

This chapter provides an overview of current theoretical and interpretative perspectives on Neolithic life and community, with particular emphasis on those debates that are most applicable to the study regions addressed in subsequent chapters. It begins with a discussion of Neolithisation processes and the suggested mechanisms and directions by which Neolithic ways of life spread. Thereafter, it offers a descriptive overview of Neolithic settlement patterns and architecture, social organisation and craft specialisation. A key theme relates to how we understand exchange and connectivity between Neolithic communities and the final sections of this chapter therefore consider those bodies of anthropological and archaeological theory that have been adopted to make sense of these issues both within and beyond the study region. This combination of both substantive and theoretical review then sets up the more detailed exploration of the character of the Neolithic material culture, chronological frameworks and analytical terminology offered in Chapter 5.

The starting point for this chapter is our current understanding of the process of Neolithisation itself. In the LN period, increasing sedentism and developments in domestic life reflect the emergence of greater complexity at both the community and household levels, amongst which specialisation and exchange are of notable importance. Subsequently, the development of social inequalities became distinct through the definition of a small group of individuals with higher status and power. In line with this, a core concern of this chapter will be to examine the nature of interaction and exchange and their relationship with Neolithic social practice. I will also build on this by discussing aspects of the following: the movement of communities in the early phases of the Neolithic; exchange and interaction within regional and household settings and in relation to subsistence and craft; and interaction and exchange as a result of travels that provided prestigious status to the individual and objects involved. The models proposed for reconstructing people's interaction through obsidian exchange are discussed in section 2.4.

2.2. The Neolithic: A review

2.2.1. Models of Neolithisation

The Neolithic 'revolution', whether or not we wish to retain this idea of very abrupt change, refers to an important transition in human history and behaviour that, in this part of the world, started in the Fertile Crescent around the 10th-9th millennia BC. It was characterised by the formation and spread of sedentary communities along with crop and animal domestication, the regular creation of food surplus and new modes of storage, and various technological inventions (Cauvin 2000; Perlès 2001). It has been said that a "great exodus" (Cauvin 2000) from the core of the Fertile Crescent probably began in the late Pre-pottery Neolithic B (PPNB; c. 7500-7000 BC) via the Taurus mountains and central Anatolian plateau, reaching the Aegean coast and the southern Balkans in the early to mid-7th millennium BC (Cauvin 2000, 141; Çilingiroğlu 2005, 5; Perlès 2001, 99–110) and the inland Balkans from around 6500 BC (Borić 2005; Forenbaher & Miracle 2005; Perlès 2001; Zvelebil & Lillie 2000). There are numerous perspectives on how the Neolithic spread and degrees of Neolithisation, i.e. contact and change due to the movement of populations and their integration (or not) with local groups. Several models have been proposed to explain these changes: frontier mobility via small-scale movement of small groups of foragers and farmers based on established exchange networks (cultural diffusion); demic diffusion is colonisation of new territories by sedentary farming communities or leap-frog colonisation of small groups which involves interaction with local foraging groups (Perlès 2001; Zvelebil 2001; Zvelebil & Lillie 2000). For example, for the background to the settlements in the eastern Aegean it has been proposed that leap-frog colonisation took place. Some cultural phenomena can be related to early central Anatolian communities (domesticates, red plastered floors, monochrome ceramics), while some other finds (e.g. obsidian and marine resources) might imply that these Anatolian colonists established relationships with local forager groups. This is currently best evidenced from the earliest levels at Ulucak, dated to the first half of the 7th millennium BC (Çilingiroğlu *et al.* 2012; Çilingiroğlu & Çakirlar 2013).

Diverse hypotheses have sought to account for population movement and the colonisation of new territories. Principal amongst these are that populations crossed from Anatolia to Europe via island-hopping in the Aegean archipelagos (Broodbank 1999; Çilingiroğlu 2009, 491; Perlès 2001, 61) or a land-bridge between north-western Anatolia and Thrace (Özdoğan 1997, 1999). Recent models of the migration of farming groups are however much more complex than the traditional view of a great diffusion from the Fertile Crescent via the Anatolian Peninsula. The most recent suggestion is that there are several ‘Neolithic packages’ that can be defined according to the diversity of archaeological evidence (Çilingiroğlu 2005; Düring 2013; Özdoğan 2011). There is, however, agreement that these diverse trajectories can only be followed from c. 6500 BC as the phenomena continue to spread out from a ‘core’ area on the central Anatolian plateau towards the west and north-west (Düring 2013; Özdoğan 2011). In the Anatolian Lake District, the eastern Aegean and the Marmara region, there is a growth in settlement numbers. Some of these settlements retained a central Anatolian character (e.g. monochrome ware, pressure flaking, stamp seals, figurines, plastered floors), while equally showing changes in other aspects (predominant farming rather than hunting, architecture which vary from region to region and even site to site, different pottery forms, lack of projectile points and appearance of sling-missiles). A distinctive situation is found in the Marmara region where the presence of Mesolithic sites is documented through surveys of the east coast of the Marmara (Gatsov & Özdoğan 1994). On the other hand, in the Lake District and coastal Aegean region, the Mesolithic occupation is currently not known (Çilingiroğlu & Çakirlar 2013).

In north-western Anatolia, Mehmet Özdoğan (1997, 1999) has defined a Fikirtepe culture whose earliest phase is represented by the establishment of Neolithic communities at c. 6400 BC. We can observe, however, that there is significant diversity between Fikirtepe culture sites, those located on the east coast of the Marmara Sea and those further inland to the south. They include different types of settlement (flat vs. tell), architecture (round pit-dwellings vs. rectangular), economy and subsistence (hunting and fishing vs. farming) and burial practices (intramural vs. extramural). Özdoğan argues that this is a result of more than one process of Neolithisation, with an exogenous introduction in the south (e.g. tells at Ilıpınar and Barcın Höyük), while eastern (e.g. Fikirtepe and Pendik) represent local adaptations to a ‘Neolithic way of life’ by pre-existing Mesolithic communities (Özdoğan 1997, 23; 2011). These cultural groups are not always consistent and homogenous, and the case of Fikirtepe settlements particularly makes this clear.

There are suggestions that at least three stages of the Neolithisation of the western Anatolia, Aegean and the Balkans that can be distinguished. The earliest route dated to the end of the 8th and the first half of the 7th millennia BC. Pèrles strongly proposed that the colonisation of the southern Aegean (Crete) and the Peloponnese (visible in Franchthi Cave), is earlier than that in western Anatolia, the northern Aegean, Thessaly and Macedonia and it is related to the movement of groups along the southern Anatolian coast from the Levant and Cyprus to the Aegean, bypassing central Anatolia (Perlès 2001; Perlès *et al.* 2013). The earliest level at Ulucak (level VI) also belongs to this early phase of Neolithisation. The phase is characterised as aceramic as these are currently the only sites at which the lack of pottery can be securely confirmed. Other sites (e.g. Aceramic Argissa) are still to be accurately dated (Perlès *et al.* 2013).

Around 6500 BC seems to be an important period for the settling of the western Anatolia and the Aegean. Settlements are founded in the Anatolian Lake District, the eastern and north-eastern Aegean, Marmara region and Thessaly (Brami & Heyd 2011; Düring 2013). The third wave of settling begins around 6100 BC in the Aegean and SE Europe and this is observed in Thrace (e.g. Karanovo I), Macedonia and Starčevo culture sites farther to north in the Balkans (Brami & Heyd 2011; Reingruber 2011).

During the early phases of pottery Neolithic, regional differences are particularly visible in the pottery styles through which the above phase can be defined:

- Dark burnished ware is documented in central Anatolia and the Marmara region (particularly Archaic phase of Fikirtepe sites, c. 6500 BC) and serves to link these two regions (Brami & Heyd 2011; Özdoğan 2011).
- Red-slipped burnished ware is found in the eastern Aegean and early phases of the Lake District sites. This is largely absent in the Marmara region. This type of ware appears at the sites in the Izmir region and close parallels can be drawn to the Lake District wares and ceramic forms (Çilingiroğlu 2009). Apart from the eastern mainland, the appearance of red-slipped ware is documented in the other parts of the Aegean.
- Following the early monochrome phase, in the Lake District (as well as central Anatolia), the occurrence of painted pottery is documented, although this type is almost absent in the eastern and northern Aegean. On the contrary, around 6 000 BC, painted pottery became typical within assemblages in the western Aegean and to the north of the Aegean Sea (e.g. Balkan Karanovo and Starčevo cultures).
- At around the same time when the Lake District communities started producing painted pottery, in the coastal Aegean sites, the impressed pottery is found (on red-slipped wares). This type of decoration is absent at the inland sites, the Lake District

included. The impressed ware is recorded in Ulucak Va-VI, Yeşilova III late, Ege Gübre, Çukuriçi Höyük VIII and Dedecik-Heybelitepe, levels that are dated to c. 6000 BC (Çilingiroğlu 2010). This is important as the obsidian from the first three sites is included in this study (Chapter 7). Furthermore, impressed decoration is found at the northern Aegean sites of Hoca Çeşme and Uğurlu on the island of Gökçeada (Imbros), also studied in the thesis. A small percentage comes from the Fikirtepe sites of Ilıpınar, Yarımburgaz and Demircihöyük. In the western Aegean, impressed ware was found in Thessaly (e.g. Argissa and Achilleion) and Macedonia (Yannitsa B, Nea Nikomedeia), although of somewhat different style (Çilingiroğlu 2010).

I will here briefly turn to the question of the movement of groups across the Aegean and the suggestions about possible routes that might have been taken in the movement between Anatolia and the Aegean, as this will serve as a basis for dispersal of obsidian. The movement of early farming groups from the Levant to the Aegean started at the end of the 8th / early 7th millennia BC. As it was noted above, these farmers probably travelled along the southern Anatolian coast and south-eastern Aegean via island-hopping to Crete (Broodbank 1999). From c. 6500 BC the dissemination of mobile farming communities within the Aegean is widespread. Trans-Aegean leaping across the chain of islands and early seafaring knowledge is supported by the increasing evidence about the Mesolithic hunter-gatherer groups in the Aegean (Broodbank 2013; Kaczanowska & Kozlowski 2013). The current data for EN habitation of the Aegean islands, particularly the small ones, is still sparse, and there is still an assumption that main colonisation started later than on the mainland (Broodbank 2013). On the other hand, excavation of the settlement at Uğurlu on Gökçeada (Erdoğu 2011, 2013) is an example of early colonisation of the Aegean islands (c. 6400 BC), which includes the farming package, which might be related to its closeness to the coast of Troad (occasional open air and cave habitation is known from several islands, e.g. Ayio Gala cave on Chios nearby Anatolian littoral; Çilingiroğlu 2009; Hood 1981).

The southern Anatolian coast route that was proposed for the Aceramic Neolithic, seem to be used in the later phases of the EN (c. 6000 BC), according to the dissemination of impressed wares, which can be following from Syria, along the Cilician coast, the eastern Aegean and northern Aegean. Özdoğan (2011) believes that this direction of movement can also be identified on the basis of round-plan buildings known from the sites on Cyprus and more recently discovered at the site of Ege Gübre, near Izmir. Çiler Çilingiroğlu, however, noted that there is a divergence in impressed pottery styles, between the eastern and western Aegean. The latter region shows more similarities with the Levantine sites, again by-passing Anatolian mainland (Çilingiroğlu 2010). Her suggestion is that reason for taking different routes might be a related to strong winds and currents. Recently explored eastern Aegean coast could represent the 'new missing link' in the Neolithisation of the Aegean, connecting Anatolia with the western Aegean / Thessalian sites via the chain of Cycladic but also providing an important 'seafaring nursery' (Broodbank 1999) for the journeys to the northern Aegean regions. The study of obsidian from the sites in the eastern and north-eastern Aegean will give an important contribution towards understanding these contacts.

2.2.2. Settlement patterns in the EN periods

In the following sections, I will give an overview of some of the characteristics of settlements, social organisation and regional variations in the study areas during EN and LN periods. Since the first farmers settled in the areas of the western Anatolia and the Aegean, from c. mid-7th millennium BC, they started building houses in repeated sequences in one place, thus forming tells (mounds) in some locations. The build-up of settlements into tells is associated with the Neolithic lifestyle and reflects a typical Near Eastern and Anatolian phenomenon that appears in the Aegean, southern and eastern Balkans (southern Bulgaria, Thrace, Macedonia) from the EN, and in northern parts of the Balkans from later Neolithic times (Chapman 1981; Demoule & Perlès 1993; Greenfield & Jongsma 2006; Halstead 1999; Kotsakis 1999). Tells are formed by rebuilding and repairing of houses, through multiple generations of inhabitants (Chapman 1998; Kotsakis 1999). Small, rectangular houses, often one-roomed, made of mud-brick are a Near Eastern and Anatolian feature, though specifics of constructions vary from site to site. In Greece and Anatolia, both mud-brick and wattle-and-daub techniques were practiced, sometimes with stone foundations (Demoule & Perlès 1993; Rosenstock 2006; Souvatzi 2008). Catherine Perlès (2001, 197) observed that because of the diversity and co-existence of different building techniques, as well as the variable internal features, it would be hard to make any typological classifications. The houses were densely clustered, often aligned in rows, occasionally sharing walls and courtyards (Anatolia) or built only slightly apart. In Thessaly, freestanding structures were often scattered with no particular order (Perlès 2001, 180; Schoop 2005). Early houses contain hearths and ovens, although ovens were also found in the outside spaces, possibly for communal use, while the consumption of food was at times a public event (Halstead 1999, 80).

On the eastern coast of the Sea of Marmara (e.g. Fikirtepe and Pendik) and in Thrace, as previously mentioned, another type of EN settlement is found. It is composed of circular semi-subterranean pit-houses with wattle-and-daub superstructures. The unique are structures at Ege Gübre where two types of buildings were possibly used simultaneously. Its round houses were most likely made of wattle-and-daub, while rectangular ones exhibit mud-brick walls built on stone foundations (Sağlamtimur 2012). Early Neolithic pit-houses have not been documented in Greece; only possible storage and/or rubbish and or 'clay' pits have been found at few sites (Perlès 2001, 185). In some locations in the Aegean and eastern Adriatic, recognition of the earliest Neolithic is characterised by cave occupation, although this could imply the continuation of Mesolithic occupation, assimilation with the Mesolithic populations or Neolithic newcomers (Borić 2005; Forenbaher & Miracle 2005; Souvatzi 2008).

While inhabitants of the southern Balkan Peninsula were creating long-lasting tell settlements, a fixed place of 'time and ancestry' (Halstead 1999, 87), the northern and central Balkan communities lived in a more 'elusive built environment' (Borić 2008, 123). Until the formation of tell settlements from the MN/LN mid-6th millennium BC, building traditions included only semi-permanent pit-dwellings in settlements (Borić 2008; Chapman 1981; Greenfield & Jongsma 2006), similar to some Marmara settlements (Fikirtepe and Pendik). One of the explanations for the lack of surface structures in this area and the existence of short-lived pit houses is that they were occupied by mobile communities that "would be considered similar to or descendants of the indigenous hunter-gatherers of the Balkans" (Greenfield and Jongsma 2006, 77).

2.2.3. Settlement patterns in the LN period

The LN period (from the mid-6th millennium BC) is characterised by continuity of habitation in some locations, but we can also observe settlement expansion, particularly in Macedonia, and the central and northern Balkans. In the Aegean, a number of islands were colonised, with settlers living either in caves or building settlements, often consisting only of a few stone houses (Broodbank 1999; Sampson 2008a). In the central and northern Balkans, for the first time, we find the development of tell settlements (Chapman 1998; Halstead 1999; Kotsakis 1999). The emergence of tell sites and the practice of repeated rebuilding of houses in a single location might have been influenced by the communities living in the southern Balkan and Aegean tradition (Borić 2008).

Contemporaneous with the tell sites, we have evidence for the formation of large flat settlements with horizontal expansion, particularly recognised in LN Macedonia (e.g. Makriylos, Thermi B and Kleitos) but also common in the central and northern parts of the Balkans (e.g. Selevac and Opovo). The distinctive features of the flat settlements are perimeter ditches and walls that surround the village, large pit-dwellings and storage/production pits. Demoule and Perlès (1993, 364) suggested that "they might be characteristic of more wooded environments, where rejuvenation of the forest and weeds precluded long-term use of the fields and, thus, long-term occupation of the villages". The coexistence of tell and flat settlements in the same region (e.g. Macedonia) and especially in the same location (e.g. Sesklo) undermines the environmental hypothesis (Kotsakis 1999; Souvatzi 2008, 199). In the Balkans, flat settlements are not unusual and the establishment of tell settlements "might better be explained by the spatial restrictions of their riverside locations" (Tringham & Krstić 1990, 588). Considering the social aspect, there seems to be agreement (Skourtopoulou 2006; Souvatzi 2008, 200–201; Tringham 2000) that flat and horizontally displaced settlements do not necessarily represent short term and discontinuous habitation, but different concepts of permanence and stability. Furthermore, it could also be assumed that not all the communities had a similar sense of their place within the landscape from practical, environmental or economic perspectives. Habitants of the tell settlements built solid houses with vertical superimposition of structures creating obvious markers of their lineage and social memory (Halstead 1999, 87; Kotsakis 1999). On the other hand, flat settlements could mean that as families expanded, some members could build houses close to their family, whereas the limited space in tell settlements, after one or two generations, would cause a displacement of members imposing discontinuity of family lineages. In the flat settlements, the ancestral continuity might have been maintained through practice of burying the dead in the communal ditches (e.g. Makriyalos), which may have emphasised the connections of the community with its predecessors (Triantaphyllou 1999, 131–132).

Physical demarcation of villages in the Aegean and Balkans has been ascribed to an appreciation of a community's living space that is distinct from the activities and people outside the boundaries (Bailey 2000, 44; Demoule & Perlès 1993; Souvatzi 2008). Construction, digging, and maintenance of the perimeter ditches and walls probably indicates social organisation that involved work and cooperation of the entire community (Andreou *et al.* 1996; Souvatzi 2008). However, the walls and ditches that run through the settlements, dividing internal spaces and activities, potentially show an image of social differentiation

(Kotsakis 1999, 71; Souvatzi 2008, 201). Separation of different forms of habitational space and perhaps behaviour is best known in case of Sesklo where two distinct areas, 'polis' and 'acropolis', are divided apparently according to social structure. Demarcation of space within the village and differentiation amongst inhabitants is also marked in the quality of house building and pottery styles (Kotsakis 1999, 2006).

The LN division of villages by walls and ditches, according to Paul Halstead (1999, 80), restricted sharing amongst the households and represents actions that he described as "hoarding" (Halstead 1995). Solidly built houses are more insulated from one another and their interiors are divided into several rooms. Many activities are shifted from open space into the interior of the buildings, where the production, preparation and storage of food took place (Halstead 1995; Tomkins 2004, 50).

In north-western Anatolia, well-documented finds from Ilıpınar (phases X-V) demonstrate an interesting change in the economy of this site that could have particular social relevance. The early village of Ilıpınar (X-VI) is characterised by freestanding, post-framed, rectangular houses in a radial layout, with a single room and some interior facilities. In the middle of the 6th millennium BC (Ilıpınar VI), striking changes occurred in building construction and the economy. The timber-framed buildings were replaced with mud-brick ones that were more substantial houses, with interiors divided into several spaces for different activities (cooking, storing, living area) (Roodenberg 1999).

As in the later Neolithic of the Aegean, the Balkans went through its second major transformation when farming had become firmly embedded in social practices of subsistence and land-use, and could no longer be considered a novel activity. Studies of pottery fabrics from later Starčevo sites (c. 6000-5500 BC) have shown a shift from using organic inclusions to mineral tempers in pottery manufacture (Manson 1995; Spataro 2013). Pottery made of organic material is lighter and therefore easier to transport, while use of mineral tempers was associated with more sedentary communities as a symbol of "residential stability" (Manson 1995, 74), but could also be related to a better knowledge of the local geology. Furthermore, as the sedentary way of life became fully established, intentional burning of houses at almost all the settlements, flat and tell, became a common practice (Stevanović 1997). Rectangular houses were solidly built on surface levels, consisted of post-framed structures with wattle-and-daub walls and two or more rooms. In contrast to EN settlements, in LN period, at almost all settlements in the central Balkans, ovens, storage vessels, and pits were found inside the houses, suggesting that production activities and food-processing now took place in interior spaces (Bailey 2000; Chapman 1981; Tringham *et al.* 1985; Tringham & Krstić 1990; Tripković 2007, 2011). The building complexity and increased focus on differentiated uses of interior space find ready parallels in the elaboration of households in the later Neolithic in the Aegean and western Anatolia.

2.2.4. Social dynamics in LN period in the Balkans

As noted above, by the beginning of the 6th millennium BC, fully developed villages had storage facilities, which could signify longevity and community continuity (Bailey 2000, 280; Chapman 1981, 133; Tripković 2011). Food storage and pithos production suggests a concern with forward planning and by extension an expectation of stability.

Greater household independence, the emergence of craft specialisation and long-distance exchange initiated competition and imbalance in social relations (Chapman 1981; Halstead 1995; Perlès & Vitelli 1999). This new organisation implied the emergence of specialists, i.e. individuals and groups involved in particular activities that were not accessible to others. Some authors, nevertheless, believe that uniform distribution of artefacts within the settlement and cooperation in public works (ditches) indicate that there is no evidence for these hierarchical developments in communities in the southern and central Balkans (Porčić 2012; Souvatzi 2008, 230–235). Some aspects of social diversity are visible through architectural elaboration of certain buildings or the recognition of unequal concentrations of finds in different parts of a village, and through mortuary contexts. The appearance of central structures in villages has its roots in the EN, although they are typical for LN settlements. A Later Neolithic type of central house called a 'megaron' is larger, with two or three rooms and has a central position within a settlement, sometimes physically separated from the rest of the houses with a ditch (Demoule and Perlès 1993). They are solidly built, containing hearths, platforms and plastered floors. Unlike EN houses, the LN megaron structures are regarded as elite residences (Halstead 1995). Some scholars (e.g. Demoule & Perlès 1993; Halstead 1995) believe that LN megaron houses served as a signal of institutionalised inequalities in a community rather than just special-purpose communal structures (Theocharis 1973). In the central Balkans, special purpose houses - 'shrines'- occurred at several sites. Here, the distinction is the appearance of 'bucrania' (plastered skulls of cattle) as architectural features on the walls of larger houses in some villages (e.g. Gomolava). Bigger houses, whether they were decorated with bucrania, or contained an unusual number of finds (prominent are Vinča type figurines) are seen at number of settlements (e.g. Vinča-Belo Brdo) and could have been of hierarchical or ancestral significance (Tripković 2013).

2.2.5. Craft specialisation

Craft specialisation in ancient communities has been intensively analysed in social anthropology, particularly since the 1980s. In small-scale, low-population societies, such as those in the study areas considered here, craft production is commonly thought to be either purely domestic for consumption by the producers, or at a low level of specialization, associated with individual households, which then exchanged their products with other neighbours on the basis of reciprocity (Sahlins 1972). Households are often characterised as being somewhat dependent on the goods crafted by the others; they needed to produce a surplus to be able to exchange for the goods that they cannot manufacture themselves (Clark and Parry 1990; Cobb 1993; Costin 1991).

Several different types of specialisation have been widely discussed in the literature. Initially Earle (1981, 230; also Brumfiel and Earle 1987) proposed two types of specialists, independent and attached, that in turn could, it was argued, be related to differing levels of societal complexity. Independent specialists are those craftspersons who can keep and control the distribution of their own products. These kinds of craftspeople are especially common in situations involving the domestic production of objects (e.g. tools, pottery and clothes) that are used for the maintenance of utilitarian, every-day needs. In contrast, attached specialisation is largely related to complex, stratified societies in which the production of symbolic and wealth goods is sponsored by the elite who control their manufacture and distribution, and use them for gaining status and power (Costin 1991; Costin and Hagstrum 1995: Earle 1981). The twofold categorisation is further separated into a number of different types of craft specialisation, some of which are production for local consumption, production for regional consumption and production for elites or central institutions (cf. Clark and Parry 1990; Costin 1991, 8-9).

Costin (1991) emphasised that production and specialisation are different phenomena in which the former is the simple transformation of raw material into objects while the latter is more organised production dependent on several parameters, some of which are skill, efficiency, and time spent, i.e. full-time or part-time specialists. These links with the economic aspects of specialisation, including product standardisation, overall productivity in manufacture and surplus generation, which consequently have social ramifications (Adams 1974; Costin 1991; Rice 1981; Torrence 1986).

Standardisation in product style, size and form is one of the central indicators of specialisation, and refers to the production of a large number of very uniform objects. These objects are likely to have been crafted by fewer producers and, therefore, there is less variability regarding the techniques, forms and decorations. Likewise, such individuals build-up greater experience and develop better control by regularly producing larger quantities of artefacts (Costin and Hagstrum 1995; Eerkens and Bettinger 2001; Rice 1981). This in turn has a great effect on overall levels of efficiency, mass production and cost (Rice 1981; Torrence 1986). Specialised production can best be recognised in archaeological contexts through the presence of specialised workshops, localised production debris, tools, etc. but also standardised forms and features of both rare and commonly used forms of material culture.

Work on obsidian assemblages from the great obsidian deposit at Phylakopi on Melos, led Torrence (1986) to suggest that there was a distinction between part- and full-time knapping specialists which she examined through calculation of time needed to produce quantities of obsidian debris that was found at the site, throughout the entire duration of the use of the deposit. In this study, she concluded against the existence of 'commercial' blade production and the resourcing / support of full-time knappers. Moreover, the distinction between full- and part-time workers can hardly be recognised within non-stratified societies.

A key question is what specialisation entails in small-scale societies where the organisation of production is based on kinship systems. There are some suggestions that standardised production can occur in smaller, non-stratified societies, although the scale of production or efficiency and time are not necessarily implied (Clark and Parry 1990). Clark and Parry (*ibid*., 296) put emphasis on the political nature of craft specialisation in which the production of 'socially meaningful' or, as Perlès (1992) describes them as 'symbolic and ritual' goods (e.g. highly decorated pottery, stone vessels, shell objects) as opposed to mundane ones, were used as a medium for gaining status.

In the Neolithic period of Anatolia, the Aegean and the Balkans, craft specialisation, even though traditionally considered as 'simple' and limited (Childe 1981), can be observed in building techniques, the production of pottery, figurines, pressure-flaked tools, Spondylus shells, bone and stone objects, and later for metal production and use (Chapman 2008; Perlès

1992). Craft specialisation, however, represents part of a chain of activities related not only to manufacture *per se*, but also to the acquisition of raw materials, utilisation and exchange (Costin 1991; Dobres & Robb 2000; Kaiser & Voytek 1983; Perlès 1992).

As noted above, good indicators of specialisation are the existence of distinct workshops / activity areas, tool-kits, storing and possibly hoarding. In the technological sense, this relates to the work of skilful craftsmen, standardisation of production, and often the development of regional exchange networks. The practices surrounding exchange could have been in the hands of itinerant craftsmen as individuals who travelled from village to village, making pots or knapping stone. According to Perlès (1990, 1992), notable persons in such a scenario are obsidian knappers, who may have been the same persons who also had knowledge as specialised seafarers for traveling to Melos to acquire obsidian from the sources. In relation to this proposal, this research will also address the existence of specialised knappers in other obsidian-using regions.

The question of production efficiency in EN small-scale communities once again can be examined through well-studied obsidian from the Melian sources. After the work of Torrence on the Bronze Age deposits from Melos, Perlès' examination of Melian obsidian blades from sites in Thessaly was important because it suggested craft specialisation for the production of pressure-flaked blades in the earliest stages of the Neolithic period (Perlès 1990, 1992). In this case, pressure-flaked technology was necessary for the production of as many blades as possible that would be more economically to transport and distribute in farther areas across the seas.

The scale of various forms of specialisation ranges from simple household-based activities in the EN (Chapman & Gaydarska 2011; Çilingiroğlu 2009, 225) to increased standardisation in the LN (Halstead 1995; Perlès 1992). Perlès (*ibid.*) emphasised that, in the Aegean, there are different mechanisms of production and exchange for each category of objects and raw material. For example, EN pottery was locally produced, simple and small-scale, and this pattern of consumption does not imply widespread production, estimated at up to 20 pots per year per village (Perlès 2001, 214). According to Vitelli (Perlès & Vitelli 1999, 102; also Çilingiroğlu 2009, 223) pottery was used in special events for particular people, for sharing food and perhaps for feasting. EN stone tools, on the other hand, were mostly made of non-local raw materials procured from a long distance and production was carefully performed using pressure flaked technology. In the LN period, the elaboration of pottery production is visible in vessel shapes and decoration, now implying some degree of craft specialisation, organised production and long-distance exchange. In the case of obsidian, its consumption reveals an apparent increase in seafaring frequency in the Aegean which led to the direct procurement of obsidian by specific communities and its wide distribution, which in turn facilitated domestic production and 'de-specialisation' (Perlès 1990; Perlès & Vitelli 1999, 100). This is related to settling of the Cyclades in the 6^{th} millennium BC, after which obsidian became easily available and accessible for exploitation directly, in many trips and with minimum time invested, not requiring specialised knapping expertise. The blades were manufactured using percussion technology, less productive in terms of number and regularity of blades that could be knapped from a nodule (Perlès 1990). In the areas farther away from the sources, in Thessaly and Macedonia, however, specialised production and exchange still relies on the knowledge of 'experts'. Moreover, different degrees of craft specialisation and exchange existed for the exploitation of other raw materials. Honey flint and jasper are very rare in Greece, and Perlès argues that tools made from these materials were never produced locally but by skilled craftsmen in workshops near the sources. Locally available cherts were exploited and manufactured in domestic contexts, using less careful knapping techniques (Perlès 1990; 1992). She argued that the production and exchange of obsidian and good quality imported flint was under the control of itinerant knappers (Perlès 1992, 137).

In the Balkans, in contrast to the Aegean, EN pottery was monochrome, rarely painted, and usually with incised or impressed decoration. The predominant coarse ware typically had a barbotine surface (Bailey 2000, 87; Spataro 2013). Standardisation in pottery production increased through time, as seen through the increase in the use of black burnished pottery from the MN/LN period of the second half of the 6th millennium BC (Chapman 1981; Kaiser & Voytek 1983; Spataro 2013). It has been noted that, in the Vinča period, two main elements of specialisation are lacking: workshops and specialised tool-kits (Chapman 1981, 118; Greenfield 1991; Kaiser 1990). Separate studies on pottery assemblages from several Vinča sites in Serbia showed that pottery was produced within individual households, possibly fired in fire-pits and not in specialised workshops (Chapman 1981; Greenfield 1991; Kaiser 1990; Kaiser & Voytek 1983). Similarly, figurine production was associated with households and their distribution in settlements is equally spread within each household and not necessarily related to bigger houses with larger labour forces (Chapman 1981, 68; Greenfield 1991, 295). Specialisation in the production of black-burnished pottery, however, could be seen in the exploitation of resources, standardisation of ceramic forms and decoration and in firing technology. This led to increased production and consumption at settlements. Particular skill was required to achieve the high firing temperature and this might be related to the development of pyrotechnology that was needed for emerging metallurgy. This phenomenon is dated to the first half of the 5th millennium BC, particularly in the central and eastern Balkans in Serbia and Bulgaria. Several centres for copper extraction and smelting have been identified (Rudna Glava and Ai Bunar), while at several other settlements there is evidence for smelting and production (e.g. Belovode and Pločnik; Radivojević *et al.* 2010).

The manufacture of stone tools also becomes more skilful and a variety of good quality raw materials is now acquired from more distant quarries. At some sites, early knapping was less careful, with in-situ working of chert pebbles and with the majority of assemblages comprised of flakes. The situation changed in the LN when the material included regular cores knapped into standardised blades which were imported as semi-finished tools rather than blocks of raw material (Kaiser & Voytek 1983, 344).

Even though the black-burnished pottery seemed to be produced by many different potters, its extensive spread is used as a marker of LN connectivity throughout the wide region of south-eastern Europe. This type of pottery is principally linked with the most widespread cultural grouping known from the central Balkans, the Vinča culture (5500-4500 BC). The appearance of dark burnished rippled pottery in Ilıpınar phase VB, contemporary with the same assemblages from Karanovo III, is dated to 5500 BC and seen as a reflection of Balkan-Anatolian interregional interaction (Roodenberg 1999). Similarly, sites in the Troad (Gülpınar, Kumtepe, and Beşik-Sivritepe) might have been open to influences from the Balkans (Takaoğlu 2006). Overall, Black-burnished pottery and pottery with pattern-burnished decoration is found throughout the Aegean islands and the mainland, including Troad, Thrace, Macedonia and Thessaly.

Craft specialisation within societies is closely related to the development of exchange as the "[S]pecialization thus implies not only production, but production for exchange" (Cobb 1993, 66). There are several proposals as to how exchange, particularly at small-scale Neolithic societies can be perceived. Some of the motives for the interactions and exchange amongst individuals and communities are considered in the following section.

2.3. Exchange as a sign of mobility, interaction and competition

The movement of early farming groups is an important characteristic of the Neolithic period, and has been discussed in detail at the beginning of this chapter (section 2.2.) given that it is particularly salient for the study regions considered by this research. Throughout the history of the discipline, there has been a particular focus on linking artefacts and assemblages across wide regions on the basis of their formal similarities. The starting point has often been to understand and explain the existence of non-local objects on archaeological sites in areas where they, or their raw materials, did not naturally exist (Renfrew 1975; Torrence 1986). In Childe's view, the movement of artefacts was used to document the wider diffusion of whole populations or culture groups (Childe 1981).

The ways in which people move, even what may be termed migration, has many different forms that are related to what elements of communities were moving, for how long, and if they were intending to return (Anthony 1997). As we saw, one aspect of movement is generally in terms of wholesale migrations, and this can be contrasted with the more specific mobility of specialists who brought know-how with them (Perlès 1992). The connectivity in early farming communities might be associated with exploration of new territories and colonisation. Colonising communities would have carried some of their personal belongings with them as well as habits and skills into new regions where these were further exploited, developed and transmitted. In the context of possible long-distance movement from the Near East to Greece, Perlès (2001, 62) suggested "that the first pioneer groups in Greece would have been constituted of (adventurous) individuals, continuing the PPNB 'great exodus', and having followed different pathways from their original ancestral 'homes' in to Greece. Each would have retained some, but only some, of their most valuable symbols and techniques." Social and cultural links are visible in material culture that was exchanged and raw materials procured and transported via terrestrial and maritime routes.

As noted in the previous section, an important economic characteristic of small-scale Neolithic communities is the production and exchange of utilitarian and non-utilitarian goods. Exchange represents a central process in establishing and maintaining intra- and inter-community relationships. Within a substantivist perspective in which archaic economies are embedded in social processes, Karl Polanyi (1957) fostered the idea that "social exchange" was predominant in non-monetary societies, and that the reciprocal movement of goods between people was a "social process functioning to provide essential resources, maintain alliances, or to establish prestige and status" (Hodder 1982, 200). He distinguished three types of exchange: reciprocity, redistribution, and market-exchange, related to the levels of societal development. Following his logic, the principal mechanism of tribal Neolithic societies would be reciprocal exchange of gifts (e.g. Malinowski 1922; Mauss 1990). Simple exchange within a community is, in step with this view, seen as the sharing of goods on a basis of reciprocity, usually within kin groups (Sahlins 1972). Exchange that was maintained between different villages is related to the intentional production of more specialised goods in which other communities were expected to reciprocate. Exchange based on reciprocal sharing serves many purposes, e.g. exchange of valuables and agricultural products, widening of genetic pools (both human and animal), or exchange of labour and making alliances (Halstead 1995; Perlès 2001, 295; Shennan 1999).

Within intercommunity exchange it is possible to distinguish adaptionist and political approaches (Brumfiel and Earle 1987; Cobb 1993). An adaptionist model puts the emphasis on exchange which would have served the entire community. This is particularly beneficial during hard periods (e.g. local crop failure) when the communities are mutually dependent. Perlès (2001, 300) suggested that in the EN of Greece, craft specialisation and inter-site exchange of goods could have developed as the result of a social need for interdependence within and between communities rather than for strictly economic and technical reasons. These partnerships, together with kinship ties, would serve as a means to provide partnerships between neighbouring village communities and in turn prevent conflict over territory and resources (Perlès 1992, 121; Robb 2007, 313–4). The Later Neolithic is associated with the development of larger-scale exchange systems in which the accumulation of valuables was a means to establish and display social inequalities (Halstead 1995, 20). According to this view, some households would produce more than they required for subsistence and the spare produce would be exchanged for other goods or status symbols (Adams 1974; Cobb 1993; Sahlins 1972). This order, nevertheless, could have been changed in times of need when external alliances and help is needed from further afield and therefore exchange partnerships were maintained with more distant communities (Halstead 1995, 1999).

In contrast to the adaptionist perspective, a political model implies that an individual participates in exchange in order to achieve prestige and the status of a 'big-man' (Gosden 1989). This exchange brings very little direct material benefit to the other members of the society. There is a clear distinction between gift-giving or sharing with no economic / profit intentions, as opposed to intentional status-gaining exchanges which create rivalry (Appadurai 1986, 11; Bevan 2007, 25; Hodder 1982).

2.3.1. Exchange for status

While exchange between EN communities could be seen in the light of mobility and the relocation of groups and communities, by contrast most commentators view the later Neolithic as more complex, with a growing emphasis on the individual and the diminution of collective values (section 2.2.5.).

For the Aegean Neolithic, Perlès (1992, 148-9) proposed the co-existence of three exchange systems: exchange of utilitarian goods that may be widely distributed (e.g. obsidian); exchange of non-utilitarian objects with social functions amongst the groups in a smaller geographic region (e.g. fine wares); and the exchange of 'prestige goods' limited to certain groups or individuals (e.g. stone and shell ornaments, stone vases). The concept of prestige goods is often used to explain the regional and long-distance interaction that would have an impact on social differentiation (Cobb 1993).

The exchange of objects and technological know-how often was a medium for gaining status and wealth. This is the exchange that is related not only to the movement and reciprocal exchange of artefacts and raw materials *per se*, but also travel and contacts with people outside familiar settings (Cobb 1993; Sahlins 1972). It has been pointed out (Chapman 1981, 79; Greenfield 1991, 299) that LN inter-community interaction, at least in the central Balkans, is based on very small quantities of exchanged products (obsidian, shell, non-local pottery, metal objects). According to Greenfield (1991), the Balkan Vinča communities were self-sufficient in producing their own goods, particularly for mundane use, that there was no need for external exchange. However, the participation in long-distance exchanges which involved the exchange of ‘exotic’ and rare objects would likely involve an individual, rather than the entire community, who is participating in some kind of prestige or status-gaining exchange.

Expanded social and exchange networks undeniably brought the circulation of visually distinctive objects to people’s attention, whether or not this was perceived as accumulation of status for only some members or for an entire community. This is demonstrated in the LN period by the ‘expressive’ character of material culture, arguably visible in an increased preference for objects that possess distinctive aesthetic qualities such as the selection of materials with reflective surfaces like lustrous obsidian, polished stones, Spondylus ornaments, copper, and even some shiny black-burnished pottery and figurines (Bailey 2000; Chapman 2008; Robb 2007). Visual identity (Chapman 2008, 298) and the circulation of objects, local or exogenous, which had less functional purpose, put an emphasis on emerging personhood and prestige oriented exchanges (Greenfield 1991, 304).

Helms (1988) has discussed the ethnographic evidence for high status long-distance specialists who have witnessed more than other members in their community. These specialists would travel and bring home some exotic objects, skills and information, but also traveller's tales as the "main medium of information exchange" (Chapman 1998, 20; also Cobb 1993; Renfrew 1993). Often, these voyages are long-distance and complex and for that reason give enhanced status to the people and objects involved in the adventures. Polanyi (1957) emphasised that the routes travelled and the means and modes of transport are as important as the goods themselves. Maritime travels, boat technology, topography, currents and tides have been previously discussed (Agourides 1997; Broodbank 1993, 2006; Farr 2006). In the case of maritime transport, it has been suggested (Broodbank 1999; Broodbank & Strasser 1991) that coastal routes might have provided easier and safer travelling that is related to frequent stops at coastal settlements and harbours, where food and shelter were offered but also as places where exchanges could have taken place (Braudel's 'slow motion shipping'). Travelling across open water has also been recognised as important (e.g. Crete; Broodbank & Strasser 1991). On the other hand, land crossings might have equally involved stop-overs at certain villages en route. These stop-overs could be suitable in establishing alliances for safer crossing through foreign territories and providing shelters for unexpected environmental events or any other complications. Equally, these stop-overs might increase the duration of the travel, but such 'delays' may be as much a purpose of the journey as the acquisition of materials. The economics of time, in this sense, can be a product of investing in different forms of social as well as material capital.

Renfrew (1993) observed that certain objects should be a marker of 'communication' rather than of 'trade' and this involves contacts and activities that are less to do with material purposes (economic) and more closely linked to symbolic and ritual purposes (exchange gifts or travel tokens). The emphasis is on the social processes of exchange, not on the object. Certain goods gain value according to the social context of exchange which is based on desires and demand for them (Appadurai 1986). Traditionally, we have often sought those objects that are unusual and exceptional, and tend to place them on a pedestal when investigating interaction, and in so doing, remove them from their relational and symbolic contexts. Renfrew (1993, 14) stated that “[T]he material culture is a by-product of the interaction and communication”. Sometimes exotic objects can be objects of great power with their own specific life histories.

2.4. Understanding interactions through obsidian

The following section will consider how the circulation of obsidian has informed the study of prehistoric exchange and how the role of obsidian in societies has thus far been examined via a range of social perspectives. For the purpose of this thesis, exchange and interaction could be recognised in relation to two contexts, in which obsidian can be recognised as playing the role: (a) the movement of farming groups, and (b) economic and social interaction among existing communities and individuals.

Obsidian is a volcanic glass that was used mainly as a raw material for the production of chipped stone tools since the Palaeolithic through throughout the Bronze Age periods. Obsidian comes from distinctive geological sources, which is important because the limited number of such sources exploited in prehistory enables their easy identification. The relative rarity of obsidian sources, its shiny appearance and cutting properties are considered to be the reason why this raw material was consumed throughout prehistory and moved over large distances. Our archaeological interest in this material arose from the opportunity to explore and trace its exploitation and distribution through scientific methods, because this allows us to pose a range of questions relevant to social analyses. The ability to trace artefacts very closely is extremely rare in prehistoric archaeology, and therefore has been seen as a particular benefit for understanding societies that used obsidian.

2.4.1. Tracing the movement

Neolithic interaction and mobility are recognised through the procurement and exchange of obsidian. The starting point for many models has been grounded in obsidian sourcing studies (see section 2.4.2.). Developed in the 1960s, these were seen as a way to explore Childe’s theories on diffusionism, based on Anatolian and Near-eastern sources and sites. Jacques Cauvin (2000, 93–95) observed that the spread of central and eastern Anatolian obsidian into south-western Asia could be linked with the movement of early farming communities from the Levant into these regions. Levantine communities explored these Anatolian territories through obsidian exploitation and would eventually settle in these regions (also Binder 2002). Andrew Sherratt (2005) further argued that mapping obsidian find distributions through characterisation studies could be used to trace routes along which the first farming groups travelled to procure their obsidian. These routes became the primary corridor for the diffusion of a Neolithic way of life. Furthermore, the presence of obsidian on Cyprus is one of the elements to demonstrate the spread of farming into the Mediterranean island during 9th millennium BC. Cyprus was likely colonised by agro-pastoralists from the Levant who brought with them domesticated animals and plants c. 9000 BC. The connection with the mainland, both Anatolia and Levant, is seen not only through the presence of central Anatolian obsidian but also through dissemination of technological knowledge, naviform bipolar technique, used widely in Anatolia and the Near East in the PPNB period[1] (Binder 2002; Peltenburg *et al.* 2001).

John Binliff (1977, 539–43) provides an example of reasoning about the acquisition of obsidian in arguing that procurement of Melian obsidian was `embedded' within other economic activities in the Cyclades, specifically tuna fishing, although the importance of tuna in the Neolithic diet has subsequently been challenged (Broodbank 2000, 129). Furthermore, Barge and Chataigner (2003, 178) linked the acquisition of obsidian in eastern Anatolia to transhumance in the case of sources located at certain altitudes.

The exploitation of obsidian sources located on the islands is often used as indirect evidence for the existence of seafaring and boat technology (Ammerman 2011; Farr 2006; Perlès 1990). Ammerman’s exchange models (Ammerman 1979) are created on the basis of obsidian movement in the context of seafaring in the Mediterranean. He showed that sites located closer to the coast would receive more obsidian than those inland based on an assumption that it was easier to travel and transport by sea than overland (*ibid.*, 102). Prehistoric maritime activity is particularly relevant in the case of exploitation of the Melian sources. We know that navigation around the Aegean took place in the Upper Palaeolithic and Mesolithic periods due to the presence of obsidian on several locations, mainly islands (Carter *et al.* forthcoming; Perlès 1987; Sampson 2008b; Sampson *et al.* 2002). More organised seafaring is attested from the EN period when pressure-flaked obsidian cores and

[1] In Cyprus, central Anatolian obsidian appears as centred blades, not as products of naviform technology as it was known from the Cappadocian obsidian sources and workshops. Naviform technology conversely was used only on flint.

blades became widely distributed in eastern and western Aegean mainland regions (Perlès 1990; Perlès *et al.* 2011). This latter case will be further explored through analyses of obsidian from the eastern and northern Aegean (Chapter 7).

2.4.2. Exotica - obsidian as a social artefact

Returning to issues raised in section 2.3.1, it is necessary to address the role of obsidian as an 'exotic' material in different environments. When discussing exchange, archaeologists often include objects that are characterised as exotic on the basis of their uncommon appearance. Some of the most well-known examples of social exchange that adopt this position are found in the work of Mauss (1990) and Malinowski (1922). In a few studies that have dealt with the presence of 'exotica' in pre-state societies in the eastern Mediterranean and the Balkans, the objects have been interpreted according to the concept of gift exchange or status symbols (Chapman 2008; Greenfield 1991; Perlès 1992). This largely relies on substantivist models that view local artefacts as behaving in similar ways to those traditionally described in ethnographic cases studies (e.g. of Melanesian *kula* ring valuables) where 'non-utilitarian' items have been observed being traded mainly for the purpose of displaying and enhancing social status. Understandably, these items are expected to be well made (elaborate jewellery, ornaments, and vases) and/or deposited within special archaeological contexts (burials, hoards, foundation or abandonment deposits in buildings). Obsidian from Perlès' distant zone, in Macedonia (1992, 146) is rare and travels long-distances, but we must still question whether we can correctly label obsidian as a 'prestige' item or not, based on their technical complexity and aesthetics. The possible distinct role of obsidian objects in long-distance exchange, and in case of Macedonian assemblages, could be illustrated by Cobb's (1993, 63) statement that "[D]ue to primitive transport technology and related factors, prestige goods are usually high in value per unit of weight and are easy to transport... They may also occur in the form of raw materials or finished products". Tykot (2011) has recently discussed the problem of using *exotic* in exchange studies, and favoured the introduction of the term *eccentric* for objects marking those unusual and odd occurrences. Some of characteristics of eccentric obsidian artefacts would be that these appear in very small numbers, they are not of the same origin as the more common obsidian type, and their shape and production are unusual (*ibid.*, 35).

It was previously shown that obsidian is assumed to have had a role in past societies as a *marker* of exchange or movement. It thereby would not have any particular value *per se* (aesthetic or technological) but rather it would have been the processes that brought an artefact to the site (seafaring know-how, travel into mysterious worlds, etc.) that would have been appreciated in determining its significance (Broodbank 1993; Helms 1988; Perlès 2005). When talking about the movement of a small number of obsidian blades from Cappadocia to the southern Levant in the 11^{th} millennium BC, Cauvin considered them as a part of a social and symbolic phenomenon rather than part of ordinary economic exchange. The value of obsidian, from this perspective, is not technological and utilitarian but of more symbolic kind (Cauvin 2000, 93). On the other hand, Renfrew (1993) stated that in any of these studies, obsidian was not a valuable commodity, but its traceability merely helps us to understand certain processes.

As an example, the value of obsidian in the Aegean has been discussed by several scholars. Fledgling ideas came from Mackenzie and Bosanquet while excavating the "The Great Obsidian Workshop" at Phylakopi on Melos. Mackenzie believed that obsidian contributed towards the wealth of the settlement, whose inhabitants controlled access to the sources. Bosanquet's opinion, on the other hand, was that the value of obsidian was associated with knapping skills that would ultimately allow the development of social differentiation (Bosanquet 1904). In contrast, Renfrew (1972, 455) claimed that obsidian trade would not have been well organised in modern sense, and also that obsidian was not valuable enough to have any effect on the rise of complex societies in the Bronze Age Aegean. Torrence (1986) also supported Renfrew's position, arguing against organised and commercial exploitation of the sources. She argued that there is no evidence for the existence of permanent specialist craftsmen at the sources and that exploitation was irregular and unsystematic. She, however, agreed that there was significance in the interactions between travellers on their trips to Melos (Shelford *et al.* 1982, 221; Torrence 1986, 97–119).

With these prior approaches in mind, I consider there to be three primary criteria that help us to think about the potential value of obsidian objects: (1) technical complexity, aesthetics and the know-how of object manufacture; (2) the deposition of objects, and (3) the overall mechanism of exchange.

2.4.2.1. Aesthetics and manufacture

Perlès has many times emphasised the level of expertise involved in the production of materials acquired from distant places (Perlès 1990, 1992, 2007). The case is augmented when considering a community's knowledge of how to use and knapp the material and their knowledge about the origin of the material (Appadurai 1986, 41). In the case of long distance procurement, the question is whether the technological aspect was held to be most important or whether it was rather knowledge about unknown and foreign, immaterial of the aesthetics that was a key feature.

To try to answer this, the starting point would be to consider whether artefacts that appear at these distant places are common knapped tools or highly sophisticated objects. As a raw material, obsidian is mainly transformed into regular blades, scrapers, and boring implements, but also technologically more advanced products such as projectile points and daggers. Apart from its role as a chipped stone raw material, the use of obsidian for the production of other, more 'attractive' objects is also well attested. The production of these objects usually includes 'chipping' and then elaborate grinding and polishing. Carved and polished artefacts of personal adornment such as beads, pendants and bracelets are documented in Anatolia from the 8th millennium BC in settlements such as Asıklı Höyük (Astruc *et al.* 2011), Çatalhöyük (Bains *et al.* 2013) and Hacılar (Mellaart 1960). Mirrors made of obsidian were found at several sites in Anatolia including Çatalhöyük (Vedder 2005) and Domuztepe (Healey 2007), while obsidian vessels dated to the Halaf period (c. 6000-5500 BC) were found mainly at the sites in eastern Anatolia and in Bronze Age Aegean and Anatolia (*ibid.*, Table 3, 182) and as decorative details. Obsidian flakes were used in sculptures as eyes in the life-sized stone statue from Urfa in eastern Turkey, dated to c. 10,000 BC (Schmidt 2007, 287–88). The eyes of the statue were made of two obsidian blade fragments (Figure 2.1). Similarly, at Hacılar, where anthropomorphic vases and figurines have been found that possess small obsidian chips for their eyes (Mellaart 1970, 1960).

2.4.2.2. Depositional patterns

It is a rather challenging to understand how long obsidian objects had been in use and therefore to address how contextual information can indicate the role and the significance of this raw material. Section 5.1.5. deals in more detail with the specifics of depositional patterns of obsidian in archaeological contexts, as well as post-depositional taphonomic processes. In case of the Italian Neolithic, Robb (2007, 202) observed that obsidian is rarely found in ‘special’ contexts. Moreover, these special contexts are even harder to define in regions farther away from the sources, where obsidian is rare. Robb demonstrated that, at any given site, obsidian artefacts are usually not found in the form of skilfully worked spear-heads but as small utilitarian blades or flakes deposited in middens or other secondary deposits. In contrast, a good example for the importance of preservation of depositional context is suggested through obsidian use in the aforementioned Urfa statue and the vases from Hacılar. If found in an isolated context, the value of these broken obsidian fragments would certainly not point to such an unusual use.

Some examples suggest that the quantity of obsidian finds is not the most suitable marker of the ‘value’ (i.e. that rare = valuable) obsidian has in a community and occasionally, it is rather than the depositional patterns and the type of artefacts involved are the main indicators. At Çatalhöyük, where 99% of the chipped stone is obsidian used for every-day activities, we still find hoards where obsidian was carefully buried under house floor surfaces. The projectile points, of high typical quality, produced on site are the most common tool type, but they can be found in rubbish areas and sometimes carefully deposited in house post-holes (Carter & Milić 2013a). Moreover, obsidian mirrors are likely to be found as grave goods, while projectile preforms hidden in caches buried under the house floors (Carter 2011).

One other example comes from the Bronze Age Cyclades, in the Melian ‘core’ area, where Carter (2007) suggests “theatricality” and performance in the pressure-flake manufacture of long obsidian blades found within a cosmetic kit (depilatory implements) as part of burial goods. He emphasised the performance of production and consumption of blades as an active component during funerary practices in the Bronze Age Aegean. The act of knapping in this context could represent the display of the power and prestige of those involved, the decadents, the knapper and the members of the community that attended the event.

In sum, the value of obsidian could be considered to be two-fold. Its primary value can be measured through its cutting properties, the expertise required in its production (pressure-flaking, projectile points, mirrors, vases), as well as its potential symbolic properties (journey tokens, heirlooms of immigrant farmers, projectile points for ceremonial practices). Obsidian’s secondary significance is that through mapping the circulation of this material we have a useful proxy for movement and interaction, helping us to understand certain processes in prehistory (e.g. Neolithisation, seafaring, subsistence strategies).

The following section will consider how the circulation of obsidian has informed the study of prehistoric exchange and how the role of obsidian in societies has thus far been examined via a range of statistical, technological and social perspectives.

2.4.3. Modelling exchange through distance effects

This section explores several models that are used in archaeology for reconstructing interaction in prehistory, based on obsidian exchange but explained in terms of more complex human relations. In a methodological sense, the attractiveness of these models is that they need not be limited to obsidian as a medium. It is, however, the traceability and distinctiveness of obsidian in the archaeological record that makes these models viable rather than aspirational, as they may be when applied to other archaeological materials which lack such distinctive geochemical or genetic fingerprints.

Obsidian provenancing has a significant role to play in trade and exchange studies, with clear knock-on effects on the interpretation of movement of other archaeological artefacts, such as stone axes and pottery (e.g. Bradley & Edmonds 1993; Hodder 1974). In the 1960s Renfrew, Cann and Dixon demonstrated how the nature and form of inter-regional and cross-cultural contacts could be quantified and interpreted through obsidian sourcing studies (Cann & Renfrew 1964; Renfrew *et al.* 1968b). Models for understanding obsidian exchange were originally applied in two study areas, namely Anatolia and the Aegean (Renfrew *et al.* 1965, 1968a), with further models subsequently developed for the central Mediterranean (Ammerman 1979; Hallam *et al.* 1976) and the Carpathian (Williams-Thorpe *et al.* 1984) obsidian exchange networks. These studies typically rely on a combination of analytical sourcing techniques and mathematical modelling of particular exchange modes. Regression analyses have been used to address the frequency of exchanged objects set against distance from a source or centre, producing fall-off models that could be linked to specific exchange mechanisms (Hodder 1982; Renfrew 1975). For instance, the relative proportion of obsidian in the lithic assemblages at different archaeological sites has been plotted against the distance of those sites from known obsidian sources, producing patterns that might define obsidian procurement strategies (Renfrew 1969).

2.4.3.1. Anatolia

Previous studies have involved the analysis of obsidian from a number of Neolithic sites throughout Anatolia and the Near East, considering two main variables: (a) the relative proportion of obsidian in the community's chipped stone assemblage, and (b) the linear (as-the-crow-flies) distance of that site from the source (as defined by the characterisation study). On the basis of these data, Renfrew was able to chart the dissemination of obsidian throughout the region, recording in the process what appeared to be a regular fall-off in the relative quantity of central and eastern Anatolian obsidian in direct relationship to distance from the source.

One key concept that he introduced is that of a 'supply zone' in which sites that have 80% or more obsidian in their overall lithics assemblage should be taken to imply that people were travelling directly to the sources to obtain obsidian, without intermediaries. In Central Anatolia, the sites within this proposed 'supply zone' were located within 250 km from the Cappadocian sources, while in eastern Anatolia, the same 'supply' zone was suggested to span the area up to 350 km away (Renfrew *et al.* 1968b, 327). Beyond this zone, Renfrew suggested, was a 'contact zone' in which obsidian was procured based on reciprocity systems through contacts with other communities in a 'down-the-line exchange' (Figure 2.2). This latter trade model proposed that when a community obtained an amount of raw material, they would keep a proportion and pass the remainder to neighbouring villages on a reciprocal basis (Renfrew's 'law of monotonic decrement'), and the procedure would then be repeated by the recipients further `down-the-line'. Sites located 600 km from the sources usually contain only 1% of obsidian in their chipped stone assemblages (Renfrew 1969; Renfrew *et al.* 1968b).

2.4.3.2. The Aegean

Renfrew offered the same model for the Aegean procurement and redistribution of Melian obsidian, although the model initially used for the exchange of obsidian from the Near East could not be so simply translated to the case of maritime movement in the Aegean (Renfrew 1972, 442; Torrence 1986). During the EN, Melos and the Cyclades remained uninhabited and most explorers had to travel to Melos and obtain obsidian directly from the quarries (Renfrew 1972, 449). Perlès (1990, 1992) later suggested that the distribution of Melian obsidian coincides with Renfrew's *freelance middleman trade* in which the "middleman has an effective area of operation outside of which he does not normally travel" (Renfrew 1975, 49). In the Early and Middle Neolithic period, with the lack of 'supply' zone, southern Greece and Thessaly received high quantities of obsidian (50-95%), representing the areas of specialists' action. Farther away, in Macedonia and Thrace, there is an abrupt fall-off of this material (less than 1%) which, according to this argument, would lie outside the jurisdiction of an itinerant trader (Perlès 1990, 1992; see also Renfrew 1975). During the Late and Final Neolithic, the islands in the vicinity of the Melian sources became inhabited and formed a direct 'supply zone' with over 95% of obsidian in their lithic assemblages. Thessaly and the Peloponnese became an intermediate zone that acquired obsidian as semi-finished products in relatively large amounts, like in previous periods, with no noticeable decrease as one moved farther away from the sources.

2.4.3.3. Carpathians

In the Carpathian region, Williams-Thorpe *et al*. (1984, 197) also calculated a fall-off model for central and eastern Europe with a 'supply' zone of radius 25 km and the 'contact' zone of some 400 km. They introduced the concept of "half-distance" at which the percentage of obsidian found at sites is reduced to half its initial value. Using this concept, the sites that contain more obsidian than expected can be detected and these are interpreted as 'preferred' or central places of redistribution. It is noted that the east European situation is different to the Near Eastern one as the majority of the sites are located close to the major rivers which influence the quantity of obsidian received at these sites (O'Shea 2011). Kaczanowska and Kozlowski (2008, 16) suggested the importance of the riverine distribution, showing that some sites along the Tisza river could receive over 90% of obsidian in their lithic assemblages at distances of 150 km from the source areas.

Thorpe has calculated fall-off curves for the different periods and the different directions of obsidian distribution (Thorpe 1978, 279). Renfrew's models for the distribution of Cappadocian obsidian were mono-directional, towards south and south-east, but the distribution of Aegean and Carpathian obsidian could be documented in more than one direction. Thorpe concludes that "the trade in both directions from the Zemplen sources appears to be down-the-line, with as yet no evidence of wide supply zones."

2.4.3.4. Critiques

The exchange models discussed here have been criticised as too 'mathematically-abstract' not least because they do not take account of topographical and local environmental conditions. These may make it difficult to assess the relevance of a particular model, as was shown for the sites of the Carpathian basin. These models went through various alternations firstly offered by Wright (in Klejn *et al.* 1970, 171–3). His criticisms considered: weight of obsidian at a site in relation to transport without animal aid; function of a site, permanent or seasonal settlement; the form in which obsidian was transported and exchanged, blocks or blades; availability of flint - in eastern Anatolia flint is abundant, while in central Anatolia, obsidian is the main raw material which makes the model incomparable in two areas. In his reply to Wright, Renfrew rightly pointed out that the weight of obsidian is strictly associated with excavation and recovery techniques (presence or absence of sieving) which is not standardised in archaeological practice (Klejn *et al.* 1970). In addition, the count and weight of obsidian should be related to the volume of soil excavated which would provide an actual density of obsidian found at a site (Sydris 1977).

Similarly to Wright, Sydris (*ibid.*), working on Mayan sites, also noticed that a distinction between the major centres and smaller sites is necessary for successful results of regression analyses. The two different types of sites created different values with the larger (major) sites consuming more obsidian, while small villages were less active in obsidian trade. This led Sydris to interpret the major sites as obsidian marketplaces, following Renfrew's models (Renfrew 1975). Working in California, Ericson (1982) suggested new important variables to be added to these exchange models: topography and natural barriers had a significant influence on how the materials were distributed; the distance from the next closest source; the existence of alternative resources is also important in determining exchange systems.

In Calabria, Ammerman and colleagues reported that the down-the-line model did not give that the sites on the west coast (close to the source) receive more than 90% of obsidian, while those on the east coast of the peninsula see a rapid rather than gradual drop off (Ammerman 1979; Ammerman & Andrefsky 1982; also Farr 2010). They suggested that the distribution of Lipari obsidian was not land-based but occurred by boat in a radial pattern from Lipari to the sites on the west coast of Calabria. Hodder (1982, 203) thus concluded that detailed surveys of small areas could produce different patterns than those taken from large-scale regions.

This type of methods, in which exchange mechanisms can be explained through patterns in the data, was challenged when researchers recognised that different processes can produce similar distribution patterns. Furthermore, the distributions of obsidian are modelled as unidirectional from the source, while simulations of random walk processes show that the movement could happen in various directions (Hodder 1982; Hodder & Orton 1976).

In obsidian studies, however, some scholars continued to use these models often to schematically illustrate simple modes of obsidian exchange, down-the-line, direct procurement or through redistribution (Carter *et al.* 2008a; Kilikoglou *et al.* 1996; Kuzmin *et al.* 2002; Tykot 2002).

2.4.4. Reduction methods

Perlès (1990, 1992) also argues that all exchanged items must be examined and compared with due regard to production, distribution and consumption, with particular attention to a *chaîne opératoire*. In light of this, it is important to consider the distribution of objects in relation to raw material acquisition, manufacture know-how, use and deposition. Each of these aspects represents elements of the object's biography that is linked to a series of social relations. The way in which I have utilised the *chaîne opératoire* for the study of project datasets is detailed in Chapter 4.

Torrence (1986) observed that, the proposed obsidian distribution curves do not take account of the types of products used, which in turn relates to different consumption patterns with desired object, depending on the location of the site. This was also a critique by other scholars (Ammerman & Andrefsky 1982; Perlès 1992, 2007) who argued that artefacts of different nature were grouped together (raw material blocks, cores, finished products) which could be part of different production techniques (percussion or pressure) and level of expertise. Hence, some more recent studies of exchange networks have taken closer account of the patterns of production and specialisation (i.e. via the idea of a *chaîne opératoire*). The reduction technology takes into consideration the form in which obsidian artefacts travelled - cores or finished products (Ammerman 1979; Ammerman & Andrefsky 1982). In their work, Ammerman and Andrefsky (*ibid.*, 153) noted that it was cores and not blades and flakes that were exchanged, while the reduction of cores was taking place at various sites within the exchange network.

Studies of obsidian in the Aegean have also shown that the dissemination of obsidian products included objects at different stages of knapping and of different forms, throughout the wider region (and zones). The systematic work of Torrence and Perlès in this region represents a particularly relevant case. Torrence (1986) argued that craft specialisation and commercial exchange could be explained through examples from the ethnographic, historical and archaeological records. The question of 'value' was approached via the interpretation of the functional economies, i.e. whether or not obsidian was worked with greater care and efficiency further from its source. Focusing on efficiency, Torrence's work at sources in Melos led to the conclusion that procurement of obsidian was not organised, specialised on commercial, and that the extraction of obsidian had been undertaken in an 'unsophisticated' manner (Torrence 1986, 214). Obsidian was considered to be a utilitarian commodity, recovered from domestic deposits with no evidence for "any special social or economic significance" (*ibid.*, 119).

In contrast, Perlès (1990, 1992) has argued that the existence of specialised production of stone tools is documented in the Aegean Neolithic. In the EN and MN periods, with the lack of settlements on the islands, the procurement, distribution and knapping of obsidian was in the hands of skilful itinerant craftsmen who were knowledgeable enough to undertake trips to Melos. Even those communities with a large percentage of obsidian (over 95%) in their assemblages were, on this understanding, dependant on travelling seafarers and craftspeople. Obsidian is worked using pressure-flaked technology that is likely to have been exercised by only some members in a community. These assemblages are comprised of de-corticated cores and large amounts of pressure flaked blades associated with specialised knapping. During the LN period, when the Cycladic islands became colonised, obsidian became more readily available and the supply became more direct. At sites on the islands and southern mainland (e.g. southern Peloponnese), it is distributed in a less prepared (block) form and worked in a less efficient manner, while typologically it became more varied with the addition of a number of retouched tools, including arrow-heads, to the repertoire. The intermediate areas (e.g. Thessaly, western Peloponnese) were still relying on itinerant specialists who were bringing pre-formed cores and manufacture blades within the consuming settlements (Perlès 1990, 1992). It is clear that Perlès' ideas about the 'de-specialisation' in LN and FN are in broad agreement with Torrence's (1986) views on the 'unsophisticated' exploitation of obsidian. It needs to be added that, at the same time, the manufacture of a wide range of tool types in the core areas, particularly variability in projectile points (e.g. Saliagos tanged and barbed points and ovates), suggests sophistication in tools that might transcend functional needs alone.

Looking to the evidence in Anatolia, some parallels can be drawn in central Anatolia, although the work of Renfrew et al. in this region on down-the-line trade has yet to be systematically linked to the forms of obsidian exchanged. Detailed work on individual sites has been conducted (e.g. Çatalhöyük; Aşıklı Höyük, Lake District), but not working at larger spatial scales, i.e. the distribution of different production forms from the supply to the contact zone. In Anatolia, the picture is that the inhabitants of the supposed 'supply' zone procured obsidian in roughed-out form and this was worked on-site into prismatic end-blades and a variety of tools (various spear-heads, scrapers, denticulates, etc.). In the intermediate zone (e.g. Lake District) the obsidian seemed to be transported as prepared cores used mainly for manufacture of regular end-blades (Balkan-Atlı 2005; Baykal-Seeher 1994). This project is aiming to reconstruct the form in which Anatolian obsidian circulated in 'a more distant'[2] zone in central-western and north-western Anatolia and therefore this will be discussed in detail in Chapter 6.

Technological aspect of obsidian production and the criteria used in reconstruction of reduction sequences of assemblages represented at each site and from each obsidian type are described in Chapter 4 (section 4.5.).

2.5. Summary

This chapter has prioritised discussion of three inter-related issues: the character of Neolithic, society, mechanisms of regional interaction and the specifics of obsidian exchange. Despite some variation, processes of Neolithisation, types of settlements or building, and characteristic practices have much in common across the different chosen study regions. It is evident that communication networks and movement of people represent a crucial component for the maintenance and reproduction of Neolithic life-styles across wide territories and these networks can be investigated through the exchange of objects, habits and ideas at various scales. Obsidian in particular can be used to link the temporal (Neolithic) and theoretical (exchange and interaction) aspects of the chapter and study as a whole.

Obsidian is a crucial proxy for wider exchange regimes because its geochemistry, on the one hand, nicely maps its movement in space, and its tool-making technology, on the other, maps the transfer and interpretation of technological and social practices within and between communities. Obsidian exchange is also usually seen as a particularly Neolithic phenomenon,

[2] The term is borrowed from Perlès' (1992, 146) description of a zone that marks "an expansion of the obsidian distribution circle and characterized by a sharp relative and absolute fall-off".

although obsidian movement and consumption can also be documented in other periods. As we saw, obsidian data has been used as a signature for the movement of people in several different ways. One early application involved modelling the activity of hunter-gatherers and fishermen as part of seasonal mobility and raw material procurement strategies (e.g. Franchthi Cave). A second has contributed to the reconstruction of population migrations and colonisation such as the overall process of Near-eastern and European Neolithisation itself (Binder 2002; Cauvin 2000; Sherratt 2005) and island colonisation (Ammerman 2011; Broodbank & Strasser 1991; Farr 2010). Apart from serving as a proxy to explore larger-range movements, obsidian consumption has also been used to understand how prestige might be generated via tangible evidence for long-distance contacts or to characterise the accumulation of wealth in certain communities that might have acted as redistribution or exchange centres (e.g. Vinča and Çatalhöyük). Nevertheless, obsidian artefacts may not only have been exchanged between different parties, but also may have travelled with their users. Obsidian raw materials and finished goods were certainly worth exchanging or giving as gifts, but they are unlikely to have usually been the primary commodity or the primary economic basis of society. Equally, there are other social contexts, beliefs and practices (e.g. ritual butchering - Robb 2007, 203; body modification - Carter 2007; seafaring - Farr 2006) in which obsidian had an accompanying but not central role but where it has remained the only visible mark of that broader process.

Chapter 3. Obsidian and its research history

3.1. Introduction

The regions surrounding the source areas of obsidian in central Anatolia, the Aegean and the Carpathians have been a focus of study for a long time, spanning everything from the notes of 18^{th} century explorers to 21^{st} century cutting edge technologies. This rich research history will be the subject of this chapter, while analytical methods and their applications are discussed in detail in Chapter 4. Volcanoes that produced obsidian are located on every continent on earth, although not all were used by past societies as sources of raw materials. The homogenous chemical composition of any particular source is what makes each source different and therefore unique to a particular geographical area. Exploitation of obsidian from the above volcanic regions has a long history beginning in many cases with the activities of Upper Palaeolithic (or earlier) communities and continuing on with both intensive and extensive use in the Neolithic and later periods. This chapter explores how research in each of the three source areas has created and dealt with different kinds of dataset and what presently we can learn about past societies through obsidian investigation. It concludes with a discussion of the multiple, competitive exchanges in which certain regions and settlements were part of a more complex interaction network that could be influenced by different social and environmental factors.

The earliest mention of a version of the modern word 'obsidian' is by Pliny the Elder in his *Encyclopaedia Naturalis Historiae* where he states that the stone was discovered by someone named Obsius in Ethiopia and defines it as a semi-precious dark and transparent rock (Pliny the Elder n.d., Naturalis Historiae xxxvi). It was first utilised by early hominines between 1.7 and 1.9 million years ago (Leakey 1971, 89; Piperno *et al.* 2009), but the first widespread use in Europe and circulation throughout large territories in the form of raw material and artefacts can be best documented in the Neolithic and Chalcolithic periods (7^{th}-5^{th} millennia BC). It continues throughout the Bronze Age, although its exploitation gradually declined. Its material qualities are still appreciated in modern times, with obsidian blades still used in some societies as surgical scalpels (Buck 1982; Scott & Scott 1982).

There are three strands of obsidian research that are more or less interwoven: chemistry, lithic technology and distribution. The success of chemistry in obsidian provenancing, as discussed in Chapter 4, inspired archaeologists to explore human interaction, particularly focussing on trade and exchange. The work on obsidian assemblages also included the reconstruction of technology and the circulation of obsidian via attention to its c*haîne opératoire* (e.g. Perlès 1990; 2010 *inter alia*). Matching obsidian artefacts from sites to a specific volcanic source laid a foundation for the relationship between 'sourcing' and archaeology. Procurement of obsidian is a form of interaction that is particularly archaeologically visible and acts as a useful proxy for tracing a range of movements, from hunter-gatherers to state level societies. It was used to address territorial mobility, seafaring, hunting and fishing (seasonal mobility) (e.g. Farr 2006; Jacobsen 1973; Shackley 2005), migrations and/or colonisations (e.g. Binder 2002; Cauvin 2000; Sherratt 2005), exchange of mundane or prestige goods (Ammerman *et al.* 1990; Perlès 1992; Tykot 2011) and complex relationships among groups (e.g. Moholy-Nagy 1999).

3.1.1. The "gold rush" - an overview

There are hundreds of sources of workable obsidian around the world that were exploited in prehistory, including those in American North- and Southwest (e.g. Dillian *et al.* 2010; Shackley 2005), Mesoamerica (Cobean *et al.* 1991; Moholy-Nagy 2003; Vogt *et al.* 1981), the Russian Far East (Kuzmin 2006; Kuzmin *et al.* 2002; Phillips & Speakman 2009), Japan (e.g. Izuho & Sato 2007; Kuzmin & Glascock 2007) and Oceania (e.g. Summerhayes *et al.* 1998; Torrence 2004). In Eurasia, the distinct areas are located in the central Mediterranean (e.g. Ammerman *et al.* 1990; Le Bourdonnec *et al.* 2010; Tykot 1996, 2011), the Aegean (e.g. Carter 2009; Shelford *et al.* 1982; Torrence 1986), Central Europe (e.g. Biró 2014; Rosania *et al.* 2008; Williams-Thorpe *et al.* 1984) and Anatolia, including central and eastern parts (e.g. Cauvin *et al.* 1998; Chataigner *et al.* 1998; Keller & Seifried 1990).

Its limited occurrence in the landscape brought obsidian to the attention of scholars in the early years of archaeological research. The history of obsidian studies in Europe goes back to the 18th and 19th century, before the development of archaeometry, when numerous obsidian scatters and workshops were observed and discussed by early geologists and archaeologists (Biró 2014). The Melian obsidian sources were discovered in the middle of 19th century, but some of the first observations on the importance of obsidian in prehistory are those written by Bosanquet. While excavating the Bronze Age site of Phylakopi on Melos, Bosanquet (1904, 216) noted that Melian obsidian seemed to be the principal source for the communities in the Aegean and that it had a commercial significance in the Aegean and beyond. He suspected that this obsidian could be found in Asia Minor and Egypt, but “a petrological examination is necessary before the connection can be regarded as proved” (Bosanquet 1904, 229).

Özdoğan (1994) noted that the occurrence of obsidian in Anatolia and the Near East went almost unnoticed until the mid-20th century. The history of obsidian research in Anatolia is tightly related to the work of Renfrew, Dixon and Cann in the 1960s, despite the existence of a number of visible sources that still cover extensive areas today. Paradoxically, in the Carpathians, where large primary flows do not exist anymore and only occasional scatters occur on modern cultivated land, Nandris (1975) observed that a number of obsidian locations have been reported by various authors in the 18th and 19th centuries. In the 1960s, Renfrew et al. (Cann & Renfrew 1964; Renfrew *et al.* 1968b), showed how inter-regional and cross-cultural contacts can be interpreted through obsidian provenancing. Since then, a large number of research programmes have been dedicated to obsidian studies in different regions, all with one aim - to match trace elemental fingerprints of obsidian artefacts to an obsidian source and try to reconstruct people’s activities and interactions. The initial success of obsidian characterisation in archaeological practice contributed towards a number of publications in this field, particularly in the 1970s and 1980s. Obsidian procurement has a large influence on theoretical discourses related to the models of exchange / trade / networks / interaction between individuals or groups (edited volumes by Earle & Ericson 1977; Ericson & Earle 1982; Renfrew 1969, 1975, 1993). Williams-Thorpe (1995, 235) explains that this increased interest was due to obsidian provenancing being relatively straightforward, although potential complexities arise in the cases of multiple sources (e.g. Göllü Dağ, Monte Arci) and multi-directionality of the obsidian distribution, i.e. presence of more obsidian types in one region (e.g. central Mediterranean). The “gold-rush” (Özdoğan 1994, 423) in obsidian studies, primarily related to research in the Near East and the Mediterranean in the 1960s and 1970s, shifted in the 1980s and 1990s to the Americas, particularly Mesoamerica, where vast obsidian territories represent the largest and the most complex obsidian using regions in the world. Unlike most sources in Europe or Asia, obsidian flows in Mesoamerica may cover large areas, with several outcrops and many obsidian workshops and mines (e.g. Cobean *et al.* 1991). Thousands of obsidian artefacts have been analysed in laboratories in the United States, which is much more substantial than the situation in European research.

In the 1990s, after the initial impetus, and when the distribution boundaries of the main European sources were more-or-less established, obsidian research became mainly focused on site-specific analyses. Even though powerful scientific techniques were developed, it became extremely difficult (due to bureaucratic and financial obstacles) to undertake large-scale obsidian characterisation programmes, if any were undertaken at all. The impression is that during this period, obsidian became a more scientific rather than archaeological (social) artefact. In more recent years, portable XRF (pXRF) instruments have become available for on-site analyses enabling analyses of large assemblages (described in Chapter 4). The new advances in obsidian studies and provenancing of assemblages from a large number of sites opened up new agendas stimulating once again regional perspectives. When more obsidian samples have been analysed, it suddenly becomes possible to quantitatively evaluate the spatial distribution of obsidian from different known provenances. This has in turn led to an upsurge in publication about the scientific potential of mass-sampling (Frahm 2013a; Milić 2014) though this 'revolution' has yet to ground itself comprehensively in a social, rather than methodological emphasis. This is therefore one of the core objectives of this thesis.

Turning to the three case studies under investigation, we can note that these areas are neighbouring with overlaps in distributions (communities in their distributional zones occasionally share their products). Figure 3.1 shows the distributional boundaries of these sources as they were known before this study. It can be noticed that the obsidian occurs in quite different environmental settings. The Central Anatolian volcanic complex is located in the Anatolian plateau at 1400-1800 meters above sea level, surrounded by a vast plain. The Aegean sources are situated on small islands, particularly Melos, an island in the Aegean some 120 km as the crow-flies from the mainland but only ca. 30 km from its neighbouring islands (Broodbank 2006, 209). In contrast, the Carpathian sources are located deep inland the European continent, in the northern part of the Carpathian arc at the northern edges of the Great Hungarian Plain, and are connected with the rest of Europe though complex riverine networks (Chapman & Dolukhanov 1997). This means that through obsidian distribution we can explore three different kinds of obsidian exchange regimes, each differently promoted through overland, maritime and riverine networks.

Central Mediterranean obsidian sources are also considered in this chapter (section 3.5.) since they provide a comparative frame of reference for the Aegean material, with maritime as well as terrestrial elements the distribution networks. I will not be dealing with these sources in much detail, but available data and research are useful for considering the exchange of obsidian in overlapping interactions in my case-study regions (discussed below).

The chronological range and relative extent of obsidian procurement from the major European obsidian sources has been illustrated in Figure 3.2. This chart includes all major sources in Europe showing broad trends across a chronological and spatial extent that has not been previously considered. The chart is based on currently available published data and shows that most of the sources have been exploited to a limited extent since Palaeolithic and Epi-Palaeolithic times by local hunter-gather groups. The situation is somewhat different in the case of two major central Mediterranean source islands, Sardinia and Lipari. Here, present evidence places the beginnings of obsidian consumption in the 6th millennium BC (Tykot 2011). This is, in fact, the period of the most extensive use and circulation of obsidian in European prehistory, throughout the Neolithic, while its decline is marked during the 3rd millennium BC in most of the sources.

3.2. Central Anatolian sources

The exploitation of obsidian sources in Cappadocia (central Anatolia), eastern Anatolia and Armenia and their presence in archaeological contexts throughout Anatolia and the Near East inspired Renfrew, Dixon and Cann (1966, 1968b) to develop models of trade and cultural contact to account for the character of their distribution. Their provenancing work sought to characterise chemical groups of obsidian on the basis of geology. They showed the existence of several sources and sub-sources in this region with Cappadocian and Armenian assigned to analytical Group 1, while the east Anatolian (Lake Van region) fell into their Group 4c (Cann & Renfrew 1964, 116-117). Using Optical Emission Spectroscopy they were able to chemically separate sub-sources; in Cappadocia, the major sources were Acigöl and Çiftlik, while in east Anatolia these were Bingöl and Nemrut Dağ. The obsidian from Hasan Dağ volcano proved to allow poor conchoidal fracture and, like Antiparos in the Aegean, appears only in small lumps suggesting that it may have never been exploited in prehistory as initially proposed by Mellaart (Cann & Renfrew 1964; Mellaart 1967; Renfrew *et al.* 1966, 177). In 1990, Keller and Seifried employed X-Ray Florescence on material defining the Göllüdağ Group, formerly known as Çiftlik, along with a new source at Nenezi Dağ, located between Acigöl and Çiftlik. Göllüdağ is a complex volcanic area with several outcrops of obsidian and the one called Komürcü is of primary archaeological interest (Figure 3.3). Material from both sources, Göllüdağ and Nenezi Dağ, was documented at a number of prehistoric settlements, including Çatalhöyük, where it represents the main raw material.

An inter-disciplinary team of archaeologists, geologists, geochronologists and geochemists undertook a large survey of obsidian sources in central and eastern Anatolia and Transcaucasia identifying a number of sources which were then analysed using various techniques (Chatagner *et al*. 1998). The project offered an archaeological approach and considered the consumption of obsidian across a large geographical and temporal span. It included sites in Anatolia, Cyprus, the Levant, Mesopotamia and the Zagros from the Kebarian, Zarzian and Natufian phases, through to the pre-pottery and pottery Neolithic and up to the "post-Neolithic" period, in other words roughly between 12000 and 3700 BC (Cauvin & Chataigner 1998). In this research, the Göllü Dağ source group was further separated into East Göllü Dağ including the East Kayırlı, Kömürcü and Sirça Deresi flows, and the West Göllü Dağ with Kayırlı Village, North-Bozköy and Gösterli flows (Poidevin 1998). The list of sources and sub-sources in this complex volcanic massif was recently revised by Binder et al. (2011, 3179–81). The previous distinction was dismissed as the situation is much more complex and seven new main chemical groups were defined. Of course, considering this complicated geo-chemistry, the real consideration for the purposes of the question addressed in this thesis is what are the archaeological implications of tracing the networks of obsidian consumers?

Nenezi Dağ, on the other hand, is quite different as the landscape has drastically changed since prehistory and the number of outcrops and workshops utilised remains unknown (Poidevin 1998). The remains of knapping floors are still present at the source, containing material, especially cores, that can also be identified on archaeological sites (e.g. Aşıklı Höyük) (Chataigner *et al.* 1998). Nenezi Dağ obsidian is, alongside Göllü Dağ material, reported at a number of sites in Anatolia, the Levant and the Aegean. Recent excavations at the quarries moved the earliest dates for the use of Anatolian obsidian to the Lower Palaeolithic, revealing Acheulean hand-axes over 1 million years old at Kaletepe Deresi 3 site, located on top of the Göllü Dağ source (Slimak *et al.* 2008).

3.2.1. Temporality and transmission

Largely relying on the research by Cauvin et al. (1998), the history of use of the two main central Anatolian sources can be traced. These Cappadocian sources were exploited since the Palaeolithic period onwards, with objects produced in local workshops circulating throughout central and southern Anatolia, Cyprus and the Levant (Carter *et al.* 2011; Chataigner 1998, Figs. 5a and 7a; Delerue 2007).

The Göllü Dag source has been used by the local population since Lower Palaeolithic times (at least 1 million years ago) followed by Middle Palaeolithic Mousterian at Kaletepe Deresi 3 (Slimak *et al*. 2008). Long distance procurement of both Göllü Dağ and Nenezi Dağ obsidian is dated as early as the early Epi-Palaeolithic period (late 17th millennium BC), as reported in Ökuzini and Karaın B caves (south Anatolian coast near Antalya), some 380 km distant as-the-crow-flies from these sources (Carter *et al*. 2012). The spread of small quantities of Cappadocian obsidian to the Levant, particularly from Göllü Dag, is documented from Late Epi-Palaeolithic Natufian times (11th and 10th millennia BC) followed by the PPNA and PPNB periods at a number of sites in the upper Euphrates and in the southern Levant, some 800 km away (Chataigner 1998, Fig. 7a; Renfrew *et al.* 1968b). Following its first appearance in the Epi-Palaeolithic at Ökuzini cave, long-distance movement of Nenezi Dağ obsidian is currently known from the middle PPNB (9th millennium BC), when it reached settlements in the Levant.

From the PPNB period, both obsidian types are present at sites in close vicinity to the sources (e.g. Aşıklı Höyük) as well as farther away. The real geographic expansion happened in the Aceramic Neolithic (late PPNB horizon in Levantine terminology) and early Neolithic (9th-7th millennia BC) at sites in central Anatolia (Aşıklı Höyük, Çatalhöyük, Can Hasan III, Mersin), in Cyprus (Shillourokambos, Khirokitia and Kalavassos-Tenta) and at sites across the Levant. Göllü Dağ pieces were found at sites of Nahal Lavan and Beidha in southern Levant, over 1000 km distant from Cappadocia (Caneva 1999; Carter *et al.* 2006; Cauvin & Chataigner 1998). In early Neolithic Anatolia, obsidian diffusion is also directed towards western areas (Süberde, Erbaba) that were part of a proposed 'supply zone' (Renfrew *et al*. 1968b) and farther to the Lake Region (Kuruçay and Höyücek; Balkan-Atlı 2005; Baykal-Seeher 1994). Small quantities of Cappadocian obsidian are also attested in western Anatolia (Bergner *et al.* 2009; Perlès *et al.* 2011; Pernicka *et al.* 1994) and on a few Aegean islands (e.g. Ayio Gala on Chios and Knossos on Crete) from the late 7th millennium BC onwards (Ayio Gala, pers. obs.; Knossos, Panagiotaki 1999). In the Bronze Ages, material from both sources is found in Crete (Bellot-Gurlet *et al.* 2008; Carter & Kilikoglou 2007) and in the Cyclades (Carter & Milić 2013b).

The long distance diffusion of Anatolian obsidian is well attested, travelling through various means of exchange from sources to sites across seas or inhospitable landscapes over hundreds of kilometres. Perhaps the most important aspect of this movement is not simply the material in its own right as an ancient resource, but our ability to use it as a component in the reconstruction of human actions. In the case of Cappadocia, it has been suggested that the procurement and exchange of obsidian had an important role within the wider processes of Neolithisation. In Near Eastern archaeology, obsidian use has been portrayed as a quintessentially Neolithic phenomenon (e.g. study by Renfrew, Dixon and Cann, 1968b) and obsidian trade routes have been seen by some as a proxy for the movement of population from the Near East to Anatolia (Cauvin 2000; Sherratt 2005). Extensive excavations at Kaletepe, on top of the Komürcü outcrop at the Göllü Dağ source, revealed an obsidian workshop used from the early PPNB onwards and indicated that the people exploiting the Cappadocian quarries may have been specialists from the Levant. Trace-elemental and technological analysis of obsidian artefacts showed that these products were found as far away as Syria, Israel, Palestine and Cyprus. The settling of central Anatolia in the late PPNB has been seen as the product of movements of these Levantine people to the area closer to the sources (Balkan-Atlı *et al.* 1999; Binder 2002).

3.2.2. Other Anatolian sources

There are a number of outcrops in Anatolia that were, similarly to the Aegean Giali and Antiparos, rarely if at all used in prehistory. In addition, there are sources that have been recently discovered and their ancient exploitation still needs to be confirmed by archaeological analyses, either there or at sites using obsidian traceable to them. In the following section, I will briefly describe these sources, whose exploitation could have been expected, but on the basis of current evidence, appear to have had very little impact on the communities in my research area.

3.2.2.1. Açigöl

Renfrew et al. (1966; 1968b) referred to Açigöl (Group 1e-f) as one of two major sources in Cappadocia, besides Çiftlik (Group 2b), now known as Göllü Dağ. This complex is consisted of three separate eruption events: Açigöl-East ante-caldera, Açigöl-East post-caldera and Açigöl-West. The latter two outcrops are reported as not very good quality raw material, while Açigöl-East ante-caldera is suitable for knapping. However, even though this source drew the attention of researchers from the early days of obsidian studies, it was not found in many prehistoric settlements (Chataigner *et al*. 1998, 523). Renfrew et al. (1968b) reported Açigöl obsidian in a number of assemblages but recent research could not confirm this. In fact, it is quite possible that the material they identified belongs to Nenezi Dağ which also fell within their analytical Group 1e-f (Carter *et al.* 2005b).

3.2.2.2. Galatian massif

The sources in this volcanic complex located in north-central Turkey (Figure 3.1) were identified in the late 1980s (Keller & Seifried 1990, 61–62) and comprised outcrops termed Sakaelı-Orta and Yağlar. Keller and Seifried also discovered a third scatter of obsidian chips, named Galatia-X (*ibid*., 62; also Bigazzi *et al.* 1998; Keller *et al.* 1994). These sources are much smaller than those in central Anatolia and their material usually appears in the form of small pebbles which limited their consumption. It seems that this obsidian was not much in circulation, only in "some villages close to the Sea of Marmara (Fikirtepe, Pendik, Ilıpınar)" (Chataigner *et al.* 1998, 523; also Düring & Gratuze 2013). In fact, only three (?) pieces from Pendik and Ilıpınar were ever identified to originate from this complex (Keller & Seifried 1990). Because of the scarcity of this obsidian and its supposed absence from long-distance exchange, these source areas have not been part of any significant study. The potential consumers of the Galatian obsidian, to date mainly sites in the Marmara region, contain ca. 5-10% of obsidian in their assemblages (sometimes counting dozens to over a hundred pieces) and therefore the presence of Galatian types would have had more impact on these communities, if used. In Chapter 6, I discuss the results of obsidian analyses from the Marmara sites and pieces that potentially could have originated from the Galatian massif sources.

3.2.2.3. Eskişehir

A small source is reported in the Kalabak valley near Eskişehir. It is of poor quality for knapping, this raw material was not suitable for tool manufacture (Chataigner *et al.* 1998, 523).

3.2.2.4. East Anatolian sources

This large volcanic area has dozens of outcrops and extends from eastern Turkey to Transcaucasia (Georgia, Russia and Armenia). Two major sources widely used in prehistory are Nemrut Dağ and Bingöl (Figure 3.1). They are chemically and macroscopically distinctive as they belong to a peralkaline (green) type of obsidian (Keller & Seifried 1990, 63-65). According to the known data from excavated sites, Bingöl and Nemrut Dağ obsidian was acquired by groups in south-eastern Anatolia, Mesopotamia and the Zagros and its distribution overlaps with central Anatolian material in the northern Levant. Renfrew, Dixon and Cann (1966, 1968b) proposed the same model on this area as in the Cappadocian case, with obsidian being exchanged from the sources in eastern Anatolia to sites in the Zagros foothills. Eastern Anatolian sources were exploited from the Upper Palaeolithic period and the most well-known occurrence is obsidian found in Shanidar Cave in the Zagros Mountains approximately 30, 000 years old. In the pre-pottery and pottery Neolithic, these sources were almost exclusively used by the communities in south-east Anatolia (Cauvin & Chataigner 1998, 338).

3.3. The Aegean - Melos

The sources in the Aegean are located on the islands of Melos, Antiparos and Giali (Figure 3.1). Even though material from these sources is distributed over extensive areas (Aegean islands, eastern, western and northern Aegean mainland), the work on Aegean obsidian differs from the research undertaken in other volcanic areas, especially Anatolia and the central Mediterranean. The sources in the latter two regions demonstrate considerable complexity such that it is possible to distinguish more than one outcrop of the same source chemically (i.e. multiple flows at Göllü Dağ or Monte Arci; Cauvin *et al.* 1998; Gratuze 1999; Tykot *et al.* 2008). In the Aegean, the focus has been less on chemical discrimination of different outcrops and more on technological characteristics and spatial patterning (Perlès 1992; Torrence 1986).

The Cycladic island of Melos was the major obsidian source in the Aegean, with two main quarries - Demenegaki and Adamas (Sta Nychia). Adamas, situated on the north side of the Melos Bay, is easily accessible and material is available in the form of blocks and pebbles up to 25 cm in diameter. Demenegaki is located on a high plateau on the east side of the island, and is less accessible from the sea, with the source of obsidian extending along the cliff in layers of veins (Figure 3.4). Both quarries have been extensively used in prehistory which is documented by a series of knapping floors and workshops at both sources (Arias *et al.* 2006; Kaczanowska & Kozlowski 2013; Renfrew *et al.* 1965; Shelford *et al.* 1982; Torrence 1986).

Located only ca. 9 km apart, the two Melian sources produced obsidian of similar knapping quality and elemental composition. The discrimination of the two Melian sources has been explored, with varying degrees of success, using OES, NAA, XRF, pXRF, ICP-AES and

SEM-EDS (Acquafredda & Paglionico 2004; Aspinall *et al.* 1972; Kilikoglou *et al.* 1996; Liritzis 2008; Renfrew *et al.* 1965; Shelford *et al.* 1982), but the most commonly used method of discrimination to date has been NAA. This method differentiated Adamas from Demenegaki clearly through the relative concentration of Scandium (Sc) (Aspinall *et al.* 1972, Kilikoglou *et al.* 1996).

Shelford et al. (1982) showed XRF to be successful for discrimination of the two sources through major elements. Since the early 1980s, when the two Melian sources were first chemically distinguished, there have been very few subsequent Aegean obsidian characterisation studies. The quantification of consumption of obsidian from Adamas and Demenegaki within the Aegean and the immediate mainland remained under-developed, mainly due to the destruction of artefacts necessary using NAA, thus inhibiting mass-sampling or sampling at all. Recently, the use of pXRF has changed the potential for mass sampling (Milić 2014), as this technology has proved more than adequate for differentiating the various Aegean obsidians (Frahm *et al.* 2014; Liritzis 2008; Milić 2014).

Due to the location of both quarries on the same island, Torrence considered them as "a single source" (Torrence 1986, 96). They are however geochronologically and geochemically distinct (Arias *et al*. 2006; Shelford *et al.* 1982), and there are suggestions that the two foci were exploited and consumed in different ways and in different periods (Carter 2008, 225; Carter & Kilikoglou 2007; Molloy *et al.* 2014; Perlès *et al.* 2011, 47). Detailed exploration of their individual distribution and use, within various chronological time-frames, may yet provide new insights into obsidian exploitation and exchange systems in the Aegean.

3.3.1. Temporality and transmission

Adamas and Demenegaki sources were the major sources of obsidian in the Aegean. The vast quantities of obsidian scattered on Melos were firstly reported in the 19th century but it was the excavation of Phylakopi at the end of the 19th century that drew attention to the two sources (Atkinson *et al.* 1904). Mackenzie and Bosanquet offered their first interpretations of the obsidian quarries and the meaning that obsidian use had for Aegean prehistory. They speculated that obsidian was obtained before the colonisation of the Cyclades, during Neolithic times. The Melian quarries represented the "first independent stations" exploited directly by the foragers who travelled to Melos for this raw material (Mackenzie 1904, 246). According to them, the situation changed with the establishment of a large settlement at

Phylakopi whose settlers took control over the sources and workshops in the Early Bronze Age. Hence, on this view, Phylakopi, 'the great Aegean emporium in Melos' grew wealthy through control over the obsidian market, which supplied settlements all over the Aegean (*ibid.*).

However, we now know that the earliest procurement of Melian obsidian took place much earlier than Mackenzie and Bosanquet had suggested. The presence of both Melian sources is first documented in late Upper Palaeolithic and Lower Mesolithic levels at Franchthi Cave in the Argolid (Renfrew & Aspinall 1990). This discovery was clear evidence for early maritime movements between the Aegean islands and southern Greek mainland dated to c. 10 900 BC (Ammerman 2011; Broodbank 2006, 208; Renfrew & Aspinall 1990). In the Mesolithic period, apart from Franchthi Cave, Melian obsidian is also reported at Cyclops Cave on the island of Youra in the Northern Sporades, Maroula on Kythnos, Kerame on Ikaria (Kaczanowska & Kozlowski 2013; Sampson *et al.* 2002, 52–53) and most recently from Livari in south-eastern Crete (Carter *et al.* forthcoming). This raw material is more broadly attested from the Aceramic and Early Neolithic (LN / EC in the eastern Aegean), but a major expansion of its use occurred in the Late Neolithic period. In the Neolithic (7th - 4th millennium BC), obsidian presence in lithics assemblages varied in different Aegean regions, being dominant in most of the sites in the Cyclades, Peloponnese and Thessaly, while less well represented in the eastern and northern Aegean (more in Chapter 7). Overall, the distribution of Melian obsidian is very much concentrated in the regions in and around the Aegean. Unlike other source areas, the extensive use of Melian obsidian in the Early Bronze Age is relatively uninterrupted, especially in the Cycladic islands where it represents the main raw material for the manufacture of stone tools (Carter 2009).

3.3.2. Other Aegean sources

Obsidian occurs on the islands of Antiparos and Giali, although their consumption is limited to a small number of very local communities due to their poor physical and knapping properties.

3.3.2.1. Antiparos

Obsidian from Antiparos, also in the Cyclades, was not used extensively in prehistory. This source produced obsidian that has conchoidal fracture and is of good quality but the small size of the nodules did not allow wider exploitation. It has been chemically documented at

Late Neolithic Saliagos, a site located in close vicinity to the source, but is possibly present at some other Neolithic and EBA sites located on the neighbouring Cycladic islands (Carter & Contreras 2012; Renfrew *et al.* 1968a, 106).

3.3.2.2. Giali

Giali is a small island in the Dodecanese (Figure 3.1) that was a source of highly distinctive white-spotted obsidian. It is translucent (*giali* means glass, in modern Greek) with white crystalline inclusions. Because of the inclusions, this raw material has poor knapping qualities, although in the archaeological record it appears in the form of vessels manufactured from the mid-2nd millennium BC, Middle and Late Bronze Age periods on Crete (Bevan 2007, 123; Carter 2009, 202; Renfrew *et al.* 1965, 240; Warren 1969, 135-136). However, there is some evidence for the first use of Giali obsidian for knapped tools in the Mesolithic period on Ikaria (Georgiadis 2008, 106; Kaczanowska & Kozlowski 2013). The material came into more frequent circulation from the LN/FN period when it is reported at sites on neighbouring islands in Dodecanese (Kalymnos, Kos, Nisyros, Rhodes, Telos and Karpathos; Betancourt 1997; Carter 2009; Georgiadis 2008). Overall, the sporadic appearance of Giali obsidian could be seen only in the Aegean, particularly in the Dodecanese, Crete and the Cyclades.

3.3.2.3. Foça

This source is located on the Anatolian western coast, just north of Izmir (Figure 3.1). This source does not appear to have good knapping quality obsidian and there is little evidence to support it being exploited in prehistory (Chataigner *et al.* 1998, 523). At present, there is no evidence amongst archaeological assemblages that Foça obsidian has been utilised for any types of artefacts.

3.4. The Carpathians

The Carpathian volcanic complex is situated in central-eastern Europe, with the main sources located in modern-day Hungary and Slovakia. Obsidian sources are also documented in Romania and Ukraine, although the former has been dismissed as unworkable and the latter has not been sampled and investigated in detail (Nandris 1975; Williams & Nandris 1977). In recent years, another source area has been explored in Ukraine's eastern Carpathians (Biró

2014; Rosania *et al.* 2008), but there is currently no evidence that its material appears in the study area addressed here.

Long before characterisation work, obsidian finds were reported by various authors since the 18th century (Nandris 1975). The first small-scale characterisation of obsidian from this area was undertaken by Cann and Renfrew and their results clustered the Carpathian obsidian sources together with the Aegean and Anatolian obsidian in their Group 1 (Cann & Renfrew 1964). Since then, a large number of samples have been collected and analysed using NAA, EDXRF, PIXE, PIGE and PGAA (Biró 2004; Biró *et al.* 1986; Oddone *et al.* 1999; Rózsa *et al.* 2006; Thorpe 1978; Williams-Thorpe *et al.* 1984). As a result, the Carpathian sources were separated into the Zemplin Hills sources in eastern Slovakia (Carpathian 1) and the Tokaj Mountain sources in north-eastern Hungary (Carpathian 2). Each of these contained several distinct outcrops, but some of them contained obsidian that was not of workable quality. In Hungary, the scatters are reported in Tokaj, Erdőbénye, Telkibány, Csepegö Forrás, Tolcsva, Olaszliszka, while in Slovakia in Viničky (Szöllöske), Mala Torona, Streda nad Bodrogom and Čejkov (Biró 2014; Williams-Thorpe *et al.* 1984, 184). Further chemical characterisation led to the splitting of certain Hungarian sources into sub-groups, Erdőbénye C2E and Tolcsva C2T (Biró 2014; Biró *et al*. 1986; Williams-Thorpe *et al*. 1984).

Unlike other European sources, the total amount of obsidian available was relatively small, and nowadays only small nodules can be collected in situ (Figure 3.5). The quarries that could sustain prehistoric exploitation no longer exist due to natural erosion processes and recent intensive cultivation (Nandris 1975; Oddone *et al.* 1999). Today, the geological context is in secondary deposits, in which obsidian does not occur in massive flows (Williams & Nandris 1977, 208). Nevertheless, these are the unique sources of a raw material procured and used in continental Europe. Slovakian obsidian (C1) was a better quality material, in terms of size and knapping properties, and it predominated amongst the assemblages and was more widely distributed. Although Hungarian obsidian (C2) is less frequent in assemblages, it is present in most of the same areas as C1 (Biró *et al*. 1986, 278; Williams-Thorpe *et al*. 1984).

3.4.1. Temporality and transmission

Carpathian obsidian was most widely used in Hungary, Slovakia and Romania, though its distribution in smaller quantities stretches east to the Black Sea, west to Austria and

Germany, north to central Poland (see Hovorka 2010) and south into northern Croatia and central Serbia (Težak-Gregl & Burić 2009; Williams-Thorpe *et al.* 1984). Two LN sites with quite an unusual appearance of C1 obsidian, given their geographical location, are Grotta Tartaruga in the Adriatic near Trieste where one piece is provenanced to the C1 source and, in a different direction, 11 artefacts of C1 obsidian detected at Mandalo in Greek Macedonia (Kilikoglou *et al.* 1996; Williams-Thorpe *et al.* 1984). Whether these two cases should be represented as a part of the typical distribution zone, since their appearance is quite exceptional, will be discussed in Chapter 9.

Carpathian obsidian is first evidenced in the Middle Palaeolithic Mousterian (Subaljuk in Hungary), mainly found on sites relatively close to the sources, but more widely used in the Upper Palaeolithic Aurignacian and Gravettian periods (Dobosi 2011). In the Mesolithic period the circulation of obsidian is still limited but it sporadically appears on sites further away from the sources, as is demonstrated at sites in Romania, Serbia and Croatia. The most intensive exchange and use of obsidian correspond to the Neolithic period, LBK (Linearbandkeramik) 5500-4500 BC (with variants Bükk, Tisza, Vinča A-B). The decline in obsidian use started with the end of the Bükk culture in the north part of the Carpathian basin. Biró (1998, 7) suggested that LN Lengyel communities became middlemen in the obsidian trade and supply system, even taking the control over sources, cutting the Tisza communities off from access to the quarries.

The distribution of obsidian in this general region is predominantly riverine, with concentrations of sites close to the main rivers, including the Mures, Körös, Sava and Morava, but with the most intensive communication along the Tisza and Danube rivers (Biró 1998; 2013; Williams-Thorpe *et al*. 1984). The spread and the frequency of obsidian at the sites in this region are described in detail in Chapter 8.

3.5. Central Mediterranean sources

The Central Mediterranean is rich in sources of good quality obsidian that supplied the raw material for tool production in prehistoric times. Just like the Aegean, the sources are located on islands, Sardinia and on the small islands of Palmarola, Lipari and Pantelleria (Figure 3.1). Palmarola is the westernmost of the Pontine Islands, located west of Naples, about 35 km from the mainland. Lipari is one of the Aeolian Islands located some 30 km north of Sicily. Several sources have been identified but the primary source was Gabellotto (Tykot 1996, 2004). Pantelleria is a small island located between the coasts of Sicily and Tunisia. It is known for a distinctive type of green obsidian also called Pantellerite (Tykot 1996). Because of its colour, this peralkaline obsidian has been recognized as atypical within the Mediterranean group (Cann & Renfrew 1964). Unlike other Mediterranean islands, Sardinia (5000 km^2) presents a large area with obsidian sources extended over around 200 km^2, particularly in the Monti Arci volcanic complex. Within this source, four chemically distinctive outcrops have been recognized (SA, SB1, SB2, and SC) (Le Bourdonnec *et al.* 2005; Tykot 1996; Tykot & Ammerman 1997).

Similarly to other studies, the history of obsidian provenancing from these quarries started in the early 1960s, when Cann and Renfrew had the most success in discriminating the sources using OES. They created six major source groups, separating the Sardinian into two sources (Groups 6 and 2a), while Lipari and Palmarola fell into one group (Group 4a) and Pantelleria into group 4b (Cann & Renfrew 1964, 115-117). More recently, meticulous work has been conducted on discrimination not only of sources, but of multiple flows at a single source using advanced methods (NAA, LA-ICP-MS, PIXE, XRF). These techniques have also been used for analysing archaeological obsidian artefacts from various sites in Italy and France (Francaviglia 1988; Hallam *et al.* 1976; Le Bourdonnec *et al.* 2005; Lugliè *et al.* 2007; Tykot 1996; Tykot & Ammerman 1997). Robert Tykot, in particular, focuses on the distribution of central Mediterranean obsidian throughout the region in the context of trade and exchange (Tykot 1996, 2011 *inter alia*).

It is interesting that, unlike the other regions, material all four central Mediterranean sources is first documented on sites dated from the EN period (6000-5000 BC), but mainly as a raw material from the LN (4000-3000 BC). There are two possible cases of early appearance of Lipari obsidian, Mesolithic at Perriere Sottano in Sicily, and Final Epi-Paleolithic at Arma Dello Stefanin in Liguria (Broodbank 2006, 213; Robb 2007, 192)[3]. Their use continues in the Copper, Bronze and Iron Ages, either newly procured or even recycled from earlier occupations of sites (Tykot 1996, 46). Obsidian artefacts have been found at over 1000 archaeological sites in the central and western Mediterranean, including the islands (Sardinia, Corsica, Sicily, Malta), the Italian peninsula, southern France, Dalmatia and North Africa (Tunisia and Algeria) (Cann & Renfrew 1964; Farr 2010; Francaviglia 1988; Mulazzani *et al.*

---

[3] This is marked in grey in Figure 3.2.

2010; Tykot 1996). The most widely used and circulated obsidian in this area is certainly Liparian and Sardinian Monte Arci, which spread to north and south Italy, Sicily, Malta, South France, Dalmatia, while Pantellerian obsidian primarily travelled to the north African coast (Ammerman 1979; Francaviglia 1988, 110; Williams-Thorpe 1995, 227-229; Tykot 1996).

Numerous sources of obsidian and their circulation produce a complex picture in terms of spatial distribution and interaction networks. The overlaps in the distribution of obsidian from these sources are common, and it has been suggested that the study of the exchange networks needs to be focused a smaller area (e.g. Calabria; Ammerman 1979; Ammerman *et al.* 1990). Hallam et al. (1976) introduced a 'gravity' model in case of two overlapping interaction zones (commented in more detail below). In Chapter 2, I referred to a more recent concept on how to tackle multiple obsidian consumptions that has been proposed by Tykot (2011). Besides complex distribution networks in the central Mediterranean, there is almost no evidence for overlaps / interactions between this and other neighbouring obsidian distribution zones, more specifically the Aegean and central European. The only exception is the aforementioned 'overlap' between Carpathian and central Mediterranean sources at Grotta Tartaruga alongside Liparian obsidian (Williams-Thorpe *et al.* 1984, 195). The validity of these perhaps 'incidental' instances in which obsidian supply is of a multidirectional nature will be further discussed in Chapters 6, 7, and 8.

3.6. Overlaps of obsidian interaction zones

There are many more examples in which overlap in obsidian interaction zones is documented. The study areas discussed in this thesis are located in the areas where obsidian could be brought from two separate obsidian regions, but intentional selection of one, two or more sources might depend on environmental, chronological and social factors. Datasets from the other parts of the world, discussed below, is of interest for methodological reasons and can provide some useful models that are further developed in this present research.

Drawing approximate borders around the perceived distribution of artefacts (Figure 3.1) is a common aim in the archaeological literature, aiming to explain social behaviour and exchange processes. A *down-the-line* approach (Renfrew *et al.* 1968b), as seen in Chapter 2, has been influential in attempting to explain the movement of obsidian through distant territories, although it becomes more complex in areas that attract material from more than one source. In this situation in which obsidian could be supplied from two or more sources but from the same source region, e.g. Göllü Dağ and Nenezi Dağ in central Anatolia, or obsidian originates from two or more usually environmentally and culturally distinct regions, e.g. central Anatolia and the Aegean. A group's choice to acquire obsidian from more sources has many possible explanations and interpretations, mainly being social factors (e.g. barter, control over sources, competition, warfare, marriage deals, etc.), but also environmental ones (e.g. disappearance of access to one source causes the development of connections with another). The occurrence of material from more than one source at a site can be seen in at least two ways:

- Material from two sources is more or less equally represented. These are often sites at which obsidian is the main raw material, supplied from two (or more) sources, simultaneously or in alternation, e.g. Çatalhöyük in Anatolia with Göllü Dağ and Nenezi Dağ obsidian (Carter *et al.* 2006); Saliagos in the Aegean with Melian Adamas and Demenegaki (Evans & Renfrew 1968); EN sites in Sardinia (Lugliè *et al.* 2007).
- The majority of obsidian comes from one source or source area, but the appearance of other obsidian types is occasionally documented. This is very often the case in both core and marginal areas as it was seen above in, for example, Mandalo (Kilikoglou *et al.* 1996), but also at Coşkuntepe (Perlès *et al.* 2011) and a number of sites supplied from the sources in the central Mediterranean (Tykot 2011). More cases are discussed on the basis of the new data from this thesis.

The concept of competitive trading of obsidian in the central Mediterranean was developed in research undertaken by Hallam et al. (1976), described in their 'gravity' model. The focus was on four sources on the islands of Sardinia, Lipari, Palmarola and Pantelleria, with an emphasis on two interaction zones - the Sardinian and Liparian. The distribution of Lipari obsidian covers central and southern Italy and Sicily, while Sardinian circulates around northern Italy and south-east France. An interesting characteristic in these interactions is the division between the two zones at the area in the northern Apennines (Hallam *et al*. 1976; Robb 2007, 193). Palmarolan interaction overlaps with the Lipari zone, but these raw materials do not have the same qualities, given that Lipari obsidian is found in much larger blocks enabling the production of larger blades. Pantelleria, on the other hand, is seen mainly at sites on the Tunisian coast and Malta (Hallam *et al.* 1976, 97-99). It is clear that the attractiveness of a specific obsidian source is related to different factors, not only straight line distance from the source (Robb 2007, 1993; Tykot 2011). Robb (2007, 193) noted that Sardinian and Palmarolan sources are closer to the Adriatic in straight line, but instead, Lipari obsidian is the only material used, brought to the Adriatic a following coastal routes. Another factor is raw material quality, as is the case of Lipari and Palmarola, and this would influence the abundance of 'better' obsidian at a site. Finally, the preference towards certain obsidian types changes through time. In Italy, the amount of obsidian increases in the LN period and this is the period of development of 'broker' sites, usually located farther from the sources that are more active in obsidian exchange than others (*ibid*. 193-196).

3.6.1. Changes at Çatalhöyük

I will now turn to some specific studies in which socio-environmental factors had an impact on obsidian procurement. Looking from the perspective of a single site, the changes in obsidian supply could be related to the longevity of settlements, whereby the change in raw material consumption is often linked to different chronological phases of occupation at a site.

Central Anatolian Göllü Dağ obsidian is the most widely spread of any raw material in the Anatolian and Levantine Neolithic. Its parallel consumption with Nenezi Dağ is documented at a number of Anatolian sites (e.g. Carter *et al.* 2012; Chataigner 1998). Inhabitants of Çatalhöyük were major consumers of material from both Cappadocian sources, being located at approximately the same distance, some 150 km northwest from the site. Throughout eighteen levels of occupation (Gd-a, H-T) obsidian represents 92-97% of the entire lithics assemblages. The earlier phases of the tell are characterised by the dominance of Göllü Dağ obsidian (85% on average) over Nenezi Dağ. The situation drastically changed in the second half of the 7th millennium BC, when Nenezi Dag becomes the principal raw material with 87% (Carter & Milić 2013). The change is also detected in knapping technology when skilled pressure-flaked blade technology replaced the earlier percussive blade-like flake industry (Carter *et al.* 2005a; Conolly 1999). The change in obsidian source and tool technology (among other changes) has allowed us to propose that this shift was a product of the arrival of newcomers, possibly from the east (Carter *et al.* 2005b, 2006, 2008a). To make it even more convincing, in this later period of the settlement, a small amount of material from a third source area has been identified, which could be termed as exotic or eccentric, since its presence in central Anatolia is entirely alien. This obsidian was brought from the east Anatolian source Bingöl/Nemrut Dağ located some 650-825 km distant from Çatalhöyük

(Carter *et al*. 2008, 3). It has been suggested that the presence of eastern Anatolian obsidian at Çatalhöyük demonstrates new inter-regional relations, even if this involves only certain members of the community connected through marriage or pilgrimage (Carter *et al.* 2008, 7). The detailed study on assemblages, which included characterisation of large obsidian sample, has shown the preference towards the two dominant sources, Göllü Dag and Nenezi Dag, and also the appearance of the third, unusual raw material. On the other hand, the detailed image of the Çatalhöyük assemblages does not permit further comparison and relation on a regional scale due to the general lack of other close by or distant communities.

3.6.2. Environmental factors for obsidian consumption: The Kuril archipelago

The region of northeast Asia includes the Kuril archipelago and the Russian Far East, with sources of high quality obsidian. The quarries are located on the island of Hokkaido (Japan), the Russian region of Primorye and on the Kamchatka Peninsula (Izuho & Sato 2007; Kuzmin 2006; Kuzmin & Glascock 2007; Phillips & Speakman 2009). An interesting case occurred in the Kuril archipelago, a chain of islands between Hokkaido to the south and Kamchatka to the north, separating the Okhotsk Sea and the North Pacific Ocean. Phillips and Speakman (2009) used a portable XRF method to characterize artefacts from 18 archaeological sites on eight islands within the archipelago. The results demonstrate the existence of two trade and transport networks (interaction zones), with the southern Kuril Islands obtaining obsidian from Hokkaido, while the central and northern islands of the chain represent part of the other obsidian complex dependant on Kamchatka sources. It is most likely that environment and natural factors played a crucial role in these interactions, with the Bussol Strait and a strong sea-current as a barrier between the southern and central Kuril Islands (Phillips & Speakman 2009). The authors concluded that there are three mechanisms of procurement: directly from the source, through exchange, or as a part of the colonization process (Phillips & Speakman 2009, 1261).

3.6.3. The case of West New Britain and Papua New Guinea

In the western Pacific region, several source groups have been identified, although not all were quarried and consumed at the same time and some temporal changes in obsidian procurement can be observed (Summerhayes *et al.* 1998). Here, changes in distribution patterns are results from a combination of environmental and social factors. Additional volcanic activity created new sources and old ones became inaccessible, while sea-level change affected easy access to the quarries. Torrence (2004, 115), however, argued that social factors played an important role in the choice of obsidian sources since it appears that material from all the quarries had excellent flaking properties but not all these obsidian sources were extensively used. The consumers had a wide range of good obsidian in their vicinity, equally available and the reason for prioritizing one source to another was due to the social links between suppliers and consumers.

3.7. Overlap between central Anatolian, the Aegean and the Carpathian obsidian

The circulation of raw materials from volcanic regions in central Anatolia, the Aegean and the Carpathians has overlaps with the neighbouring regions at the edges of their distributions (Figure 3.1). The appearance of obsidian from more than one source is documented in several periods, although the emphasis here is on the Neolithic period of the late 7th, 6th to mid-5th millennia BC. It was mentioned above that the consumption of the two main central Anatolian sources at one site is very common, especially in central Anatolia and the Levant. In the northern Levant, raw material from both central and east Anatolian source regions can be found (Cauvin & Chataigner 1998, 336-340). No detailed research from a single site or a region has been undertaken to date in order to investigate the existence of patterns in which the two Melian sources have been used, although they were often considered as a single source (Torrence 1986, 96). As mentioned, the preference of one over the other Melian obsidian source is not usually highlighted in existing research, mainly due to similar visual and knapping properties of the material, apart from the location of the sources on the island. The Carpathian sources 1 and 2 are distributed in the same areas throughout prehistory, although C1 was much more extensively used and sometimes documented even at sites located closer to C2 sources (Williams-Thorpe *et al*. 1984). The preference towards C1 obsidian is most likely related to better quality of this raw material.

The distribution maps based on previous research show that central Anatolian and Aegean obsidian have overlapping distribution in the western parts of Asia Minor and the Aegean islands, occasionally in Thrace and the southern Balkans. The multi-directional origins of obsidian from two source regions is so far chemically confirmed at locations in the Izmir region (e.g. Çukariçi Höyük; after Bergner *et al*. 2009 and Dedecik-Heybelitepe; after Herling *et al.* 2008) and in the Troad (Troy and Beşik-Sivirtepe; after Pernicka et al. 1994 and Coşkuntepe, after Perlès *et al*. 2011). Farther north in Thrace, rare obsidian finds from both Göllü Dağ and Melos were documented only at Sitagroi, although only one piece from Göllü Dağ is possibly of EBA date (Renfrew & Aspinall 1990, 266). The penetration of Melian raw material inland into Anatolia and its overlap with central Anatolian obsidian has been identified at Late Chalcolithic levels at Aphrodisias (Blackman 1986). In the Aegean islands, chipped stone assemblages are dominated by Melian products, but occasionally are accompanied with small amounts of obsidian from central Anatolia that have been noticed usually on the basis of macroscopic examination having glassy appearance (e.g. Crete; after Panagiotaki 1999; and Dodecanese; after Sampson 1987). Carpathian and Aegean obsidian are documented at a single location (Mandalo with C1 and Melos Demenegaki), while Carpathian and central Anatolian do not overlap. Overlaps of the Carpathian obsidian with other sources are not common, apart from two isolated cases (at the Neolithic site of Grotta Tartaruga - C1 and Lipari and aforementioned Mandalo). To the west, there is no evidence for parallel use of Aegean and central Mediterranean obsidian at the same site.

3.8. Summary

This chapter provides an overview of the history of archaeological research on the sources of obsidian found at the sites studied in this thesis, including the chronological and spatial scales of consumption. The emphasis was on the central Anatolian, Melian and Carpathian 1 and 2 sources, while other sources in the central Mediterranean, the Aegean and Anatolia were also briefly described although their consumption is not documented at the study sites. The source regions are described through the history of the research of the outcrops, trace elemental characterisation of the geological material and their identification at archaeological sites. In turn, this allowed us to explore the extent of exploitation and the distribution of material from these sources through time. The archaeological investigation and provenancing of obsidian artefacts has demonstrated that the sources in these three main regions, central Anatolia, Melos and the Carpathians, were used from the Palaeolithic period, while the most widespread consumption appears to be in the Neolithic period of the 6th millennium BC (Figure 3.2). The location of the sources in different landscape settings might imply different acquisition and distribution mechanisms (e.g. terrestrial or maritime). The discovery and identification of these obsidian types within the site assemblages enabled us to draw the boundaries of their circulation. The distribution boundaries of obsidian from the central Anatolian, Melian and Carpathian sources overlap in some parts of the Aegean. These occurrences are known from other studies and the reasons for the procurement of obsidian from different regions and preference towards some material have been linked to factors such as: social (e.g. Çatalhöyük), environmental (e.g. Papua New Guinea and Kuril archipelago) and quality of raw materials (e.g. Lipari and Palmarola).

Even though obsidian from two or more sources occurs at a number of sites in the Aegean, the quantities of each obsidian type and the forms in which they occur are often not known. The known factors, however, can allow insights into movements and interaction between sites and sources. The level of overlap of obsidian zones from central Anatolia and Melos on the one hand, and Carpathians and Melos on the other, is not well-defined at present and overlaps are only known from individual sites that might belong to different chronological phases. The data generated in this research (as discussed in Chapters 6, 7 and 8), has sought to characterise and understand these 'boundaries' more systematically, on the basis of the quantification of larger datasets.

A significant number of models of 'overlap' regions have been defined on the basis of small samples of material (e.g. Coşkuntepe with three analysed pieces; Perlès *et al.* 2011). It is only through the analyses of larger assemblages that it becomes more realistic to develop a clearer understanding of the 'overlap' as has been demonstrated at Çatalhöyük. The modelling of overlap boundaries needs to be chronologically sensitive or we risk plotting two or more independent social practices, potentially separated by centuries. This project offers the analysis of larger number of artefacts from sites and groups of sites in a region in tandem with technological analysis of artefacts to contribute to the development of a clearer understanding of the processes that could have been responsible for bringing obsidian to each particular place at a given time. In Chapter 4, I demonstrate the advantages of pXRF technology for achieving high resolution results using large samples in order to pursue this objective.

Chapter 4. Methods: Provenancing and technological characterisation

4.1. Introduction

In this chapter I will examine the applications of pXRF for attributing archaeological artefacts to geological sources. Two major methodological aspects are considered when examining obsidian assemblages in relation to the particular conditions of the study sites and regions. Firstly, the elemental composition of obsidian was analysed and the results of this were used to indicate the origin of the objects. This main part of the chapter describes the development of the methods using pXRF during the course of this study and assesses the validity of these for gathering useful analytical data from archaeological obsidian. Of equal importance for the outcomes of this project was the sampling strategy employed to determine what pieces would be analysed. The second part of this chapter discusses the methodology employed in the techno-typological classification of artefacts. The purpose of this is to reconstruct the form in which obsidian was exchanged and consumed by Neolithic communities, and for this I will employ the concept of the *chaîne opératoire*. In the study of artefacts from all the sites, I have used an adapted recording system which is presented in Data 5 (CD).

For obsidian provenancing, three methods were employed:

a) Hand-held portable XRF (pXRF) for analyses of 1) geological source samples (Göllü Dağ, Nenezi Dağ, Melos Adamas, Melos Demenegaki, Giali, Antiparos, Carpathian 1 and Carpathian 2) and archaeological artefacts from the northern Aegean mainland (Paliambela, Makriyalos, Thermi B, Vasilara Rahi, Kleitos, Mandalo and Dispilio), eastern and north-eastern Aegean (Ulucak, Yeşilova, Ege Gübre, Uğurlu, Gülpınar and Hoca Çeşme), north-western Anatolia (Aktopraklık, Barcın Höyük, Fikirtepe, Pendik) and central Balkans (Belovode).
b) Lab-based EDXRF for analyses of material from sites in the central Balkans (Vršac-At, Potporanj-Kremenjak, Potporanjske granice, Vinča-Belo Brdo, Banjica, Gomolava, Opovo, Masinske njive, Supska, Slatina and Drenovac).

c) Visual (macroscopic) characterisation of archaeological assemblages in the eastern Aegean (Tigani, Emporio and Ayio Gala[4]) and all of the above material prior to chemical characterisation, and in the cases of artefacts not suited to XRF analysis.

The main body of research is based on elemental characterisation conducted on-site in museums using a hand-held pXRF type INNOV-X Delta owned by the UCL Institute of Archaeology. The main focus of this chapter is on the establishment of analytical parameters for this device in relation to 'control' reference materials and examination of its validity for generating suitable datasets. The analyses conducted with EDXRF at the Geoarchaeological Laboratory, University of Berkeley, California, were completed prior to beginning this PhD research, although this work is unpublished, it was integrated into the research for this project (Chapter 8).

Recently, there has been much debate about the accuracy and validity of pXRF technology for the examination of obsidian and various other materials, as demonstrated by the increasing number of related publications in scientific journals (not least the *Journal of Archaeological Science* and *Archaeometry*). A major concern has been the precision of the instrument and the creation of multiple records that are not calibrated against international standards (Shackley 2012; Speakman & Steven Shackley 2013). In this project, the validity, accuracy and reliability of pXRF were tested in two ways: a) through the analyses of obsidian collected at the sources themselves, b) through comparison with intra-laboratory analyses of particular artefacts examined by pXRF and other instruments. The geological samples were used as a reference collection for work on the archaeological assemblages.

The aim of this chapter is not only to demonstrate the validity of the method in terms of its analytical precision but also to show the further analytical advantages gained though the examination of large assemblages through mass-sampling. This approach, in which obsidian provenancing is complemented with the ability to analyse archaeologically significant artefacts, then enables us to consider the question of inter-regional contacts, exchange, raw material choice and other social processes that different communities have been involved in. A further issue considered in this chapter is the correlation between the chemical and physical

[4] These assemblages were studied technologically, but the permits for undertaking pXRF analyses were not issued on time for the Chios museum (Emporio and Ayio Gala) while the Samos museum did not contain relevant material from the Tigani excavation (Felsch 1988), only material from the early excavations that was largely unstratified.

characteristics of obsidian. Analytical procedures, even with pXRF, are usually financially and bureaucratically demanding, but it is important to stress that they can be complemented by the macroscopic examination of obsidian artefacts which has proved to be valuable not only in source determination, but also in the initial design of an analytical sampling strategy (discussed in Chapter 5).

4.2. Identifying obsidian provenance

Obsidian is a natural glass of magma origin, formed when lava rapidly cools on the edges of flows. It is a hard (6 on Moh's scale) material but fragile and very sharp when freshly knapped. A commonly used description of obsidian calls it a 'black and shiny' rock. Generally, however, obsidian has a dark grey and glossy appearance with variations in colour, translucency and inclusions. Differences in colour can be caused by the chemical composition and formation processes of this igneous rock. Usefully for us, the chemical composition and presence of major, minor and trace elements make each source of obsidian unique. Volcanoes could produce more than one flow at a single location (e.g. the multiple flows known at Göllü Dağ in central Anatolia or at sources in Sardinia), although obsidian can also appear in the form of smaller nodules in secondary depositional contexts (e.g. Carpathian 2; Pollard & Heron 2008; Williams-Thorpe 1995). Obsidian is an acidic volcanic glass with 65-75% of silica (SiO_2) and has very little or no crystallisation. Together with silica, a number of other major elements are present, aluminium (Al_2O_3, ca. 10-15%), sodium (Na_2O 3-5%), potassium (2-5%), iron (F_2O_3+FeO) and calcium (0.5-1.5). The trace elements represent less than 0.1%, or less than 1000 ppm (*parts per million*), of the composition (Glascock 1998, 18; Pollard & Heron 2008).

On the basis of elemental composition, obsidians can be classified into three basic groups: *alkaline*, *calc-alkaline* and *peralkaline*. Calc-alkaline obsidian has high levels of Ca and alkalis (e.g. K and Na); alkaline obsidian contain high alkalis but low Ca, and peralkaline obsidian is richer in Fe. The concentrations of trace elements also differ between these geochemical types. Alkaline and calc-alkaline obsidians usually have higher levels of Ba and Sr, and peralkaline obsidian has high Zr and Nb contents, frequently over 1000 ppm (Cann 1983; Pollard & Heron 2008, 86–87; Williams-Thorpe 1995, 219). Alkaline/calc-alkaline is the most common type, being black or dark grey in colour, making visual discrimination extremely difficult. Most obsidian types fall into this group, including the Carpathian, Melian, the central Anatolian and Liparian sources. Peralkaline obsidian has a very distinctive green or brown colour in transmitted light and is easy to recognise macroscopically (Cann 1983, 234; Williams-Thorpe 1995, 221). Sources of distinctive green peralkaline obsidian are located on Pantelleria in the central Mediterranean and at Bingöl/Nemrut Dağ in Eastern Anatolia (Carter *et al.* 2008; Cann 1983). Another visually distinctive type is obsidian with inclusions, especially with speckled white crystalline spherulites. This type can be found in the central Anatolian sources of Göllü Dağ and Nenezi Dağ but the best known white-spotted obsidian is certainly the one that derives from the Aegean island of Giali (Carter 2009; Renfrew *et al.* 1965, 232).

4.2.1. A brief history of obsidian provenancing

The early history of interaction between archaeology and chemistry started in the late 19th and early 20th century. However, in the 1960s, the scientific priorities associated with the 'New Archaeology' in US and UK academic circles in particular saw the emergence of archaeometry as an archaeological science. A wide range of scientific methods were developed in order to analyse the origins of archaeological objects and raw materials and by extension to investigate peoples' movements and interactions (Pollard & Heron 2008).

Obsidian is compositionally homogeneous and each single flow possesses a unique elemental composition. Our ability to chemically characterise the obsidian of an archaeological artefact and match its fingerprint to a specific geological source represents one of the most successful stories in archaeological science (Pollard & Heron 2008; Williams-Thorpe 1995). Obsidian characterisation studies started in the 1950s (Boyer & Robinson 1956), but they were developed and given a greater interpretative (as well as analytical) aspect by Renfrew, Cann and Dixon (Cann & Renfrew 1964; Renfrew *et al.* 1965, 1966, 1968b). The list of techniques used in obsidian provenancing is extensive, although the most common methods used to date have been Neutron Activation Analyses (NAA or INAA), Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS), Particle Induced X-ray Emission/Gamma-ray Emission (PIXE/PIGME), Scanning Electron Microscopy (SEM) and X-Ray Fluorescence (XRF) including portable XRF.

4.2.2. Validity and accuracy of the pXRF method

A fundamental advantage of portable XRF is that it allows for non-destructive and non-invasive analyses, which in turn means that the objects can be re-used for future reference and other purposes (e.g. for subsequent dating via obsidian hydration). The examination is very fast so that it takes between 30 and 200 seconds per artefact and demands no special preparation (Frahm 2013a; Shackley 2011). The development of pXRF technology has introduced a more ‘user-friendly’ method, with a software interface and operational capacities designed to accommodate archaeological research, but also to assist researchers in disciplines such as environmental studies, art history or cultural heritage. The pXRF method is suited to use for in-situ field archaeology material and soil characterisation, museum analysis, provenance studies, or conservation science, for example. It is being increasingly accepted as a useful method, albeit with due caution, for the analyses of metals, ceramics, soil, various rocks, glass and pigments (Frahm & Doonan 2013; Liritzis & Zacharias 2011). The benefits of using pXRF are not only due to bypassing bureaucratic restrictions that previously enabled the destructive examination of only a handful of contextually and typologically non-distinctive material, but also in terms of the preservation of objects’ aesthetic value (e.g. wall-paintings).

PXRF technology has found considerable support in obsidian provenancing studies, and so far has been tested in almost all the obsidian-using regions of the world (Craig *et al.* 2007; Golitko *et al.* 2010; Jia *et al.* 2010; Millhauser *et al.* 2011; Nazaroff *et al.* 2009; Phillips & Speakman 2009; Sheppard *et al.* 2011; Tykot 2010). This has not been without dissent and debate, particularly about the reliability of these ‘fast’ methods in archaeology and geology (Craig *et al.* 2007; Frahm 2013a, 2013b; Nazaroff *et al.* 2009; Shackley 2011; Speakman & Steven Shackley 2013). Some commentators have also dealt with the issue of precision and comparability of pXRF derived datasets to those produced by other methods, mainly with comparative reference to lab-based EDXRF, but also NAA and PIXE. Further concerns relate to the size and morphology of artefacts being analysed (Davis *et al.* 2011; Liritzis & Zacharias 2011), as well as stability when holding the instrument (using a hand-held gun introduces particular concerns about operational precision) because any potential movement can differentially affect the X-ray counts hitting the detector and therefore the reproducibility of the results.

Inter-instrumental tests have shown the ability of pXRF instruments to effectively discriminate different sources, although the specific quantities of elements detected were not always comparable to the results produced using other instruments (Craig *et al.*, 2007; Nazaroff *et al.*, 2009; Shackley, 2011). This is a common issue that can be affected by different operators and software in different laboratories using the same technology. In particular, the software algorithms that interpret the various peaks can arrive at different "conclusions" for specific elements (e.g. Ti is systematically low using the Innov-X pXRF). A critical issue for obsidian provenancing, however, is that each instrument, using the method described below, will independently, and consistently, come to the same archaeologically relevant conclusions - that is provenancing archaeological obsidians to specific geological sources (Frahm 2013a). This development in science in which results are 'internally consistent' but potentially incomparable across different instruments recently triggered some disagreements amongst scholars as to whether pXRF technology is suitable for 'off-the-shelf' use in archaeology (Frahm 2013a; see also Speakman & Shackley 2013 and response by Frahm 2013b). The primary concern in this debate related to the applicability and use of standards to calibrate the instrumentation and provide a mechanism to equate data from the pXRF method with other datasets (Shackley 2011).

In relation to terminology, there has been some uncertainty as how to define the validity, reliability and accuracy of data produced by pXRF technique. *Validity* is here taken to mean the ability to discriminate geochemical sources. This can even be in a situation when the values produced are 'internally consistent' and directly replicable using other techniques. *Precision* (reproducibility or reliability) is when the results of analyses on the same samples using the same instrument are continuously repeated within an accepted range of standard deviation. *Accuracy* is here characterised as the perceived 'true' value of the elemental concentration in an object, usually set against the international reference standards or known (and published) source data (Frahm 2013b, reply to Speakman & Shackley 2013; Nazaroff *et al*. 2010).

In order to test instrumental accuracy and precision for the purposes of this research project, discrimination of obsidian sources was conducted through multiple analyses of reference collections of geological and archaeological materials of known provenance. Firstly, each sample was analysed for 30, 60 and 90 seconds and this repeated examination showed that the instrument produced closely matching results (Figure 4.2, A). Secondly, geological samples were acquired at known obsidian quarries and the results of pXRF analysis of these were compared to the published data on other samples from the same sources produced by other methods (Figure 4.2, B; after Carter & Shackley 2007; Poupeau *et al.* 2010). Inter-laboratory comparison is also tested through analyses of 16 archaeological artefacts from Çatalhöyük (Turkey) that were analysed using EDXRF, PIXE, ICP-MS and pXRF (Figure

4.2, C), and 10 source samples from Carpathian 1 and 2 analysed with EDXRF and pXRF (Figure 4.2, D). The results of these were then compared and the tables with the raw data are given in Data 2 (CD).

Following source discrimination, the analytical procedure adopted by this project included pXRF provenancing of archaeological assemblages from the study sites listed above. The interpretation of the chemical and techno-typological results of these assemblages is discussed in Chapters 6, 7 and 8. The material from sites in the central Balkans (Chapter 8) was previously characterised using EDXRF (described below) which proved to be compatible with the data derived from the pXRF used for the main sites in my field-work.

4.2.3. Mass-sampling

Prior to the advent of pXRF, the analyses and sample sizes proposed for archaeological research were often constrained by bureaucratic and operational limitations, particularly in terms of gaining permission to conduct analyses and/or the export of items to laboratories. Archaeological material culture is protected, with extensive legislation covering its circulation in the countries and regions considered in this thesis. Obsidian artefacts thus often demand complicated procedures for gaining permission to sample. The administration varies in different countries but gaining permits to sample objects from archaeological collections typically takes a minimum of six months. Practical administrative restrictions have, in the past, often led to analyses of what are effectively ‘random’ pieces that fulfil bureaucratic criteria (‘non-museum quality’), which often lack techno-typological diagnostics, leading to researchers often talking in reductionist terms about ‘samples’ rather than characteristic ‘artefacts’ (Carter 2003). These sampling constraints can have major implications for the types of questions we are able to ask of our material. This is particularly delicate when dealing with archaeological groups or cultures that extend into different modern countries, as such countries usually implement different sampling regulations that can confound the degree to which it is possible to assess patterns in a consistent way.

The pioneering work developed by Renfrew and his colleagues in the 1960s was based on 340 archaeological samples (data from Cann & Renfrew 1964, Renfrew et al. 1965; 1966; 1968b). They also examined 80 geological samples including sources from Hungary, Slovakia, Romania, Melos Adamas, Melos Demenegaki, Giali, Antiparos, central Anatolian Çiftlik and Acigöl as well as those that are not part of this thesis (east Anatolian, Armenian, Ethiopian, central Mediterranean quarries). The artefacts came from 260 archaeological sites with an average of three artefacts per site, with a large number of ‘unstratified’ finds included.

As mentioned previously, several decades of analytical developments have told us much about *which* obsidian is circulating in these regions. Most of the obsidian quarries that are still visible in the landscape have been surveyed, tested through excavation and characteristic trace-elements have been identified. Building upon previous work, the aim of mass-sampling of archaeological obsidian is therefore to move forward with regard to the wider range of questions that we can pose to our data. The goal of the new research is not to search for rare ‘exotic’ pieces but to quantify and qualify entire assemblages as close to *in toto* as practicable. In this sense, I am looking at what is typical rather than exceptional for the societies in question. This can be done by determining raw material provenance ratios, using analytical and macroscopic methods to characterise individual artefacts as components of assemblages. In this case, we can avoid the creation of a false image of the choices and means for obsidian consumption, i.e. what is considered to be a more *attractive* raw material and how these have been exchanged and used. This focus on provenancing is complemented by *chaîne opératoire* characterisation of individual artefacts within assemblages. Through this we can begin to assess preferential access to, or desire for, specific sources at each particular site, and see the chronological and geographical variability from local, to regional, to macro-regional scales. Arguably then, the greatest value of pXRF lies not in its relative accuracy (as defined above), but in the logistical reality of it being possible to bring it to storage locations in order to mass-sample artefacts and get more comprehensive understanding of circulation and consumption which large-scale assemblage sampling allows.

Previous work using lab-based XRF techniques has shown that dealing with small, thin obsidian artefacts can have an diffraction effect upon the elemental readings[5] (Davis *et al*. 2011; Liritzis & Zacharias 2011; though see Frahm 2013a). The geological source material that is described in this chapter and used as a reference collection was of sufficient size to allow the screen of the analyser to be entirely covered, and all pieces were over 5mm thick,

[5] Essentially, with a thinner piece, not all of the x-rays transmitted are bounced back to the detector, so there are some “lost” x-rays, that the software cannot account for adequately, thus that the smoothness of peaks is not very good, and certain elements in particular can be significantly misrepresented.

facilitating consistent results. Unfortunately, when examining archaeological pieces, many were thinner, smaller and more irregular than the geological samples (this is often the case with very thin and narrow bladelets and debris that are usually found on archaeological sites e.g. Hoca Çeşme). In cases where pieces were too small to expect the pXRF readings to show results within the expected parameters, visual examination of objects was undertaken (discussed below), to maximise the amount of obsidian included in the discussion. The method used to prevent the movement and sliding of artefacts during analyses was to fix the object's flattest surface to the pXRF screen using sellotape (issues of geometry / flat surfaces also detailed in Davis *et al*., 2011; also Frahm *et al.* 2014).

Instantaneous and fast data processing enables immediate feed-back and 'quality control' of results, whereby outliers from known clusters could be readily identified, re-analysed or characterised as problematic readings, and removed from the data-set. The practical situation of being able to compare hundreds versus a handful of selected samples demonstrates the obvious benefits of pXRF for systematic analyses of relative proportions of artefacts from each source at any given site.

Having previously studied obsidian from several assemblages from the study regions (Çatalhöyük: Carter & Milić 2013a; Vinča-Belo Brdo: Tripković & Milić 2008; Keros: Carter & Milić 2013b), it became clear that some sites and/or regions attracted obsidian from more than one source, as discussed in Chapter 3. The intention was, therefore, to develop a method that would enable analyses of large obsidian assemblages, especially in the overlap areas, in order to capture the true variability, not only of the raw materials, but the relationship between the raw materials and the technological forms in which they appear.

In the following section, the validity and accuracy of using pXRF is illustrated through the results of analyses of geological samples from the three volcanic regions. In the Chapters 6, 7, and 8, I address the archaeological implications of this method through the analyses of archaeological obsidian, compared to the geological reference collection.

4.2.4. Analyses of source material from central Anatolian, Aegean and Carpathian sources

I previously described what type of obsidian can be expected from the sites that were examined. The artefacts were products of outcrops in 1) central Anatolia (Göllü Dağ and

Nenezi Dağ), 2) the Aegean (Adamas and Demenegaki on the island of Melos; rarely Giali and Antiparos), and 3) Central Europe (Carpathian 1 and Carpathian 2).

It is shown here that through 3D scatter plots of the trace elements strontium (Sr), zirconium (Zr) and rubidium (Rb), it is possible to separate the major sources into distinct groups, while discrimination of Adamas and Demenegaki on Melos was possible through the plotting of major elements iron (Fe) and titanium (Ti).

A total of 52 geological samples from eight sources were analysed including: Göllü Dağ - seven pieces (Bogazköy - two, Kömürcü - two and Kayırlı - three); Nenezi Dağ - five; Melos Adamas - eight; Melos Demenegaki - eleven, Giali - five; Antiparos - one; Carpathian 1 - seven; and Carpathian 2 - eight pieces.

The analyses were undertaken using a hand-held Olympus Innov-X Delta XRF device[6]. The results of nine elements (Ti, Mn, Fe, Zn, Rb, Sr, Zr, Ba, Pb) are detailed (Table in Data 2 on CD), however, the main focus is on three trace elements, Rb, Sr and Zr commonly used in obsidian provenancing for clustering the source groups (Figure 4.1). In turn, this 3D scatter plot of trace elements is used for discrimination of archaeological assemblages by plotting results against the geologically derived data.

4.2.4.1 Central Anatolia

The central Anatolian sources at Göllü Dağ and Nenezi Dağ have distinct differences in trace element concentrations. Characterisation work on geological and archaeological artefacts from these sources has been conducted using other techniques, allowing comparison of the different methods (Hancock & Carter 2010; Poupeau *et al.* 2010). Firstly, analyses of the geological obsidian data from Göllü Dağ and Nenezi Dağ produced using pXRF compares well to the published results from the same sources (the results and published data, after Carter & Shackley 2007; Poupeau *et al.* 2010, are given in Figure 4.2, B and tables in Data 3 on CD). Secondly, I analysed archaeological material from Çatalhöyük that has been also tested using lab-based EDXRF (UC Berkeley), PIXE (CR2PA, Paris), ICP-MS (Grenoble). Table 2 in Data 3 shows the results of Rb, Sr and Zr using these techniques on the same

[6] The model operates at 40kV X-ray tubes, equipped with the Delta Rhodium (Rh) anode X-Ray tube. For the purpose of obsidian sourcing, the instrument was set to the ‘Soil setting’ using three-beam mode to record a wide range of elements. The “3 beam” soil mode records heavy metals, transitional metals and light elements.

artefacts (also demonstrated in Figure 4.2, C). In terms of study regions, material from these two sources might be expected to be found at sites in north-western Anatolia (Marmara region) and the eastern Aegean.

4.2.4.2. Melos

The Melian and other two Aegean sources were well discriminated from the other sources in Figure 4.1. In the cases of Antiparos and Giali the situation is also quite clear. Analysis of a small nodule of Antiparos raw material clearly chemically separated this source from the others analysed. Likewise, the 'spotty' Giali rock created a distinctive cluster on the diagram. Turning to the Melian sources of Adamas and Demenegaki, these two also formed a cluster that stands apart from the other source groups. However, scatter plots of Rb, Sr and Zr were unable to separate Adamas from Demenegaki, as their concentrations were almost identical (Figure 4.1). Here, it was necessary to plot other elements in order to separate the two obsidian quarries - Ti and Fe (Figure 4.3). The use of major elements to discriminate the Melian sources was first suggested by Shelford et al. (1982) using XRF. Liritzis (2008) published scatter plots (Fe-Ti-Sr) also using a portable EDXRF method for separation of Melian obsidian (also in Frahm *et al.* 2014). As described in Chapter 3, Melian obsidian was circulating throughout the Aegean region, including the islands and surrounding mainland, and it would be expected to be found in the northern and eastern Aegean region.

4.2.4.3. The Carpathians

Fifteen central European samples showed that the source groups can be clearly separated into C1 and C2 (Figure 4.1). For comparison, ten samples (five from C1 and five from C2) out of those 15 have also been analysed with an EDXRF instrument at MAX laboratory (Thermo Scientific ARL Quant'X energy-dispersive x-ray fluorescence spectrometer), McMaster University (Canada). Figure 4.2, D and Table 3 in Data 3 show that the trace elements produced by the two techniques are closely comparable. PXRF was unable to discriminate the two proposed C2 pyroclasts (C2T and C2E) (Biró *et al.* 1986; see Williams-Thorpe *et al.* 1984), although this would need much more systematic analyses of a larger sample and through comparison of the results produced by different techniques. It was nonetheless clear that two sub-sources were represented in the pXRF analyses as seen through the different values for Fe. As the obsidian in these areas is in secondary contexts, an extensive fieldwork program would be required to further clarify the exact range and geographical location of pyroclastic sub-sources in the area of C2.

4.2.5. EDXRF of Carpathian samples

The assemblages from the central Balkans described in Chapter 8 were collected and analysed in 2007, prior to the beginning of this dissertation, using lab based EDXRF (Spectrace QuanX energy dispersive X-ray fluorescence spectrometer) at the Archaeological XRF Laboratory, Department of Anthropology, University of California, Berkeley[7]. This method is non-destructive and analyses intact samples, recording 13 elements (Ti, Mn, Fe, Ni, Cu, Zn, Ga, Rb, Sr, Y, Zr, Nb, Th). Trace element measurements were calibrated according to analyses of international rock standards certified by the National Institute of Standards and Technology (NIST). Together with archaeological material, the geological samples from Carpathian 1 and Carpathian 2 sources were analysed under the same conditions and using the same method[8].

The sampling of archaeological objects from 11 sites in central Serbia faced some difficulties in terms of bureaucratic procedures, preventing the collection of the most representative material within obsidian assemblages (e.g. cores). In some cases, it was possible to separate for export only a small proportion of assemblages (in Vršac museum from the site Potporanj-Kremenjak, only 1.2% out of 1100 pieces of obsidian were analysed, while from the site Vinča-Belo-Brdo, it was possible to export only flakes and blades, not cores). However, the assemblages (described in Chapter 8) were macroscopically examined prior to the sampling procedure ensuring a representative sample of the assemblages was studied. These were the main reasons for choosing a mobile pXRF method for obsidian provenancing in the other two regions, the Aegean and Anatolia, during this thesis.

4.2.6. Macroscopic discrimination of obsidian

For the purposes of this dissertation, chemical characterisation has been conducted in conjunction with macroscopic (visual) discrimination, which relies on first-hand knowledge

---

[7] With the kind collaboration of M.Steven Shackley.

[8] Geological samples were received from Giulio Bigazzi CNR (Pisa) who previously analysed and discriminated them using the fission track method (Bigazzi *et al.* 1990).

of the visual properties of obsidian from the sources that are expected in an area. The study of obsidian provenance has often involved macroscopic discrimination of obsidian artefacts, using the naked eye under correct lighting indoors or direct sunlight.

Even though it can be unreliable as a stand-alone technique for differentiating different sources, remarks on physical properties are nonetheless commonly found in the literature, particularly when confirmed using geochemical analyses (Biró 2004; Braswell *et al.* 2000; Healey 2007; Lugliè *et al.* 2007; Milić *et al.* 2013). In their early studies Cann and Renfrew (1964) referred to the results of chemical characterisation and visual properties of the various obsidian sources. They used visual characteristics as a means to discriminate source materials that could not at that time be discriminated chemically. The visual characterisation of material from Çatalhöyük was based on examination of almost the entire obsidian assemblage from the mound, ca. 15,000 pieces. According to the visual characteristics, 22 types were separated and representative samples of each type were elementally analysed in order to confirm the sources and to create a reference collection. Prior to the artefact chemical analysis, through blind testing it was possible to achieve 97% accuracy with this technique (Milić *et al*. 2013).

The typical parameters used in visual characterisation include: colour, transparency inclusions and banding. The sources concerned in this study have distinct macroscopic properties and these are some of the most common (Table 4.1.):

Source	Macroscopic characteristics
Göllü Dağ	Completely transparent or with dark blue flecks. A variety is with white flecks.
Nenezi Dağ	Grey opaque or semi-transparent, sometimes with darker stripes or ‘stains’ inside.
Melos (Adamas and Demenegaki)	Grey, matt, opaque, occasionally semi-transparent, stripy.
Giali	Transparent, brown tinge with white spherulites.
Carpathian 1	Generally very glossy and transparent, occasionally with some darker tinge.
Carpathian 2	Grey, matt, opaque, occasionally semi-transparent.

Table 4.1. Description of the typical visual characteristics of obsidian from the analysed sources

The Figure 4.4 shows the colour variation of obsidian found in archaeological contexts that belong to these source groups. According to the colour and transparency, obsidian from Nenezi Dağ, Melos (both sources) and Carpathian 2 show visual similarities being grey, matt, sometimes semi-transparent, while the completely transparent Göllü Dağ type is very comparable to the Carpathian 1 variety. It is interesting that similar visual types have broadly corresponding chemistry and as a result Nenezi Dağ, Melian and Carpathian 2 are in close proximity on the scatter plots (Figure 4.1) with higher concentrations of Sr and Zr (especially from the former two sources). Transparent and glossy obsidian from Göllü Dağ, Carpathian 1 and Giali outcrops, on the other hand, have lower values in Sr and Zr.

Some of the material from the study sites (e.g. Ayio Gala and Emporio) was examined only macroscopically, usually due to the size of the artefacts occasionally that did not allow pXRF analyses. In most cases, in analyses described in Chapters 6, 7 and 8, these objects were taken into account when quantifying and discussing assemblages from individual sites and when plotting them within their respective regional groups, although I make it clear when this occurs (and the extent of the macroscopic versus microscopic components).

4.2.7. Archaeological significance of pXRF for obsidian studies

Obsidian characterisation studies have developed over the past 50 years into a powerful tool in archaeological science, especially for analysing movements of people and mapping long distance contacts (e.g. Carter *et al.* 2008; Farr 2006; Renfrew *et al.* 1968b). Intensive surveys of source areas allowed the development of analytical techniques that could discriminate various obsidian types with high precision and allocate them to sources.

The development of pXRF instrumentation allows a non-destructive, fast and cost-effective technique but, perhaps more importantly, one well-suited to the practical realities of a multi-site, inter-regional and cross-border archaeological study such as this, that will examine well over a thousand artefacts analytically. This project reveals the methodological benefits of examining the relative proportions of obsidian from different sources across entire assemblages at a single site, the material from this site can sometimes be placed into its local stratigraphic and micro-regional context and this can in turn be placed into its macro-regional context.

Even in the case of the exploitation and consumption of the two neighbouring and chemically similar Melian sources, Shelford et al. (1982, 191) stated that “It is quite possible that sites will exist where one source has been preferred, but it will require much larger numbers of stratified samples from each of several sites before one could begin to test for any archaeological significance in the results”.

4.3. Characterising technological sequences

The point of origin of raw materials, the distance between geological sources and archaeological sites and the particular contexts of deposition are some of the parameters considered in many studies of archaeological artefacts. In addition to these datasets, the examination of technological properties of artefacts can also contribute towards our evaluation of the structure and meaning of assemblages. The investigation of raw material origin was illustrated previously in this chapter is, essentially, just the first step in the reconstruction of the life-cycle or biography of chipped stone tools. Raw material procurement, artefact production, consumption and discard take place following stages defined using the *chaîne opératoire* approach, as originally defined by Leroi-Gourhan (1964). In other words, materials can be classified into a number of different reduction stages. The underlying aim of this is to define the form in which obsidian was obtained, worked and used. This provides the datasets necessary to assess the organisation of production, craft specialisation, exchange, and practices of use, discard and deposition (Figure 4.5).

4.3.1. Technology

The main production techniques used in the knapping of stone tools are categorised as direct and indirect percussion, and pressure-flaking techniques. Direct percussion is conducted with a hard hammer (stone) or a soft hammer (bone, antler or wood). Percussion with a hard hammer is the most basic technology, usually used as a starting point for core preparation or as a part of unstandardized production of low quality raw materials. It could be performed on single or opposed platform nodules, the latter often formed when one edge of a core is placed on a hard surface, while the other side is struck with a punch. This technique is recognised for the preparation (de-cortification) of raw nodules of Melian obsidian (Perlès 2001, 203), and it is also used by Neolithic communities as a part of routine activities, often when working locally available chert. These artefacts are known as *pièces esquillées* and these are commonly found at Initial Neolithic Knossos (Connolly 2008) and early Çatalhöyük (Carter *et al.* 2005). They are, essentially, exhausted cores that were also re-used as tools - ’splintered’ pieces - used for cutting hard or resistant materials (Conolly 2008, 77; Kozlowski *et al.* 1996, 372). Indirect percussion and pressure-flaking are techniques employed for the standardised production of blade blanks. It is generally accepted that this is conducted by skilful craftspeople as it requires careful preparation of cores to be able to produce a number of regular prismatic blades. In the case of production of blades from Melian obsidian in the

EN Aegean, Perlès (2001, 203) believes that the blade cores were initially worked by indirect percussion, and then by pressure. The pressure technique was achieved when pressure was applied by a sharp tool (e.g. antler) pushed by hand, shoulder or stomach (Inizan *et al.* 1992). Careful and controlled knapping of regular blade cores enabled the production of as many blades as possible from a single nucleus. Experimental work (Sheets & Muto 1972) demonstrated that in a short period of time (2.5 hours), 83 blades can be produced from a single core, if it is worked around the entire circumference. The exhaustion of cores in this manner was frequently found in obsidian assemblages, particularly for the bullet-core industry that is common in north-western Anatolia (Gatsov 2009). Often in the Aegean, cores are not knapped along the entire circumference, and in many cases only two-thirds of this range, leaving one side unworked with the initial crested blade or cortex. The formation of crested blades was at a preparation stage and served to form an angle from which the reduction of the core would start.

Pressure-flaking technology had been in use since the Upper Palaeolithic period and was widespread in areas of the Near East, Anatolia, Aegean and the Balkans. In all study areas, pressure-flaking of blade cores was done from a single platform, producing regular unipolar prismatic end-blades (*blades plain débitage*) (Gatsov 2009; Perlès 2001).

4.3.2. Reduction sequences

The criteria and terminology used for analyses of obsidian in this study was adapted from Inizan et al. (1992) and the details of the recording system of each artefact in coded form are listed in spread-sheets in Data 5. Figure 4.5 is created on the basis of Inizan et al. (1992) showing the reconstruction of various stages of production and these are used to illustrate the reduction from raw material to finished product within each assemblage. The major categories used for the material description include: *débitage*, portion represented, presence of cortex, the dimensions, blade platform type and its dimensions, scar pattern, edge morphology, artefact condition, use and modification (retouch types). Cortex is the natural surface of a raw material before it was worked into a core. The presence and proportion of cortex (here presented in percentages) on the surface of an artefact indicates the stage of tool production (Inizan *et al.* 1992, 28). The term 'débitage category' is used here to describe types of *blanks*, i.e. primary products removed from a core, that could have been also further modified and turned into tools by retouching. In this study, all pieces are assigned to one of

19 débitage categories. The full list of débitage classes is given in Data 5 (PDF on CD), the major being: core, blade, flake, rejuvenation piece and preparation piece.

Blades, as described in Inizan (1992, 76), after Bordes (1961), by definition have a length that is at least twice that of its width and a 'true' blade is regular with parallel edges (here these are called Bl Pd for *blade plain débitage*). This distinguishes it from blade-like-flakes that are irregular and here belong to the flake category. General flakes, blade-like-flakes, preparation pieces, chips and fragments are grouped as debris, a term used to describe waste products that occur during the knapping process.

The organisation of lithics production in a settlement is seen through the presence of some stages of reduction in one place (context). In situ knapping of obsidian is archaeologically only rarely documented due to taphonomic processes (contextual issues are discussed in Chapter 5). The question of understanding production of obsidian in remote areas is also problematic if the manufacture is done by non-local itinerant craftsmen, in cases when the cores are knapped in one settlement, and then, as a robust form for transport, taken to another for further reduction.

4.3.3. Tool typology

The next step in the *chaîne opératoire* is the manufacture of formal tools as the final product in the sequence, before use, potential re-shaping / re-use, and eventual discard. Various types of blanks (most often blades and flakes) are intentionally modified into tools by retouching with the intention of making or sharpening tools (Inizan *et al.* 1992, 67). Retouch is modification of the edges of a blank by percussion or pressure, and consists of small scars located in line on the object's edge, oriented in the same direction, which would create desired tools that were used for specific tasks. On the basis of retouch type (e.g. position, angle, and morphology), artefacts were allocated to certain tools: retouched pieces, scrapers, projectile points, notched pieces, perforators, etc. Types of objects could be distinctive for a region or period as is the case with e.g. geometric microliths in the Mesolithic period or tanged-and-barbed points in the LN Aegean.

4.4. Summary

This chapter has presented two main methodological components used for the study of obsidian assemblages from the study sites. Firstly, provenancing of the artefacts that was conducted using pXRF instrumentation which constituted a reliable, fast and non-destructive method. In this study, the capability and comparability of pXRF with other techniques has been demonstrated through the analysis of geological material from the obsidian sources of Göllü Dağ, Nenezi Dağ, Demenegaki, Adamas, Giali, Antiparos, Carpathian 1 and 2, i.e. raw materials that are used in the regions under the research. Precision and accuracy were determined through the analysis of artefacts that were previously examined using other analytical instruments. This work represented the basis for the identification of archaeological material discussed in Chapters 6, 7 and 8. Most of the artefacts were compositionally discriminated through concentrations of Rb, Sr and Zr elements, while bivariate plotting of Ti and Fe enabled successful distinction between the macroscopically and elementally closely related sources of Adamas and Demenegaki on Melos.

The second approach used in the analyses of artefacts was the more traditional chaîne opératoire method that was described in the second part of the chapter, in section 4.5. This allowed the definition of the reduction stages in which obsidian artefacts were exchanged and consumed by communities in the study area. Through the combination of obsidian provenancing and technology has been possible to recognise different procurement and consumption patterns within the assemblages in the marginal areas of obsidian distribution.

The aim of the following Chapter 5 is to define the study regions in relation to the sampling strategy of regions, sites and artefacts within assemblages. The latter exploits the high suitability of the pXRF for choosing representative samples, which in marginal areas of obsidian distribution often includes the analyses of entire assemblages due to the relatively small assemblages.

Chapter 5. Methods: Sampling strategy and case study regions

5.1. Introduction

This chapter will address specific aspects of the research relating to the sampling strategy in terms of regions, sites and artefacts, followed by an overview of the archaeology of the study regions and sites. The sampling strategy includes sampling at two scales: (1) why were particular regions and sites chosen for the study, and (2) what representative material was chosen from site assemblages. The discussion of the latter also follows the issues highlighted in Chapter 4 relating to the benefits of obsidian mass-sampling and the reality of using this method on site assemblages.

Following the section on sampling strategy, a large part of the chapter is dedicated to the archaeology of the study regions and sites. This will include local chronology, location, site character (e.g. flat site or tell), material culture, as well as the archaeological contexts from which material was chosen (where possible). A number of sites selected for the study were discovered in the last 15 to 20 years as part of rescue excavations. In Izmir's Bornova district, Neolithic tell settlements were buried under thick alluvial deposits which previously prevented their discovery during extensive surveys (Brami & Heyd 2011). Large flat-extended settlements in Macedonia (e.g. Makriyalos, Kleitos and Thermi B) and in Serbia (e.g. Masinske njive) were also excavated as rescue projects. Given so many different sites, it is inevitable that different excavation and interpretative traditions had been employed. This becomes particularly salient when dealing with the material excavated at the beginning of the 20th century (e.g. early excavations at Vinča-Belo Brdo), but is also relevant to those sites recovered through different modern excavation procedures that may or may not include dry and wet sieving. These differences have a large impact on the size and character of obsidian assemblages and on understanding depositional processes. Employing a contextual archaeology and seeking material found in 'secure' deposits, is an avowed objective of this research but one that can in practice only be patchily employed, and it is also important to consider poor excavation records and to take into account the particular way that obsidian is affected by taphonomic processes.

Overall, the aim of the chapter is to explain my reasons for choosing particular study regions, sites and artefacts and how this selected sample can contribute to the reconstruction of social interaction at the intra- and inter-site level.

5.2. Sampling strategy

Recently, Knappett (2011) has dealt with the various scales of interaction through macro-, meso- and micro- networks that link together spatial (inter-regional), temporal (from the *annales* perspective) and face-to-face (practice / habitus) levels. His approach usefully highlights a variety of motivations for the movement of objects through overlapping local relationships. The foundation of this study is to connect 'everyday' activity through the *chaîne opératoire* of the micro-scale, which in turn explores the meso-scale amongst contemporary communities and their common use of obsidian in a specific technological manner ('communities of practice' after Knappett 2011). The macro (regional) aspect is related to the central Anatolian, Melian and Carpathian regions, or more precisely, patterns of obsidian distribution from these regions. The distribution boundaries of obsidian from these sources are described in Chapter 3, while here the emphasis is the on selection of archaeological sites located within these distribution zones (Figure 5.1).

I will now discuss the sampling process in a) choosing study regions and sites on the basis of their location within the obsidian distribution zones, b) selection of artefacts from secure site contexts (where practicable).

5.2.1. Region and site selection

Considering the large geographical scope being considered, the main focus in terms of primary data collection has been on the areas on the 'edges' of different obsidian distribution zones (Figure 5.1). It has been proposed (Renfrew *et al.* 1968b) that each source area has 'supply' zone and 'contact' zone. Sites within the 'supply' zone typically obtain obsidian as a major raw material (80-100%), usually represented in various stages of reduction sequence (cores, production debris, end-products) and contain a variety of tool types; arrow-heads and scrapers being the most distinctive. Communities that belong to the 'contact' zone receive small amounts of obsidian indirectly through various means (more in Chapter 2).

In exploring the role, value and meaning of obsidian in areas located at some considerable distance away from the source (e.g. 400 km), a key question is to explain how obsidian occurs there less frequently and typically in fewer forms (Perlès 1992). Even so, just considering sites and regions at some distance from the source areas is insufficient on its own, and so it is important also to include material from the sites in the perceived 'core' zones of an obsidian distribution (e.g. Saliagos and Çatalhöyük) and compare and contrast their role in inter-regional mechanisms. My selection of sites and material reflects this methodological trade-off.

Figure 5.1 shows the limits and overlaps of distribution zones, as well as those sites that have been selected for analyses, with the intention to explore the following issues in particular:
a) In the northern and eastern Aegean/western Anatolia, there is strong expectation that settlements use obsidian from both Melos and central Anatolia. I have selected sites located within interface zones where the presence of obsidian from two different sources has been recorded (e.g. Çukuriçi Höyük after Bergner *et al.* 2009; Dedecik Heybelitepe, after Herling *et al.* 2008).

b) The central and southern Balkans required a different approach because obsidian is rare when present at all. The aim is to investigate this 'gap' in order to establish the character of this boundary region between the Carpathian and the Aegean obsidian complexes. Moreover, there are some overlaps in the distribution zones in which obsidian of atypical origin appears on sites where obsidian from other sources is dominant (e.g. Mandalo after Kilikoglou *et al*. 1996).

Most of the sites considered in detail for this dissertation were selected on the basis of their geographical position in relation to obsidian distribution boundaries, but without any other prior selection criteria with respect, for example, to the character of these settlements or their assemblages. It was crucial to study sites that have a good excavated spatial extent, and wherever possible to access contextual information about the artefact findspots. In the central Balkans, sites in Serbia lie towards the margin of the Carpathian zone, and have never been part of any larger sourcing study, thus any settlement that had obsidian in an assemblage was taken into consideration. From each of the distribution zones, one (or two) sites from the core were also described based on published data though they were not included in the first-hand study due to the sheer volume of material, but the available information served as a benchmark for evaluating the character of assemblages on the periphery of distributions.

5.2.2. Inner, intermediate and outer zones

In this section, I begin with a discussion of the obsidian distribution models proposed by Renfrew et al. (1965, 1968b) and how recent data may challenge these. When considering three source areas, central Anatolian, Aegean and Carpathian, the perceived core area of the distribution in each case belongs to environmentally different settings which affected the size of the core and the ways in which obsidian was distributed away from it, into a wider periphery.

In Anatolia, sites located within 250 km of the sources might be considered the core of the distribution, given the fall-off in proportions of obsidian with regard to the total lithic assemblage at a given site. This very approximate core zone includes only a handful of Early Neolithic settlements: Aşıklı Höyük, Çatalhöyük, Mersin and Süberde (Renfrew *et al.* 1968b, 329). The 'contact' zone included sites to the south and east in the Levant and Cyprus, while areas west of the central Anatolian plateau were at the time of Renfrew's research too poorly explored to give a valid representation of obsidian consumption for the model proposed. The intensification of research in north-western and western Anatolia since the 1980s and 1990s explored a sufficient number of new settlements to consider an expansion of the identified Anatolian outer zone westwards towards the Aegean coast (Figure 5.2). The vast region of central Anatolia has not to date produced many Neolithic sites, particularly those that belong to the LN and EC periods, hence the obsidian assemblage from LN Çatalhöyük East and Çatalhöyük West are investigated as a case study for the inner zone here. For this purpose, we can observe that the larger Çatalhöyük East site was occupied from 7500 to 6000 BC, after which the smaller West mound was inhabited in the first half of the 6th millennium BC. At a distance of 500-700 km to the west, the included sites are Pendik, Fikirtepe, Barcın Höyük and Aktopraklık, in the north-western Anatolia, and Ulucak, Yeşilova and Ege Gübre in central-western Anatolia. The sites in central-western Anatolian are located on the Aegean coast and in Chapters 6 and 7 they are described as eastern Aegean region (Figure 5.3).

Another area examined by Renfrew et al. (1965) was the Aegean. With the sources being located on an island, the distribution of Melian obsidian required maritime transportation to move any real distances from the sources – notably dissimilar to the land routes in the Anatolian case. Renfrew's assumption was that the fall-off model could not be applicable to a marine setting (Renfrew 1972, 370), although later studies showed that crossing the sea was not a problem (Broodbank 2000; Perlès 1992). Another obstacle is the absence of settlements discovered thus far on Melos and the surrounding islands, at least in the EN and MN periods (Cherry & Torrence 1982; Perlès 1990). Perlès (1990, 1992) suggested that the exploitation of obsidian in these periods was direct and un-organised, relying on travelling specialists, while in the LN and FN we can begin to think in terms of permanent settlement and workshops within the core area. It has been suggested that even the sites situated at a considerable distance from Melos, in the Peloponnese and Thessaly, are likely to belong to a 'supply' zone (Perlès 1990, 1992; Torrence 1986). Here, LN (5th millennium) Saliagos on Antiparos and Ftelia on Mykonos, located c. 65 km and 100 km as-the-crow-flies from the sources on Melos, are taken as case studies within the inner area. The periphery of Melian distribution extends in three directions, to the east (eastern Aegean, as is the case of Anatolian distribution), north Aegean (Hoca Çeşme, Uğurlu and Gülpınar) and north-west in Macedonia and Thrace (e.g. Makriyalos, Paliambela, Thermi B and Dispilio) (Figure 5.3).

Moving farther to the north, the circulation of material from Carpathian sources in the Great Hungarian Plain and surrounding areas represents a different environmental setting to the previous two cases. There we find settlements connected in the landscape through the complex riverine networks situated in a vast floodplain, the bed of the ancient Pannonian Sea. On the basis of data from Neolithic and Eneolithic sites, Williams-Thorpe and colleagues (1984) created a fall-off model of obsidian exchange typically with two zones. In this case, however, a small inner zone extended some 25 km in diameter, while the outer area was much more extensive. Proximity to a river could have distorted the frequency of obsidian at some sites that are located more than 150 km from the sources, containing sometimes over 70% of obsidian. These communities could be characterised as a 'geo-cultural' core of the distribution of Carpathian obsidian. The peripheral zone, specifically in the vicinity of, and south of, the Danube in Serbia, is examined through material obtained from a number of sites (e.g. Gomolava, Potporanj-Kremnenjak and Masinske njive) (Figure 5.3).

My strategy includes being able to re-address these models in a pragmatic way using similar criteria including the quantity of obsidian in lithic assemblages and the distance from sources. Through this, it is possible to determine what might constitute zones of obsidian distribution:

- Inner sites – located close to the sources, with obsidian constituting a major raw material used for the manufacture of a variety of tools and evidence for the *in situ* reduction of nodules and cores

- Intermediate – this zone could not be strictly defined because the distance of sites from sources does not always correlate with the percentage of obsidian in assemblages. Particularly in the the case of the Melian zone, the simple factor of distance from source is not consistent due to the variable distances to the nearest mainland coasts from Melos. While sites can be located at a similar distance from the sources, obsidian represents one of the main raw material types at some (c. 50-70%), while at others there was only a small amount of obsidian within assemblages (c. 5-10%). At the former sites in situ manufacture of obsidian artefacts is probable, although this is often related to knapping of blades from already prepared cores.
- Outer – sites that are at large distance and where obsidian is only a small proportion of the lithics assemblages (often less than 5%). Obsidian can occur in various forms although there is very rarely evidence that it was knapped at these sites.

5.2.3. Selecting representative material from the site assemblages

Compositional characterisation of artefacts has increasingly become common practice in archaeology, with obsidian sourcing featuring in many studies. Naturally, the greatest attention tends to be on the chemical results, i.e. determining the origin of obsidian, but often we know very little about these *samples* (Healey & Campbell 2009). Healey (2007, 173) also remarks that

> "since the basis of the selection of artefacts for analysis is often not stated, it is difficult to ascertain whether they are representative of the whole assemblage; similarly, the chronological and contextual relations of the samples are often unclear. This means that we cannot be sure how many sources are involved, the relative proportions from each source or if there is variation from context to context; so our understanding of how obsidian was acquired and worked is restricted."

I will briefly take the case of the LN-BA site at Mandalo in western Macedonia, to illustrate the response to Healey's concerns in the methodology of this current study (full discussion of the site is in Chapter 8). In 1996, an article on obsidian provenance from Mandalo was published in the *Journal of Archaeological Science* (Kilikoglou *et al.* 1996). This has been one of the most cited articles in European obsidian studies since the results of NAA analyses showed not only the success in identifying the origin of obsidian but demonstrating how obsidian acts as a true proxy for long distance inter-regional exchange. Interaction between the Aegean and central Europe through contacts with the Balkan communities (particularly Vinča culture sites) was shown to extend over 800 km on the basis of finds of Carpathian obsidian at Mandalo (Kilikoglou *et al.* 1996, 347). The results of obsidian analyses revealed the first and most southern occurrence of Carpathian 1 obsidian on the Aegean mainland. Eleven artefacts were provenanced, nine from the LN phase and two belong to the BA horizon. It was emphasised that

> "they should be considered qualitatively because the Mandalo samples analysed may not be representative of the whole sequence. Nevertheless the fact that all the nine Late Neolithic come from Carpathian 1 shows a definite preference to this source before the Bronze Age".

The significance of this work is that we of learnt the existence of communication between the southern Balkans and central Europe, and according to the authors, it spanned two millennia. But, many questions remained unanswered. We do not have any information about the total amount of obsidian at the site and what percentage of this is of Carpathian 1 and what percentage is of Melian origin. What type of artefacts were exchanged with the Balkan communities? What type of artefacts they received from the Aegean communities? What was the context of these finds, particularly those from the Carpathians and were there are *any* possibilities of some contamination of their depositional contexts and, therefore, chronological relationship? In turn, are we to assume that exchange between the Aegean and the Carpathians via the Balkans spanned LN to EBA (from 5th until 3rd millennia BC), particularly if we know that obsidian in the BA Balkans is very rare, where known at all, while at Vinča-Belo Brdo, interpreted as a re-distribution centre, obsidian virtually disappears from phase D, i.e. after 4500 BC (Tripković & Milić 2008)? The absolute dates of Neolithic Mandalo range between 4600 and 4000 BC (Kotsakis *et al.* 1989), which is just after the end of Vinča-Belo Brdo (A-D) occupation and some 500 years later than Vinča's richest obsidian horizons (Vinča A-B). My intention is not to question this specific study, but to draw attention to complications in the formation of this interpretation and to highlight the potential of quite different and potentially conflicting narratives.

The reality of many excavations is that they do not always provide appropriate archaeological documentation about the find conditions of artefacts and their stratigraphic positions, but in the case of these 'exceptional' examples, particularly when they are foregrounded in such sharp relief as a model in exchange studies, the above questions are fundamentally important. It is therefore essential when such data is missing and our interpretations are based on partial datasets, that we clarify what part of the story we are capable of telling, as the above authors highlight in relation to planned future analyses (Kilikoglou *et al*. 1996, 349). The intention here has been to raise some methodological problems via the Mandalo example, while the results of obsidian analyses from this site are discussed in Chapter 8.

5.2.4. Sampling artefacts

The character of the obsidian samples considered in this project has been affected by varying traditions of excavation and by the subsequent methodology that has been employed in this study. My intention has been to gather material from a large number of sites and where feasible to do so from secure archaeological contexts. The practical challenges faced in attempting this were considerable, particularly as the majority of the material comes from 'old' excavations where stratigraphic analysis was based more on excavation 'passes', 'levels' or 'spits' than coherent depositional contexts. At a number of older excavations it was not possible to determine the exact quantity of obsidian due to relocation, separation or even loss of assemblages or individual artefacts. It is important to observe that some excavations are on-going and the material studied does not include pieces found after the field study was completed. For some sites (e.g. Ulucak, Barcın Höyük, Paliambela) the excavators kindly offered as yet unpublished stratigraphic information that was essential to this work. This confirmed that material came from secure Neolithic and Chalcolithic deposits, and the rest of the material that came from unstratified and mixed deposits was not examined in detail, though it was quantified and provisionally assessed. The next step following stratigraphic and contextual analysis was to visually examine the material taking account of colour, translucency, texture, banding and inclusions. With regard to technology and typology, the study material was selected with a view to applying a *chaîne opératoire* framework in order to reconstruct the procurement and production processes of the artefacts. The sample included cores, debris and diagnostic end-products, although variably represented at different sites. This classification is described in Chapter 4.

My artefact sampling in most cases has taken account overall quantities as well as the physical properties of each assemblage including technology, typology, context and chronology. In the case of small assemblages, all obsidian artefacts were selected for analysis. If assemblages contained a large number of artefacts it was necessary to select a representative sample of, often between 50 and 100 artefacts per site based on technological features and an initial visual assessment of the material's likely source (see Chapter 4 for details of this method). The proportional relation of obsidian to other raw materials is provided in Data 1 on CD and Figure 5.3, although in some cases these figures are based on the available estimations by the excavators. Artefact recording procedures included chemical analysis using pXRF, techno-typological study to determine production stage and artefact function, photography of artefacts to record their physical conditions and where practical their colours and in most cases pencil illustration on site.

5.2.5. Archaeological context and archaeological practice

The importance of archaeological context has already been emphasised in this work, particularly in association with the sampling of artefacts that would be representative of site assemblages. Indeed, the work of Renfrew et al. in the mid-1960s was criticized for choosing too small samples from each site or using material that was not well stratified (e.g. Torrence 1986; Wright in Klejn et al. 1970). Subsequently, a lot of attention has been placed on the importance of archaeological context in interpreting obsidian. For example, Ian Hodder (1982, 208) proposed that

> "it is necessary to identify different associations of single artefact types in each regional or cultural context. With any such unit, an artefact type might be present or absent in burials, and in burials of particular age, sex and status groups. The type may or may not occur in settlements of different classes and sizes, in particular buildings within settlements, and in particular types of refuse contexts. It might be found in ritual contexts, hoards, or a single finds away from sites. …the associations and contexts of exchanged artefacts can be examined between regional units and at different distances from sources. Each artefact type may have different values and meanings within each local context, and the exchange of objects between cultural units and the maintenance of boundaries between ethnic groups may be based upon, and may manipulate, such differences. There is a link to the within-unit contexts in that whether artefacts cross or do not cross between ethnic groups is related to their meanings within each unit. It is thus necessary to examine variations in symbolic associations over space."

However, certain aspects of this approach need to be considered with some caution. The desire for well contextualised objects stems from two concerns: gaining an accurate chronology from multi-period sites and determining any depositional patterns associated with the introduction of artefacts into the archaeological record. The second objective needs to be considered in light of the fact that obsidian is particularly resistant to a 'contextual archaeology', as unlike most other objects, broken obsidian artefacts are dangerous to abandon in living spaces because they can injure people, and so when they fall out of use, they would often have been deliberately discarded away from floors or other easily datable contexts. While they may be expected to occur in middens or refuse pits, they are most frequently recovered in generic excavation 'passes' or 'spits'. Robb (2007, 201) has drawn attention to the fact that in Neolithic Italy, obsidian rarely comes from well-defined contexts and that it is not treated specially. While technically true, we may also observe that this in fact constitutes a form of distinctive treatment in that it exhibits different discard patterns to other objects. With specific reference to Robb's argument, it is clear that obsidian was only very rarely deposited with the intention of preserving the object involved or treating it with any form of respect as may be the case for hoards and burials. Typically, it was thrown away as rubbish. At Menteşe and Çatalhöyük, for example, it is noted that the floors and surfaces of houses usually did not contain finds while outside spaces had large amount of artefacts (Carter & Milić 2013a; Roodenberg *et al.* 2003, 19). As tiny objects, obsidian fragments also suffer from mobility through taphonomic processes and excavation recovery practices (including the individual skill of an excavator and the presence or absence of dry- and water-sieving on a site). Conversely, in the inner zone, at sites rich with obsidian, it is not unusual to find contexts in which obsidian is carefully deposited (e.g. mirrors and spear-heads in burials and hoards at Çatalhöyük, or obsidian core hoard at Nyírlugos; after Kasztovszky *et al.* 2014), while in the distant areas, it appears as simple flakes and bladelets found in not so well-defined contexts. This scenario is somewhat in contradiction to the definition of value that we might expect obsidian to be given, particularly in long-distance exchange (see discussion in section 2.4.2.2).

Determining the total amount of obsidian from different sites is a first and most basic methodological step in setting up a project that deals with a large site sample and wider regional approach. The most obvious and challenging issue is that ideal conditions do not exist throughout each project and region considered. This relates to past excavation practices, accurate excavation and finds records, current storage conditions, accessing often partially or wholly unpublished materials, working on a specific category of material within a wider assemblage under study by another specialist and general permit acquisition problems. At the start of this research it became clear that the documentation available for the majority of the sites would not provide sufficient information about the quantities, chronology and contexts of artefacts. There are several reasons for this: old excavations with incomplete documentation, in many cases completely lost; material given for various analyses in the past, never returned or published and with the total number of finds never recorded; modern excavations and research that are too specialised such that different specialists study different periods in isolation, leaving the bigger picture fragmentary; as well as finally and unfortunately some cases in which material is currently of unknown whereabouts in collections and museum storage facilities. These concerns will be noted for individual assemblages analysed in Chapters 6, 7 and 8.

As it was mentioned, in Figure 5.3, I have charted the relative proportion of obsidian to other chipped stone at all the sites in the three obsidian zones, including the study sites, although this information for each site (totalling about 240 sites) was not always easily available in publications, in which case the percentages were estimated based on available data (e.g. if obsidian is described as a "dominant" category, the estimation would be 80-90%, if its occurrence is "very rare", it would be quantified as less than 1%, etc.)[9]. Furthermore, the map shows all the sites irrespective of their chronological date including Early, Middle and Late Neolithic and Chalcolithic of the late 7th until the early 4th millennia BC.

5.3. Absolute and relative chronology of the study (and other relevant) sites

5.3.1. Relative chronology and regional terminology

The temporal range of this research - the late 7th, 6th and first half of the 5th millennia BC - typically coincides with the Early, Middle, Late Neolithic and Final Neolithic / Eneolithic / Chalcolithic periods (Figure 5.4). However, these chronological periodisations are different within each of the study areas, despite falling within the same absolute chronological range.

[9] Precise and imprecise frequencies are marked with 'yes' and 'no' respectively in the spreadsheet Data 1 on CD

The foundation of this chronological framework is based on ceramic groups and in some cases also architecture and material culture.

In Anatolia the situation is particularly complex. Chronological divisions were not readily identifiable in all areas. In central Anatolia, the Early Neolithic (7500-6500 BC) is considered to be a distinct period. Following are the Late Neolithic (6500-6000 BC) and Early Chalcolithic (6000-5500 BC) (Çilingiroğlu 2009, 24; Thissen 2005). The Late Neolithic (corresponding to Aegean EN) is characterised by monochrome burnished pottery. An initial but misleading chronology was created by Mellaart in the 1950s while working at Hacılar, which suggested a division between the Late Neolithic and Early Chalcolithic (EC) periods based on the appearance of painted pottery. The EC period is not characterised by the beginning of copper smelting but was adopted from the arbitrary separation of the Mesopotamian Neolithic and the Chalcolithic and the introduction of painted pottery in the Hassuna culture (Çilingiroğlu 2009; Schoop 2005). However, it became clear that this transition from monochrome to painted ware is idiosyncratic for sites in central Anatolia and the Lake District, while painted pottery remained a rarity in central-western (eastern Aegean) and north-western Anatolia (Brami & Heyd 2011; Çilingiroğlu 2009; Lichter 2005). In the Marmara region, on the basis of dark burnished pottery, Özdoğan (1999, 213) defined the "Fikirtepe Culture" (c. 6000-5500 BC).

The date range of the Aegean Neolithic is based on material known from hundreds of sites in Thessaly, Macedonia and to a lesser extent southern Greece (e.g. Franchthi, Lerna and Kouphovouno) that allowed relative periodisation of Early (6500-5800 BC), Middle (5800-5300 BC) and Late Neolithic (5300-4500 BC). Here also, monochrome pottery characterises EN while the appearance of painted pottery (especially red-on-white) relates to the MN period. Late Neolithic, further divided into LN I and LN II. LN I, is characterised by the presence of black burnished ware, as well as incised and matt-painted pottery, while in the mid-5th millennium BC, the LN II phase is characterised by graphite-decorated and black-on-red wares, in Thessaly known as "classic Dimini" phase (Andreou *et al.* 1996). The Final Neolithic (4500-3200 BC) generally lies outside the scope of this thesis, although Andreou, Fotiadis and Kotsakis (1996, 565) argue that this is a problematic period "because none of the excavated deposits can be confidently assigned to the fourth millennium B.C".

In the Balkans, a culture-historical terminology created at the end of the 19th century is still widely used. In the central Balkans, the Starčevo and Vinča cultures are chronological terms essentially synonymous with the Early/Middle (c. 6000-5500 BC) and Late Neolithic/Eneolithic (c. 5500-4500 BC) respectively in the Balkan-Danubian region (Bailey 2000; Chapman 1981). The situation in the early parts of the Neolithic, however, is very complex despite the homogeneity of most forms of material culture across the region. The existence of monochrome and white-dotted painted pottery was assigned to the earliest Neolithic ('Balkan-Anatolian complex' after Garašanin 1979; Proto-Starčevo after Srejović 1969), followed by the 'classic' Starčevo phase with spiral painted white-on-red, dark-on-red and barbotine decoration. Recent radiocarbon dates (Whittle *et al.* 2002, 2005) for Starčevo and Körös sites in Serbia and Hungary showed the existence of late-7th millennium settlements in the central Balkans south of the Danube, while the first Neolithic occupation of northern regions (north of the Danube and south parts of the Great Hungarian Plain) belongs to a period from 6000 BC. However, Whittle et al. (2002) have shown that C14 does not support the separation of sites with monochrome and white painted pottery since these styles often appear in the later phases of the same sites. A Later Neolithic and Eneolithic (Chalcolithic) phase of the central Balkans is based on the division of the tell at Vinča-Belo Brdo into four major phases A, B (B1 and B2), C, D (D1 and D2) (after Milojčić 1949). Another major periodisation (after Garašanin 1951) separated Vinča culture into earlier Vinča Turdaş (A-B1), intermediate Gradac phase (Vinča B2/C1) and the later Vinča Pločnik (C1-D2). Here, Milojčić's scheme will be followed.

5.3.2. Absolute dates of study sites

Figure 5.5 illustrates the absolute (dark grey) and relative (light grey)[10] chronology for sites that are relevant to this project. The data for the chart is taken from various published sources, namely absolute dates where available or relative chronology according to pottery dating. Obsidian that was collected is largely related to those phases relevant to the thesis (late 7th / 6th and 5th millennia BC) although, as previously discussed, in some instances it was hard to determine the chronological and stratigraphical contexts of all finds. It is clear that excavated sites in central-western and north-western Anatolia belong to an earlier phase of the Neolithic (Anatolian LN-EC) with earlier phases spanning approximately 6400-5800 BC, although at Ulucak even earlier layers have been uncovered dating to the first half of the 7th millennium (Çilingiroğlu *et al*. 2012). Çilingiroğlu (2009, 386) noted that most of the sites

[10] If absolute dates are not available.

in central-western and north-western Anatolia are abandoned after 5800 BC "Thus, post-5700 BC is an enigmatic time period in both regions. Whatever caused the abandonment of settlements in Lake District and Central-West Anatolia around 5700 cal. BC seems to have not affected Ilıpınar which is abandoned around 5500 BC, if we exclude phase VB which is not a permanent settlement."

In sum, it is clear that there is a chronological bias between regions and sites considered in this thesis. My intention was to develop a coherent sample of sites where obsidian was being used in marginal regions of obsidian distribution. Obsidian distribution and long-distance exchange, therefore, are examined in two major instances:

1) EN (late 7th and first half of 6th millennia BC) in the eastern and north-eastern Aegean and north-western Anatolia. The number of excavated sites in these regions that can be dated to 5500-4500 BC (European Late Neolithic) is relatively small, which affects obsidian sample size, exchange patterns and the value of obsidian in marginal areas. This is when complex exchanges can be seen in the overlap of Anatolian and Melian obsidian consumption.
2) LN (5500-4500 BC) on the Aegean islands, in Macedonia and the southern and central Balkans. The sites that belong to the second half of the 5th millennium (Greek Final Neolithic or Eneolithic in the Balkans) are not well represented in this study due to a dearth of material. In the LN period, the proportion of obsidian in circulation in the marginal areas is increasing, while complexity is particularly seen in the overlap of the Melian and Carpathian interaction zones.

5.4. Archaeology of study sites – setting, nature and material culture

The following section will give an overview of the archaeology of the different study regions addressed in this research, while each of the individual sites discussed in the research are described in Appendix 1. The discussion focuses on geographical regions and obsidian zones that were suggested by the analytical data considered in this project. The results of obsidian analyses are described in Chapters 6, 7 and 8 as listed in Table 5.1. below:

Central Anatolia (Chapter 6)	*Site:*	*Obsidian percentage (to other lithic)*	*Obsidian number (approximately)*	*Analysed with pXRF (No):*	*Analysed using other techniques*
Inner zone *Central Anatolia:*	Çatalhöyük	99	> 100 000 (Carter *et al.* 2005)		750 +
Intermediate zone (?) *Lake District:*	Hacılar	42	300 (Mortensen 1970)		4
	Kuruçay	12	153 (Baykal-Seeher 1994)		N/A
	Höyücek	10	344 (Balkan-Atlı 2005)		N/A
	Bademağaci	N/A	N/A		N/A
Outer zone *North-western Anatolia:*	Fikirtepe*	1.9	42	10	
	Pendik*	5	96	42	
	Barcın Höyük*	15	200	29	
	Aktopraklık*	5	177	34	
	Ilıpınar	3	127		N/A
	Menteşe	3	N/A		N/A
Melos (Chapter 7)	*Site:*	*Obsidian percentage (to other lithic)*	*Obsidian number (approximately)*	*Analysed in this project (No):*	*Analysed using other techniques*
Inner zone *The Cyclades:*	Saliagos	99	25 000 (Evans and Renfrew 1968)		8
Intermediate zone (?) *North-western Aegean / Peloponnese and Thessaly:*	Franchthi cave	70	2000 (Jacobsen 1973)		8
	Lerna	90	750 (Kozlowski *et al.* 1996)		N/A
	Sesklo	67	N/A		4
	Dimini	85	N/A		N/A
Eastern Aegean:	Ulucak*	20	2800 (all phases)	285	
	Yeşilova*	40	1000	86	
	Ege Gübre*	5	200	68	
	Çukariçi Höyük	86	> 1000 (Complex 6; Horejs in press)		11 +
	Dedecik-Heybelitepe	48	369 (Herling *et al.* 2008)		10
	Tigani	70	130 (Felsch 1988)		N/A
	Ayio Gala*	7	8		N/A
	Emporio*	48	100		N/A

Outer zone *Northern Aegean:*	Gülpinar*	0.5 or less	13	13	
	Çoşkuntepe	0.5 or less	118 (Perlès *et al.* 2011)		3
	Uğurlu*	0.7	80	51	
	Hoca Çeşme*	0.5 or less	10	8	
North-western Aegean / Macedonia:	Paliambela*	7	177	66	
	Makriyalos*	0.4	39	37	
	Thermi B*	2.5	106	101	
	Kleitos*	3	200	60	
	Vasilara Rahi*	0.5 or less	5	5	
	Dispilio*	2.5	58	58	
Carpathians (Chapter 8)	*Site:*	*Obsidian percentage (to other lithic)*	*Obsidian number (approximately)*	*Analysed with pXRF (No):*	*Analysed using other techniques*
Inner zone (?) *The Danube region:*	Vinča-Belo Brdo	70	> 1500		70 +
Intermediate zone (?) *North of the Danube region:*	Opovo	7	100		24
	Potporanj-Kremenjak	30	> 1000		5 + 8
	Vršac At	30	500		4
	Potporanjska granica	35	> 3000		2
Outer zone *Central and southern Balkans / South of the Danube:*	Banjica	0.5 or less	5		5
	Gomolava	0.8	6		6
	Šamatovci	2.5	N/A		N/A
	Masinske njive	2	15		15
	Supska	0.5 or less	3		3
	Slatina	0.5 or less	3		3
	Drenovac	0.5 or less	5		2
	Selevac	4	N/A		1
	Belovode*	0.5 or less	7	7	
	Mandalo*	0.5 or less	10	10	

Table 5.1. Obsidian distribution zones with key sites in their core and peripheral areas (*sites included in the primary research; the other sites are obtained from the literature). The exact number of obsidian pieces is usually not specified in the literature, while the number of

obsidian pieces from studied sites [*], in case of ongoing excavations, includes the material that was excavated up until 2011 and 2012 seasons (for more detail see tables 6.1, 7.1, 7.3, and 8.1)

5.4.1. Central Anatolia

Located far from the Anatolian coast, central Anatolia is surrounded by chains of mountains which create an isolated, almost insular environment (Schoop 2005, 42). The relatively small number of sites in central Anatolia produced a sparsely documented obsidian inner area. Central Anatolian obsidian outer areas extended to north-western Anatolia (the Marmara region), while the sites to the east and south of the core, in the Middle East, are not included in this study.

As just noted, the number of Neolithic settlements known from the inner area of obsidian supply is relatively low, and only a few sites dated to the earliest Neolithic (8th and 7th millennia) have been well explored (e.g. Aşıklı Höyük, Çatalhöyük East, Can Hasan III, Erbaba, Süberde). In the following LN and EC periods (the end of the 7th / first half of the 6th millennia), this pattern remains unchanged and the key settlements of Çatalhöyük, Can Hasan I and Köşk Höyük III/II in central Anatolia document an abandonment of settlements after 5500 BC, a phenomenon also documented at EC tells in western Anatolia (Çilingiroğlu 2009). In the Lake District, the following sites have been documented: Bademağacı, Höyücek, Hacılar and Kuruçay, and dated to the second half of the 7th millennium.

Early central Anatolian settlements are characterised by densely clustered mud-brick houses with flat roof that contained one main room and occasionally additional smaller storage spaces (seen at Çatalhöyük and Aşıklı Höyük). The walls were sometimes decorated with geometric and figural paintings. Late occupation at Çatalhöyük East (V-0) and Can Hasan I (layers 7-4), dated to c. 6500-6000 BC, are characterised by the presence of dark burnished wares and the typical shapes are hole-mouth jars, vessels with S-profiles, tubular lugs and basket handles (Çilingiroğlu 2009). The pottery finds are similar to those from the early phases of settlements in north-western Anatolia (Menteşe, Demircihöyük and Archaic Fikirtepe) (Çilingiroğlu 2009; Özdoğan 1999, 2013).

In the EC period, large quantities of painted wares appeared in the ceramic assemblages at Çatalhöyük West and Can Hasan I (layers 3-2). On the basis of painted styles, Mellaart separated Çatalhöyük West into two phases, EC I and EC II (Mellaart 1965). EC I is characterised by red-on-cream, while EC II by dark-on-light wares. At Çatalhöyük West, mud-brick rectangular houses were comprised of a series of small, cell-like spaces, with plastered walls and surfaces (Biehl *et al.* 2012; Erdoğu 2008). Çatalhöyük West shows similarities with Can Hasan I layer 2B, particularly in terms of building layout, use of mud-brick and construction of internal buttresses. The use of buttresses was also observed in the Lake District sites (Hacılar, Kuruçay) and in the Marmara region (Aktopraklık, Ilıpınar) (Biehl *et al.* 2012). One distinctive difference between central and western Anatolian villages is the settlement organisation. The concept of densely clustered houses in central Anatolia is not paralleled in the Lake District, Aegean coast and Marmara region, where houses were usually built in parallel lines with open spaces between them. Contemporary with Çatalhöyük West and Can Hasan I are the site of Tepecik-Çiftlik and Köşk Höyük (III/II) situated in Cappadocia. There, the pottery remained monochrome with some painted wares reminiscent of Lake District sites (Öztan 2012). A typical morphological feature at these sites is bead-rims (Çilingiroğlu 2009). On the other hand, it seems that Köşk Höyük preserved some early Çatalhöyük East elements that are not discovered at the EC West mound. Parallels are documented in the practice of intramural burial, plastered skulls and the use of pottery with relief decoration (Öztan 2012).

The periods relevant here include the LN levels of Çatalhöyük East mound (levels V-0 in Mellaart's stratigraphy) and EC Çatalhöyük West. The LN phase would be contemporary with the late 7th millennium sites in central-western and north-western Anatolia. Unfortunately, the excavations at Çatalhöyük still have not explained the nature of the transition between LN and EC at the two tells (Marciniak & Czerniak 2007).

5.4.2. North-western Anatolia

The investigated sites in north-western Anatolia surround the Sea of Marmara – to the east are Fikirtepe, Pendik, Yarimburgaz, Yenikapi, and to the south, close to Lake Iznik, are Barçın Höyük, Menteşe, Ilıpınar Aktopraklık and Demircihöyük (Figure 5.3). These sites are dated to the LN and EC, although not all are contemporaneous. In absolute dates, the whole period of LN-EC is considered to span approximately 6400-5500 BC (Karul 2011; Özdoğan 2013).

On the basis of strong parallels in pottery styles, the Neolithic phases of several sites are ascribed to the Fikirtepe culture (Fikirtepe, Pendik, Yarimburgaz, Ilıpınar, Menteşe, Demircihüyük). According to Özdoğan (1999) the Fikirtepe settlement consists of two levels which belong to the "Archaic" and "Classic" phases of the Fikirtepe culture. Secure stratigraphy and radiocarbon dates, however, are lacking for the type-site of Fikirtepe and nearby Pendik, so the excavation and dating of sites near Lake Iznik provided better information about the development of the Neolithic in the region. The earliest phase at Ilıpınar (X-IX) was initially dated to 6000 BC and taken as approximately marking the beginning of the Fikirtepe culture (*ibid.*, 213). Subsequently, some radiocarbon dates in the region, from Menteşe and Barçın Höyük, moved the dates for the beginning of this cultural group back to 6400–6300 BC. The earliest, "Archaic Fikirtepe" is best documented at Menteşe, although it exists at Barçın Höyük. The "Classical Fikirtepe" phase is known from Ilıpınar X, Barcın Höyük, Pendik and Fikirtepe.

Distinctive pottery constitutes the main observable link between these settlements, but other cultural characteristics vary notably from one site to the other. This applies to settlement pattern, architectural styles, subsistence strategies (faunal and botanical remains) and burial customs. Firstly, the costal settlements are usually flat or near-flat (Fikirtepe and Pendik), while tell sites appear in the plains (Menteşe, Barcın, Ilıpınar, Aktopraklık). Even though they were chronologically and regionally (and culturally?) related, the settlement architecture ranges from the rectangular mud-slabs (pisé, mud-slab walls and wattle-and-daub superstructure) recovered at Barcın, Menteşe and Ilıpınar, to semi-sub-terranean circular and semi-circular wattle-and-daub huts as in Fikirtepe, Pendik, Aktopraklık C (Karul 2011; Özdoğan 1999, 2013). At Ilıpınar, three types of buildings are discovered, two of which are contemporaneous (c. 6000 BC), while the third is of later date (c. 5700 BC) (Roodenberg 1999). Ilıpınar X-VII contained post-wall houses lined with mortar alongside the mud-slab buildings. From Level VI, the architecture is more of central Anatolian type with mud-brick as the main construction material. This shift happened after a break in the occupation, when almost all Level VI buildings had been destroyed (Roodenberg 1999). Interestingly, some mud-brick houses at Ilıpınar VA and Aktopraklık contain internal buttresses that were also found in central Anatolian settlements (Can Hasan 2B and Çatalhöyük West) and in the Lake District (Hacılar and Kuruçay) (Biehl *et al.* 2012). Burials can be found within the houses (usually under the floors) but also in outdoor contexts, individually or as part of a cemetery. Skeletal orientations and the presence and content of grave goods have no consistent patterns within the region of the Fikirtepe culture (Karul 2011).

Despite all the above differences, some authors believe that the similarities in material culture found at almost all sites are a strong claim for “cultural unity” (Karul 2011, 63; Özdoğan 2011). The typical pottery repertoire includes dark monochrome burnished ware, occasionally decorated with shallow incisions in simple geometric motifs. Typical shapes are S-profile bowls and jars, hole-mouth vessels, vertical tubular lugs, ‘Fikirtepe boxes’ with incised decoration and cult tables. The other common finds include bone objects, particularly spatulas (Figure 5.6) and chipped stone tools and distinctive bullet cores (Gatsov 2009; Özdoğan 1999). Some features like stone vessels, figurines, and beads, known from other Anatolian villages, are very rare or not present at all at these settlements (Karul 2011).

5.4.3. The Aegean (Melos)

The circulation of this obsidian unsurprisingly extends to the Greek islands and mainland as well as western Anatolia (today’s Izmir region) (Figure 5.3). The inner zone located in the Cyclades, is well characterised by only two settlements within the vicinity of Melos (Saliagos and Ftelia), while on the Greek mainland, mainly in Thessaly and Franchthi Cave in Peloponnese, it has been well-studied and of Melian obsidian dominates the chipped-stone assemblages (e.g. Karimali 1994; Perlès 1990; Torrence 1986). The crucial areas for this present study were therefore sites surrounding the Melian core zone, that is northern Aegean (Macedonia), north-eastern Aegean (including Thrace and the Troad) and the eastern Aegean (central-western Anatolia), while to the south is Knossos on Crete, also described in Chapter 7.

5.4.4. The Cyclades

Saliagos and Ftelia are sites dated to the LN period, or the late 6^{th} and 5^{th} millennia BC. These settlements are located closest to the Melian sources and as a result they are considered to belong to the inner area. The complexity of the distribution of obsidian in the Aegean is explained in Chapter 7, mainly related to the lack of EN and MN settlements in the Cycladic core that would be contemporary with the LN-EC period (late 7^{th} / early 6^{th} millennia BC) in the eastern and north-eastern Aegean and EN and MN settlements in Thessaly and Macedonia. Conversely, when LN settlements were established in the inner area (c. 5000 BC), we are presented with sparse information about the sites and obsidian assemblages in the eastern Aegean contemporary to the above sites in the Cyclades, with the only excavated settlements on the islands of Samos (Tigani) and Chios (Emporio). As discussed, this is largely related to possible abandonment of sites in central-western Anatolia sites 5700 BC (Çilingiroğlu 2009). It may also be that research questions are being focused on the earlier (Neolithic) development and so insufficient data has been produced and published for the post-5500 BC settlement in those other areas (particularly north-western Anatolia) that some describe as "the dark age in prehistory of Northwest Anatolia" (Roodenberg & Alpaslan-Roodenberg n.d.).

In the Cyclades, Renfrew defined the Saliagos culture which includes a few sites dated to the Aegean Late Neolithic in the 5th millennium BC. It is named after the type-site of Saliagos located (today) on an islet between Antiparos and Paros. Distinctive light-on-dark painted pottery and obsidian tanged points and ovates were found there and also identified at several other locations in the Cyclades, Vouni on Antiparos, Ftelia and Mavrispilia on Mykonos, Zas I on Naxos, Agrilia on Melos, Akrotiri on Thera and Minoa on Amorgos (Broodbank 2000, 123; Cherry & Torrence 1982; Evans & Renfrew 1968).

5.4.5. The North-eastern Aegean

This region is not well explored and on the basis of its geographical position and the results of obsidian provenancing, it is analysed as a single region. The key area is the Troad peninsula located in the north-eastern corner of the Aegean (Figure 5.3). The Neolithic of the Troad has not been intensively investigated and therefore does not have clearly defined chronological terminology equated with clear stratigraphic transitions or phasing. Being located partly between the north-western Anatolian Fikirtepe culture and eastern Aegean settlements, means that elements recovered from here can be linked to both regions (Çilingiroğlu 2009). Late 7th / early 6th millennia sites (LN-EC) have been excavated at Coşkuntepe (in the Troad), at Uğurlu V-IV (on Gökçeada (Imbros) c. 17 km away from the Troad mainland) and at Hoca Çeşme IV-III (Thrace), with the following pottery types: red-slipped wares, deep bowls with S-shaped profiles, hole-mouth jars, vertically placed tubular lugs and bead-rims. Coşkuntepe also contained a fragment of incised 'Fikirtepe box' that is related to the sites in north-western Anatolia (Çilingiroğlu 2009). During the late part of the 6th millennium (Aegean LN / Anatolian Chalcolithic), the remains found at Hoca Çeşme II-I in Thrace, Uğurlu II and Gülpınar in the Troad are assigned to the Beşik-Sivritepe period, characterised by distinctive material culture, principally the use of black burnished pottery (Erdoğu 2011; Takaoğlu 2006). This ceramic link could also be related to Emporio X-VIII and Tigani I-III. Pattern-burnished decorated pottery occasionally occurs at Gülpınar and Hoca Çeşme I that is analogous with Vinča A-B (Özdoğan 1998; Takaoğlu 2006).

Apart from links that can be made in pottery styles between this group and the other sites, the architecture does not find such common ground. The houses are generally not well preserved at these settlements, ranging from stone-built rectangular ones at Uğurlu II to post-hole types at Gülpınar. Hoca Çeşme IV-III contained round pits that were replaced with rectangular wattle-and-daub built structures in phase II (Erdoğu 2011; Özdoğan 1998; Takaoglu 2006).

5.4.6. The Eastern Aegean

This region geographically includes the stretch of central-western Anatolia (the areas around the modern town of Izmir) and the Aegean islands of Chios and Samos located immediately off the Anatolian littoral. Until the 1990s the prehistory of this region was poorly understood. In the 1990s large-scale excavations took place on the western Anatolian mainland revealing that this area was densely populated during the Neolithic and Chalcolithic periods (7th and 6th millennia BC). The islands, on the other hand, remained relatively unexplored with only three sites that can be considered relevant to this study. Ayio Gala on Chios should correspond to Anatolian LN-EC or mainland Early Neolithic, while Emporio X-VIII (Chios) and Tigani I-III (Samos) belong to later periods, starting from the Late Neolithic (in Greek mainland chronology). Sites located on the Anatolian mainland (Ulucak, Ege Gübre, Yeşilova, Dedecik-Heybelitepe, Çukuriçi Höyük) have been excavated by Turkish or German-Turkish and Austrian-Turkish teams, and in the literature, they have typically been discussed as part of the narrative of Anatolian prehistory (e.g. Özdoğan *et al.* 2012). The majority of obsidian found at these settlements links them, however, to the Aegean sources and, in Chapter 7 it will be shown that this relation with the Melian sources and by extension Aegean communities is a long-term phenomenon.

The Anatolian mainland settlements are tell sites that span from the LN period (second half of the 7th millennium) through to the EC period (6th millennium), and often contain the Bronze Age and later in historical levels. They most commonly consist of mud-brick rectangular houses built on stone socles that are organised in linear order or around a large courtyard. This is similar to the architecture found at some of the sites in north-western Anatolia (Ilıpınar, Aktopraklık). The architecture of Ege Gübre is, however, unique in the region as it contains round and rectangular buildings arranged around a central courtyard, possibly used at the same time. The round structures were probably made of wattle-and-daub, while the rectangular examples have mud-brick walls on stone foundations. The settlement was also surrounded by a stone wall and this feature is not known from other sites. The co-existence of circular architecture and enclosure wall is unusual and, apart from Ege Gübre, it is only evidenced at Hoca Çeşme III-IV (Sağlamtimur 2012). In this period, island habitation is evidenced so far only on Chios, at Ayio Gala cave, and there the stratigraphy was not well-preserved (Hood 1981).

The ceramic types are mainly represented by light monochrome wares, while painted wares represent only a very small percentage of assemblages (Figure 5.7). Sherds with impressed decoration are found in small percentages while there is a clear absence of any incised (Fikirtepe box type) pottery (Çilingiroğlu 2009, 2010). Because of this rare occurrence of painted pottery, Çilingiroğlu (2009) argues that Mellaart's division between LN and EC could not be applied at these sites. Some scholars working in Anatolia believe that the eastern Aegean settlements could have been influenced by inhabitants in the Lake District to which the Aegean coast is connected through the Gediz River basin (Çilingiroğlu 2009; Lichter 2005).

5.4.7. The North-western Aegean

The Neolithic of the Aegean is best known in Thessaly and Macedonia where research has a long tradition going back to the beginning of the 20th century. The Neolithic sites discussed here belong to today's Greek Macedonia, while neighbouring Thrace, to the east, is not well explored and represented by only a small number of sites. The Neolithic of eastern Macedonia (the Drama and Serres basins) is perhaps best known from excavations at two tells in the Drama plain, Sitagroi and Dikili Tash. Central Macedonia is the area between the Axios and Strymon rivers (the Thessaloniki area) with Thermi, Stavroupoli and Vassilika, while the western Macedonian sites include Servia, Nea Nikomedeia, Makriyalos, Paliambela, Dispilio and Mandalo.

A primary characteristic of this area is the co-existence of two very specific settlement types – one flat-extended with low density houses of diverse forms (Stavroupoli, Thermi, Makriyalos, Vassilika, Kleitos) and another type in the form of tells (Paliambela, Mandalo, Sitagroi, Dikili Tash). The latter have many parallels in Thessaly. The flat sites are distinctive for the Macedonian LN period, located mainly in its central and western parts. They are large settlements that expand laterally, often shifting from LN I to LN II in the form of horizontal stratigraphy (unlike the vertical development of classic tell sites). They are often surrounded by enclosing ditches and walls. Such ditches and walls are found both at tell and flat sites (e.g. Servia, Nea Nikomedeia, Makriyalos, Paliambela, Mandalo, Dispilio; also in Thessaly the enclosure walls known from Sesklo and Dimini). They are interpreted as a sign of social organisation in which collective work took place in the construction of communal structures (Andreou *et al.* 1996; Souvatzi 2008, 178). Other common features are cobbled courtyards with hearths, ovens and large refuse pits used as storage, workshops and for food processing. Pit-dwelling houses were used at LN Makriyalos, Thermi and Stavroupoli and it seems that they are associated with flat-extended settlements. In the region more generally, three types of buildings are known – post-framed houses (e.g. Servia, Kleitos, Paliambela, Dikili Tash), mud-brick houses on stone foundations (e.g. Thermi, Stavroupoli) and pit-dwellings (Thermi, Stavroupoli, Makriyalos) (Andreou *et al.* 1996; Pappa & Besios 1999b; Souvatzi 2008). The MN ceramics include brown and red-brown slipped wares, while the characteristic pottery of LN I is black burnished pottery that is believed to have spread to here from the Balkans, where it dominates assemblages. The shapes are typically carinated, large open bowls and jars. The appearance of black-on-red ware, domination of black burnished pottery and disappearance of red-brown ware mark the LN II phase. The decoration in the LN II period includes pattern burnished, incised and graphite wares (Andreou *et al.* 1996).

5.4.8. The Carpathians

The Carpathian obsidian considered in this thesis only address the southern extent of its distribution, across the central and southern Balkans. The material from the central Balkans is from an area that in the past had not been the subject of intensive characterisation research. This whole region lies at the interface between two obsidian distribution zones (Melian and Carpathian), and so a more extensive sample, in terms of site numbers, was needed in order to define the nature of the interface (Figure 5.1). The inner zone in the vicinity of the sources is not well defined (see Chapter 8) while a site that is not in the geographical core but belongs to a 'cultural' core is Vinča-Belo Brdo (described below).

The periphery is located in Serbia, Croatia and Bosnia, roughly in the mid-Danube region (Figure 5.3). The sites discussed in Chapter 8 are located in the central Balkans (today's Serbia), the majority of which are dated to the period between 5500 and 4500 BC. They could be ascribed to two zones, one north of the Danube, in Pannonia (northern Serbian sites

Opovo, Potporanj Kremenjak and Vršac-At), as a link between the central Balkans and the Carpathian basin, and the other south of the Danube, in the Morava valley (e.g. Belovode, Masinske njive, Drenovac), connecting the central and southern Balkans and the Aegean.

5.4.9. Late Neolithic Vinča period

Starting from around 5500 BC until 4500 BC, the Late Neolithic of the central and parts of the western and northern Balkans is termed the Vinča period, named after the tell site at Vinča-Belo Brdo. It extends over a large territory, although several regional groups can be identified (Garašanin 1979; Tripković 2013). The central Balkan LN is characterised by the development of classic multi-period tell settlements (e.g. Vinča-Belo-Brdo, Gomolava, Supska, Parta, Uivar), although flat extended settlements with horizontal stratigraphy are also present (e.g. Masinske njive, Selevac, Opovo). Some of the settlements were surrounded by large ditches (e.g. Vinča-Belo Brdo, Gomolava, Kormadin, Crkvine, Uivar), which might suggest collective work by the community as is claimed for LN settlements on the Greek mainland (Tripković 2013). As previously mentioned, tell settlements often witness an initial phase consisting of pit-dwellings while the architecture of subsequent phases typically includes larger above-ground rectilinear buildings (*ibid*.). The latter structures comprised post-framed houses with wattle-and-daub walls and two or more rooms. Some of the houses had walls decorated with bucrania, recorded at Gomolava, Komradin and Banjica. Ovens, storage vessels and pits were found inside the houses, suggesting that production activities and food-processing now took place in interior spaces (Bailey 2000; Chapman 1981; Stevanović 1997; Tringham *et al.* 1985; Tringham & Krstić 1990; Tripković 2013).

The distinctive Vinča ceramics include fine and semi-fine dark ware, black or grey in colour, known as black monochrome. Typical decoration is ribbed-channel decoration. Sometimes the surfaces of the vessel were burnished which gives them a metallic appearance. Another type is light grey and semi-burnished and sometimes has a 'greasy glow' (Garašanin 1978). EN Starčevo style barbotine decoration on coarse ware ceramics is still represented in this period. Apart from black burnished pottery, the use of figurines is a very distinctive feature of Vinča period material culture. The classic types have flat polygonal faces, accentuated noses (sometimes called a 'bird face') and a cylindrical lower body with complex decoration (Figure 5.7). At the end of the 6^{th} millennium, some Vinča sites (e.g. Belovode) have revealed evidence for the beginning of metal production (Borić 2009; Radivojević *et al.* 2010).

Vinča-Belo Brdo has seven metres of stratigraphy formed by consecutive Neolithic occupation. This makes this the highest tell in the region. Its importance socially is also accentuated by the richness of the material culture recovered there, particularly the quantities of imported obsidian, *Spondylus* shell and malachite beads. The accumulation of obsidian at a certain stage of its history c. 9-7m below the modern surface, or between c. 5300-5000 BC) has been accepted as indicating its role as a preferential centre for obsidian exchange (Williams-Thorpe *et al.* 1984; Chapman 1981, 81). Thus, 70% of the chipped stone from this site was obsidian at any given phase. Therefore, even though it was c. 500 km as-the-crow-flies away from the sources in the Carpathians, it will be considered in the thesis as the 'inner' zone for the distribution of the Carpathian obsidian.

5.5. Summary

The purpose of this chapter has been to offer some background to the Neolithic societies of Anatolia, the Aegean and the central Balkans. The communities that lived in these areas used and exchanged obsidian and obsidian assemblages from 20 sites were studied as part of this project. The large size of the regions required a sampling strategy in terms of sites within an area but also in terms of the selection of obsidian artefacts within wider lithics assemblages (in those cases where there were very large assemblages). For this project, I chose to examine sites and material that was located in the outer areas of obsidian distribution while also paying attention to inner and intermediate sites via published records. The study of the peripheral areas is beneficial because of their participation in long-distance exchange. Furthermore, the purpose and mechanisms of obsidian exchange do not appear to be due to necessity and so are likely to vary in different communities and periods.

Following this overview of the sites and regions, as well as the methods employed in the analyses of obsidian assemblages (Chapter 4), in the next thee chapters (Chapter 6-8) I will present the results of pXRF and technological analyses of obsidian from the study sites following the structure set out in Table 5.1.

Chapter 6. Central Anatolian obsidian

6.1. Introduction

Chapters 6, 7 and 8 discuss obsidian assemblages from each geographic case study area, including a review of material from the so-called inner, intermediate and outer zones provisionally defined with reference to the early spatial models of Renfrew et al. (1968b), as described in Chapter 5 (section 5.1.2.; see table 5.1.). In each of these areas, my strategy will be to illustrate the inner and intermediate zones by describing assemblages from one or two exemplar sites for each based upon a review of published reports. Thereafter, a detailed examination of assemblages from sites in the outer zones represents the main part of each of these three chapters, and the current chapter will focus on the Anatolian region. Previous chapters emphasised the fact that the 'contact' zone studied by Renfrew and his colleagues in Anatolia was focused on sites to the east and south of the obsidian sources, while the circulation of obsidian towards the west was not receiving comparable attention. As will be seen below, following the compositional characterisation of assemblages from sites in north-western Anatolia (Aktopraklık, Barcın Höyük, Pendik and Fikirtepe) and those in the central-western Anatolia (Ege Gübre, Yeşilova and Ulucak), it has become evident, that these two areas belong to different spheres of interaction (from the marked differences in obsidian acquisition and consumption). The sites, therefore, represent an outer zone of Cappadocian obsidian exchange (Figure 6.1) and the results of analyses of these assemblages will be discussed later in this chapter (sections 6.4. and 6.5.). Figure 6.2 shows that pieces of Cappadocian obsidian were frequently found in obsidian assemblages with a Melian composition, creating an overlap zone. The results of the pXRF and technological analyses (based on methods described in Chapter 4) are given for each assemblage.

Section 6.4.6. briefly reviews knapped stone assemblages that were dominated by other raw materials (flint and chert) in order to clarify the nature of these assemblages in relation to the role of the much less frequent obsidian pieces.

To recap, the inner and outer zone sites included for the analyses of the circulation of Cappadocian obsidian belong to the Anatolian LN/EC periods, starting in the late 7th and early 6th millennia BC and stretching up until the mid-6th millennium BC.

6.2. Quantity vs. distance: westward dissemination of Anatolian obsidian

The distances used in these plots between sources in Cappadocia and archaeological sites are expressed 'as-the-crow-flies'[11]. Settlements represented in the graph in Figure 6.3 are dated to the mid/late 7th and the beginning of the 6th millennia BC (upper levels at Çatalhöyük East VI-0 and Çatalhöyük West, Canhasan I, Köşk Höyük, later phases of Hacılar, Höyücek and Kuruçay) as they are broadly contemporary with the sites considered in this study. The character of assemblages in this inner zone can be described not only quantitatively, but also through the diversity of obsidian tool types and evidence on-site knapping activities. Section 6.3.1. discusses the material from the Çatalhöyük East and West mounds. To the west is Erbaba, a settlement that is largely supplied with Cappadocian obsidian (c. 70%), although the variety of retouched tools (e.g. projectile point and scraper types) in these assemblages appears to be smaller (Bordaz & Bordaz 1982).

Around 6000 BC, this Cappadocian inner zone of obsidian access saw the establishment of several new large settlements (Tepcik-Çiftlik, Köşk Höyük) in the vicinity of the quarries (Figure 6.1), and this development has been linked, amongst other things, to more extensive trade in obsidian (Gérard 2002; Marciniak & Czerniak 2007, 126). Indeed, Renfrew, Dixon and Cann (1966, 48) noted that "the Early Chalcolithic being renowned as a time when new obsidian sources began to be exploited and the trade in Anatolian obsidians became more cosmopolitan".

6.2.1. Anatolian routes: Distance and geographical evaluation

In the western Anatolia, obsidian has been recovered from a number of settlements. The intensity of these contacts is discussed below, but what emerges from Figure 6.1 is that the pathways of communication diverge in two directions. One leads towards the north-west and the Marmara region, probably via the Eskisehir and Iznik Lake regions. The other route runs towards the Aegean via the Lake District area (Hacılar, Kuruçay Höyük and Höyücek). The routes towards the Troad and the northern Aegean are to be explored in future research. These areas could have been in communication with either sites in the Marmara region or those in the eastern Aegean to the south.

---

[11] Calculations are based on Google earth location search and ruler tool.

Central Anatolia, with its volcanic massifs, is located on a plateau surrounded by the mountains which created an island-like setting (Schoop 2005). For travelling outside this region one needed to be aware of mountain passes and deserts in accordance with climatic conditions. Due to the high altitude, the plateau and the mountain ranges were covered in snow during the winter period, while the hot winds might have prevented travel during summer months. Ancient Neolithic routes are not well researched and most of the information about possible routes comes from much later Bronze Age and Classical sources (Barjamovic 2011; Efe 2007; Knitter *et al.* 2013; Şahoğlu 2005).

The sites in the Marmara region are located some 500-550 km from the sources in Anatolia, but it is worth also noting that the overall number of sites investigated in the northern parts of Anatolia is very low in any prehistoric period, to the extent that, when observing the obsidian map alone (Figure 6.1), it is noticeable that there are areas with not much information about LN sites between central Anatolia and northern and north-western Anatolia. The major routes between these two regions seem to go via Eskisehir, Iznik and towards Marmara or the Troad (Efe 2007; French 1967). According to Efe (2007, 60), a 'Great Caravan Route' ran through Anatolia diagonally, connecting Cilicia and north-western Anatolia and the Troad. To the west, the highlands are cut by river valleys (Büyük Menderes and Küçük Menderes) facilitating east-west communication between inner Anatolia and the Aegean coast. The central-western Anatolian sites (Ulucak, Yeşilova, Ege Gübre, Çukariçi Höyük, Dedecik-Heybelitepe), are situated close to the coast, some 600-660 km from the Cappadocian obsidian sources. These settlements are located between the Gediz and Küçük Menderes river valleys through which they are connected with inner Anatolia (Çilingiroğlu 2009; Şahoğlu 2005).

Finally, in the Troad, Thrace and the northern Aegean, settlements are located at distances that range from around 700-800 km from the Göllü Dağ and Nenezi Dağ sources. If we refer to our knowledge of Bronze Age connectivity, then through the Troad, Anatolia is also connected with the northern Aegean islands, Thrace and farther west with the Greek mainland (Efe 2007; Şahoğlu 2005).

6.3. Reconstructing interactions: The results

The following section sets out the results of elemental and techno-typological study of obsidian assemblages in Anatolia and the eastern Aegean. This chapter examines assemblages with obsidian that was obtained primarily from the sources at Göllü Dağ and Nenezi Dağ. As one goes from east to west (inner to outer zones), the assemblages from the inner zone (central Anatolia) are described (section 6.3.1.), then material from the 'intermediate zone' (the Lake District; section 6.3.2.), and finally, the main emphasis is on the sites in the Marmara region, in section 6.4. (Figure 6.1). The sites in the northern Aegean and the Troad and eastern Aegean also received Cappadocian obsidian. The Melian obsidian assemblages from these sites are described in sections 6.5.1. and 6.5.2. It must be emphasised here that central Anatolian and Lake District assemblages are discussed using published sources, while the primary research for this thesis was concerned with those sites in the outer areas (see Chapter 5). To recap briefly, the provenancing of obsidian at those sites was undertaken using a pXRF instrument and the data is compared to elemental data from the source samples using the same technology (detailed in Chapter 4). The database used for techno/typological examination is presented in spreadsheets in DATA 5, following the *chaîne opératoire* model developed by Inizan et al. (1992; see Chapter 4).

6.3.1. Inner zone: Central Anatolia (Çatalhöyük)

Only small number of sites is excavated in this area with Çatalhöyük the best known in terms of settlement size and excavation scale. The site is located in southern Anatolia, in Konya Plain, on the eastern bank of Çarşamba River, an important fresh water sources for Konya Plain. The characteristics of the archaeology of the site are described in more detail in section 5.4.1 (and Appendix 1), while here I will put emphasis on the obsidian assemblages from the site.

For the purpose of this study, the assemblages from later Neolithic levels on the East mound (IV-0; Q-T) and Early Chalcolithic levels on the West mound are considered. The site is located c. 150 km from the sources at Göllü Dağ and Nenezi Dağ and they represent the major raw material used, on average, for 96% of the total lithics component (Carter & Milić 2013a; Ostaptchouk 2009). In several instances, occasional use of other obsidian types can be documented, namely, the Acıgöl source in northern Cappadocia and the Bingöl/Nemrut Dağ in eastern Anatolia (Carter *et al.* 2008; Milić *et al.* 2013).

6.3.1.1. Provenance

Trace elemental analyses of obsidian conducted at this site constitute one of the most comprehensive analytical programmes, involving over 750 artefacts from all levels of the mound. Since the first analyses by Renfrew et al. (1966) using OES, new methods have been employed (EDXRF, PIXE, LA-ICP-MS, SEM-EDS, ICP-AES, ICP-MS and pXRF; Carter *et al.* 2005b*;* Carter 2011). The elemental work was done hand-in-hand with the technological study and has produced interesting results related to the consumption of obsidian throughout the Neolithic and Chalcolithic sequences (Carter *et al.* 2005a; Carter & Milić 2013a). We now know that the earliest phases of the settlement (pre-XII-VI; G-O) are characterised by a predominance of Göllü Dağ (c. 90%) over Nenezi Dağ obsidian. This trend changed in the second half of the 7th millennium BC (levels V-III or P-T), when use of Nenezi Dağ material increased to become the principal source from level M - c. 87% (Carter & Milić 2013a). Similarly, occupants of the upper most settlements (levels II-0, dated to the last two centuries of the 7th millennium; Marciniak & Czerniak 2007) seem to prefer Nenezi Dağ obsidian which represent c. 75% (T. Carter pers. comm.). The situation again changed for the EC (I-II) West mound. From this settlement, a total of 97 pieces were chemically characterised using EDXRF and ICP-AES techniques and the results have shown roughly equal quantities from each source, which equates to a real terms increase of Göllü Dağ over Nenezi Dağ (Carter *et al.* 2008b; Ostaptchouk 2009)[12], in contrast to the data from the East mound, even in its upper most phase.

6.3.1.2. Technology

The focus here is on the two major sources at Göllü Dağ and Nenezi Dağ. Episodic occurrences of Bingöl/Nenezi Dağ obsidian reported from later levels on the East mound (VII-II; M-T) are mainly blade products (Carter *et al*. 2008a), and similarly, Acıgöl pieces were produced in a similar manner and it is likely that all these rare artefacts have been brought to Çatalhöyük as ready-made tools. Turning to the main obsidian types, the raw material change from Göllü Dağ to Nenezi Dağ, brings some concomitant changes in

[12] Visual characterisation was part of obsidian study along with techno-typological by all project members. Separate study in which visual characterisation was tested against chemical was also done (Milić *et al*. 2013). This experience was invaluable for the examination of obsidian assemblages and sampling strategy at study sites.

knapping practices as a pressure-flaked blade technology replaced an earlier percussion industry (Carter *et al.* 2005a; Connolly 1999). Nenezi Dağ obsidian as the main raw material was used for the manufacture of pressure-flaked blades (Figure 6.4), although the same technique is employed for the Göllü Dağ material. The percussion technique is less frequently used. The production presumably took place within some of the households, even though most of the material was found in midden deposits outside the houses. The remains include mainly de-corticated flakes, rejuvenation pieces and exhausted cores and the variety of tools made on blades. The exhausted cores are occasionally further used as *piece esquillee* (splintered pieces) type tools which indicates the full or exhaustive exploitation of the raw material (Carter & Milić 2013a, 447; Was 2006). The most distinctive tool types are bifacially pressure-flaked projectile points, probably manufactured within the houses. The blanks for these tools are probably knapped at the workshops at the Nenezi Dağ quarries and were made from large opposed platform cores, probably using percussion technology (Carter & Milić 2013a, 422). The main types of projectile points are barbed and tanged along with some unshouldered and untanged examples made in various sizes (Conolly 1999). The number of projectile points decreases in later levels and become particularly rare in the EC period. Other distinctive tools are large scrapers made on Nenezi Dağ thick rejuvenation flakes, while other formal tool types are regular end-scrapers on blades, notched tools and perforators.

As mentioned above, Göllü Dağ and Nenezi Dağ obsidian appear to have been equally used sources in the 6th millennium (EC at Çatalhöyük West). Both raw materials were employed for knapping pressure-flaked blades, while percussion is less common. In this period, there are also visible products of the on-site reduction of prepared cores, in the form of a number of flakes and rejuvenation pieces. Surprisingly, only a very small number of cores and core fragments are found at the site. Regular prismatic blades are the most common tools. The striking contrast to the East mound is the rarity of projectile points at the West mound (Ostaptchouk 2009), suggesting that those few spear-heads that do exist in the EC period had a different function, possibly as drills, rather than in hunting (*ibid.*).

Even though the variability of tools decreases, the raw material exchange became more extensive, possibly through the establishment of settlements in the vicinity of the sources (Marciniak & Czerniak 2007), but also through exchange with the peoples in the western regions of the Marmara and central-western Anatolian region some 600 km away. Renfrew et al. (1966, 48) suggested that the distribution of obsidian in the Chalcolithic period becomes more widespread, although characterisation studies have yet to be conducted on a representative sample of LN/EC assemblages in the region, including those in the inner zone (e.g. Köşk Höyük, Canhasan I) and particularly those located in the transitional zone (e.g. the Lake District).

6.3.2. The Lake District: the intermediaries?

The Lake District is located in Burdur and Isparta regions, on a high plateau separated from the Mediterranean coast to the south by the Taurus Mountains range. This is well researched area with a numerous sites discovered during surveys in 1950s and 1960s, while number of them were systematically excavated in the next decades (Hacılar, Bademağacı, Kuruçay, Höyücek; Duru 2012). Excavations at the tells revealed successive Neolithic phases EN, LN and EC (c. 8000-6500 BC).

Sites in the Lake District are located some 350 and 400 km from the obsidian sources in Cappadocia. Currently, there is no published analytical information about the origin of obsidian from these settlements[13], apart from the macroscopic observation of Höyücek assemblages indicating Göllü Dağ and Nenezi Dağ as sources (Balkan-Atlı 2005, 130). The relative percentage of obsidian is c. 12% at Kuruçay (Baykal-Seeher 1994, 106) and c. 10% at Höyücek (Balkan-Atlı 2005, 130), while Hacılar displays an unusually higher proportion (42%) of obsidian in its lithic assemblage (Mortensen 1970, 153–154). Renfrew et al. (1966, 37-38) have analysed four pieces from Hacılar and the results were assigned to the Cappadocian source group (Acıgöl-Topada outcrop).

The dominant technology employed for the flint and obsidian industries is pressure-flaking. Obsidian prismatic and bullet cores seem to be imported de-corticated to be reduced *in situ* into regular blades. On-site knapping is suggested by the dearth of crested blades, rejuvenation pieces and general waste material. Some of the cores from Höyücek still have cortex and crested edge preserved, indicating the form in which they could have been brought to the settlement. A core from Kuruçay has a groove below the platform (Baykal-Seeher 1994) and this is also seen in Hacılar (Mellaart 1970, 449; Fig. 168.a). The metric analyses of obsidian cores show that even though they are reduced in the same manner as flint, they are

[13] Figs. 5a and 5b (Chataigner 1998, 286-287) lists Nenezi Dag as sources of obsidian in Hacılar.

nonetheless, finer and used more carefully for the manufacture of narrower blades than those in flint (Figure 6.5) (Balkan-Atlı 2005).

The modification of the edges of obsidian blades is occasionally done with simple retouching, while some standardised tools are limited to rare scrapers, borers and notched tools. Flint tools are slightly more varied including sickle blades, scrapers, and some pressure-flaked projectile points. The latter category is extremely rare in this region (Balkan-Atlı 2005, 133; Duru 2012, figs. 26 and 49; Mortensen 1970). Duru reported an obsidian point found at the site of Bademağacı (2011, fig. 79) that could be a rare example.

A unique use of obsidian at Hacılar is visible in the preserved inlaid obsidian eyes applied to clay figurines (Mellaart 1970, 181; figs. CLXXII and CLXXVI). Mellaart notes (*ibid*.) that this phenomenon is widely used in Hacılar for the decoration of anthropomorphic and zoomorphic figures and even on pottery. These are intriguing, but exceptional, examples of the use of obsidian.

6.4. The study region: Marmara sites

The investigated sites are surrounding the Sea of Marmara, Fikirtepe and Pendik to the east and to the south are Barçın Höyük, Aktopraklık, Menteşe and Ilıpınar, between Lakes of Iznik and Ulubat. Fikirtepe and Pendik are excavated during short campaigns in the 1950s and 1980s respectively while the sites to the south of Marmara, Barçın Höyük and Aktopraklık, are ongoing excavations, and these differences could well suggest varying excavation methodologies (as commented in sections 5.1.4. and 5.1.5.) The main characteristics of these settlements and the Fikirtepe culture are described in section 5.4.2.

The settlement history of the Marmara region begins in the Epipalaeolithic period, as recognised through survey collections of lithics that included bullet cores, single-platform cores, micro-bladelets, geometric and non-geometric microliths (Gatsov & Özdoğan 1994). This phase is known as the Ağaçli group, and for the period that follows, Özdoğan and Gatsov (1998) proposed that some settlements, particularly at Çalca and Musluçeşme, contained pre-pottery levels. These surveyed sites are larger than the Ağaçli sites, and were presumably permanent tell-type settlements. The chipped stone from these sites includes single-platform cores, micro-cores, blades and bladelets, and end-scrapers (Özdoğan & Gatsov 1998).

Turning to the bullet-core technology, Gatsov (2009, 125) suggested that its presence in Neolithic assemblages is linked to the local indigenous Ağaçli population. For the period between the 8th and early 6th millennia the use of single-platform prismatic cores is characteristic and has parallels with central Anatolia but also with sites in central-western Anatolia (Chapter 7). It involves a pressure-flake technique that allows the production of fine prismatic blades, ranging in size according to the stage of core reduction (Gatsov 2009). Besides the pressure technique, direct and indirect percussion techniques are also documented. This is related to the raw material choice in the region. The main raw materials are various types of flint and chert (*ibid.*) and small amounts of obsidian. In this section it will be shown that the obsidian assemblages, even though small, contain obsidian from at least two sources. The production, consumption and exchange of these obsidian types could, therefore, be considered as part of different processes. The bullet cores were found at almost all settlements in the Marmara region (including Ilıpınar, Menteşe, Fikirtepe, Pendik, Aktopraklık and Barcın Höyük). According to Gatsov (2009, 13), this technique is not present at sites to the north, in Thrace. The cultural layers that have bullet cores are dated between c. 6400 and 5600 BC, although there are no absolute dates available for Pendik and Fikirtepe. Özdoğan believes that the chipped stone assemblages from Pendik and Fikirtepe are important as they could represent "direct offspring of the Epipalaeolithic industries of the region" (Özdoğan 1983, 409).

The following section presents the results from elemental and visual characterisation and techno-typological examination of obsidian from sites in the Marmara region. This includes two eastern Marmara flat settlements: Pendik and Fikirtepe, and two tell sites: Barcın Höyük and Aktopraklık, located south of the Marmara Sea. In addition, I give an overview of the assemblages from tell sites at Ilıpınar and Menteşe, mainly studied by Gatsov (2008, 2009). Table 6.1. provides basic information about number of obsidian pieces and their percentage in overall lithics assemblages. Here, I also specify the reasons for the selection of artefacts analysed with pXRF, which is in many cases decided on the basis of their contextual deposition, i.e. those objects for which excavators determined to have come from secure and well-dated deposits.

The last section deals with Cappadocian objects that have been identified as a very minor component in some obsidian assemblages. The sites discussed are located on the Aegean littoral, in the northern (Hoca Çeşme and Uğurlu) and eastern Aegean (Ulucak, Ege Gübre, Yeşilova, Ayio Gala), where the majority of obsidian comes from the Melian sources. For that reason, these sites are described in Chapter 7, while this chapter provides only a brief review about the objects of Cappadocian origin.

Site	Site date	Obsidian total No	Obsidian % to other lithic	No of pieces analysed with pXRF	Seasons included	Remarks
Pendik	LN c.6400-5800 BC	96 (?)	5	42	1981-1982	Contexts are not detailed; the selection is done randomly. Some material sent to Rhodes for analyses. Some material cannot with certainty be ascribed to Pendik
Fikirtepe	LN c. 6400-5800 BC	42 (?)	1.9	10	All	The number is uncertain, some pieces were sent to Rhodes for analyses. Majority of artefacts are without labels / contexts; the number of 40 is a rough estimation
Barcın Höyük	LN 6400-6100 BC	c. 200	c. 15 (from all seasons?)	29	2009-2010	33 pieces were available for analysis. Material from the previous seasons is mixed deposits, while artefacts from excavations after 2010 were not available. Four pieces were too small for analyses
Aktopraklık	EC mid-6th millennium BC	177	5 (probably from all the periods)	34	Until 2011	Chemically are analysed only pieces from secure contexts of EC period. The LN material was not available as it was a subject of a PhD candidate at University of Istanbul

Table 6.1. Marmara sites - basic information about obsidian assemblages

6.4.1. Pendik

Fikirtepe and Pendik appear to contain a variety of chipped stone tools made both in chert and obsidian. According to Gatsov (2009), at Pendik all the activities related to core reduction were done on site. This is demonstrated through the presence of cores, crested blades, prismatic blades and retouched pieces. The main tools in the Pendik and Fikirtepe assemblages are end-scarpers, perforators, notched tools and retouched blades and flakes. Özdoğan (2008, 199) noted that two trenches at Pendik produced "about 200" obsidian artefacts, which comprised c. 5% of the total chipped stone assemblage (Özdoğan 1983, 409). During the fieldwork, I came across c. 90 pieces in the Pendik collection at Istanbul University, as a number of artefacts have in the past been sent to various laboratories for analysis, and records are not always complete. It must be added, that within the Pendik assemblage, there was a group of c. 50 obsidian pieces from a single bag (possibly therefore a single context) that had a paralkaline brownish appearance. Seven representative pieces were analysed and the results showed that they come from an eastern Anatolian source, most likely Bingöl B. This would be very unusual considering the distance between the source and the site (over 800 km as-the-crow-flies) and that it has never been discussed in the literature before. For these reasons, I describe them as 'unknown' objects and they are not included in the study because of their unclear origin and the suspicion that their provenance to Pendik is unreliable.

It is important to add that some assemblages from the Marmara sites could contain obsidian that comes from sources in north-western Anatolia, called Galatia-X (more in Chapter 3). Previous provenancing work on a small number of pieces from Ilıpınar and Pendik have identified the presence of obsidian from Galatia-X (Keller *et al.* 1994; Keller & Seifried 1990), however this was only a small sample (three pieces?) and the elemental data and visual description of the artefacts have not been published completely. In this study, I was not able to analyse geological reference material from Galatia-X, although the presence of such material in archaeological assemblages would be plausible. The analytical results from outcrops at Sakaelı-Orta and Yağlar are presented in Poidevin 1998, Annexe II, 167-168 and Keller and Seified 1990, Table 1, 70. Some of the outcrops show quantitatively very similar elemental results to the Nenezi Dağ sources. The wide range within some elements in the above publications could overlap with the composition of the Nenezi Dağ source. In addition, the visual characteristics of Galatia-X obsidian are also not published. My data is based on comparisons of the composition of the artefacts to available geological sources that we know were used in prehistory, however any new discoveries or confirmation of sources that also match the archaeological data could change the provenance of the material discussed here, especially from Pendik and Fikirtepe. In sum, the data that will be discussed in this chapter (for Pendik, Fikirtepe, Barcın Höyük and Aktopraklık) as Nenezi Dağ could in fact belong to the northern Cappadocian sources of Galatia-X, although this is currently not possible to confirm. It is, however, noted that the very characteristic transparent Göllü Dağ obsidian is also found at these sites, demonstrating that there was contact with the Cappadocian sources, such that if Nenezi Dağ is not the exclusive source of artefacts with these elemental compositions, it is most probably well represented on the basis of our archaeological (as well as geochemical) knowledge.

6.4.1.1. Provenance

In this research, 42 pieces have been considered, of which six are only assigned a provenance macroscopically, due to the small size of the pieces. The 3D plot of trace elements (Rb-Sr-Zr) revealed a variety of sources, coming from two source regions - Cappadocia (64%) and Melos (36%). The major Cappadocian obsidian sources are represented equally, Göllü Dağ, 14 (33%) and Nenezi Dağ, 14 (33%) (Figure 6.6). In other settlements, as described below, Nenezi Dağ obsidian is much more abundant than that from the Göllü Dağ source. Interestingly, artefacts of Melian origin came from both sources, nine from Adamas (22%) and five from Demenegaki (12%).

This is the first time that obsidian from Melian sources is identified at the sites in the Marmara region. The elemental signature of trace elements has given good parallels to the analyses of source material (Chapter 4). The macroscopic characteristics, colour, texture and transparency (see Chapter 4) of the Pendik and Fikirtepe pieces also correspond with Melian obsidian (Figure 6.8). The visual properties of the Galatia-X obsidian are not published, so do not permit potential identification of this obsidian at the two settlements.

6.4.1.2. Technology

The Pendik obsidian collection represents one of the most varied in terms of the frequency of different obsidian types, yet all the raw materials were obtained in the same form. To judge from the available sample at least, the excavations at Pendik have produced primarily finished objects, mainly blades, and small amount of flakes and other knapping debris (Figure 6.7). However, this seems to be an incomplete picture of the assemblage, since Gatsov (2009, 85) and Özdoğan (1983, 409) both refer to the presence of (now missing) obsidian blade cores at the site and therefore some manufacture might have taken place on site, even if this might not be true for all types of obsidian. The pieces of Melian obsidian (both Adamas and Demenegaki) found at the site were in the form of finished blades that are mostly intensively used - many with traces of use-wear - and in a dull condition, unlike the blades made of material from central Anatolian sources. Material sourced to Nenezi Dağ also appears in the form prismatic blades (n=11), most likely produced by pressure-flaking from bullet cores[14]. In addition, some debris material from this source is also represented (Figure 6.8). Finally, Göllü Dağ artefacts were found in the form of centre blades, but for Nenezi Dağ, it seems that material was brought as prepared core(s) and reduced on-site. One complete rejuvenation piece (OB 278) from the face of a bullet core was sourced to Göllü Dağ (Figure 6.8). These Göllü Dağ blades probably come from the same outcrop as they all have a distinctive transparent glossy appearance. Most of these central Anatolian artefacts do not have traces of use-wear or any modification which starkly contrasts with the pattern noted for Melian obsidian and could suggest different types of function for these objects. Anatolian pieces seemed to be thinner and more fragile and therefore may have been used for more delicate tasks (e.g. hair-cutting, shaving, cutting soft materials). It could be concluded that different obsidian types were brought to Pendik in different form, were recognised as different (either because of colour as isolated bits of stone or because of their inclusion in composite objects), and consequently used for different purposes. This implies diverse mechanisms of procurement that could have been socially, functionally or chronologically contingent and therefore poorly expressed by any single model of exchange.

6.4.2. Fikirtepe

The obsidian from Fikirtepe is unstratified and not associated with any distinct settlement or household features. Gatsov (2009, 85) noted that there are two production chains - blade and flake - represented within the Fikirtepe lithics. The flake industry is related to the reduction of

---

[14] Bullet cores were not found in the assemblage during this study but most likely existed according to Gatsov and Özdoğan (1994).

flint, while obsidian is always knapped in the form of prismatic and bullet cores into regular blades.

6.4.2.1. Provenance

Fikirtepe has a smaller obsidian collection than Pendik, counting 41 pieces or 1.9% of the total chipped stone assemblage (M. Özdoğan pers. comm.). Only 10 pieces were available for analysis from this site, and it appears that the rest of the material was sent for analyses in the past and has not yet been published or returned. The ten artefacts that I analysed showed diversity similar to that observed at Pendik: Göllü Dağ, 1 (10%), Nenezi Dağ, 5 (50%) and Melos, 2 (20%) (Figure 6.9). All of the Melian obsidian comes from the Adamas source, which differs from the results from Pendik, where both Melian sources are represented, though, again, the sample size is too small to make much of this.

Certainly, surprising is the high concentration of Nenezi Dağ obsidian since its distribution in these regions is not well documented (Chataigner 1998, 285-286)[15]. On the other hand, the occasional appearance of Göllü Dağ obsidian is not surprising, since its presence is recognised in the area of the northern and eastern Aegean and occurs even Thrace (Aspinall *et al.* 1972).

6.4.2.2. Technology

The obsidian sample from Fikirtepe is too small for a detailed interpretation[16], but it could be seen as broadly similar to the pattern seen in the Pendik assemblage (Figure 6.10). The Melian artefacts are all centre blades with use-wear visible along the edges. On the other hand, Nenezi Dağ obsidian is represented by a blade core with a rejuvenated back but not entirely exhausted. Furthermore, centre blades (n=5) and a rejuvenation piece were also found (Figure 6.11). Only one Göllü Dağ centre blade has been identified (Figure 6.11).

According to Gatsov (2009), at Fikirtepe (similarly to Pendik) blade manufacture from prepared cores has been done locally, but this could be most likely associated with only one

[15] Whether the reason for this is that material here characterised as Nenezi Dağ obsidian, in fact, belongs to the closer Galatia-X source is still to be determined.

[16] Note that some 30 known pieces from this site are currently not possible to locate.

source, Nenezi Dağ, while artefacts from the other two (Melos and Göllü Dağ) sources appear on the current limited evidence to have been produced somewhere else.

6.4.3. Barcın Höyük

The assemblages studied came from the 2009 and 2010 excavation seasons, with the rest of the material from previous seasons coming from either later (LC) or unstratified deposits or not available due to bureaucratic obstacles, according to the project director Fokke Gerritsen (pers. comm.). The obsidian that was available for study stratigraphically belongs to the LN phase, while the contexts in which they were recovered are mainly outdoor activity areas and pits. Only two blades were found within a household, on a house platform (Fokke Gerritsen pers. comm.).

Recently, a report on chipped stone from Barcın Höyük has been published, indicating that the total amount of obsidian from this site, from all periods is c. 200 or c. 15% of the total of the lithic material (Gatsov *et al.* 2013; Table 1, 130). The authors observed that, in comparison to the flint and chert material, obsidian pieces consisted of smaller blade fragments and some debris and preparation pieces. Only one fragment of a core was found, likely to have been from a bullet core (*ibid.*, 131). However, *in situ* core preparation and knapping is not established.

Less than 10% of the obsidian artefacts have traces of modification. Unsurprisingly, the most common are retouched pieces and end-scrapers and perforators. The variability is greater amongst objects made in flint (*ibid.*, Table 2, 130).

6.4.3.1. Provenance

The number examined is 34 pieces of which 28 have been elementally analysed and six are assigned on the basis of visual properties. The main source is Nenezi Dağ, 24 pieces (71%), Göllü Dağ, 8 pieces (24%) and Melos, 1 piece (3%) (Figure 6.12). Again, Melos is represented by the Adamas source only. One piece (OB 215) remained 'unknown' due to its higher concentration of trace elements (Rb, Sr and Zr), however the colour and translucency could indicate a Nenezi Dağ origin.

6.4.3.2. Technology

In terms of the frequency of forms against the different obsidian sources, the obsidian analysed from Barcın Höyük also shows some variability (Figure 6.13). Nenezi Dağ is the principal source represented, mainly by pressure-flaked blades (n=14) and several rejuvenation pieces (n=5). Even though cores are not present in the analysed assemblage, we cannot rule out their existence at the site on the basis of the rejuvenation flakes. One bullet core fragment identified by Gatsov et al. (2013, fig. 3, 6) is likely associated with the Nenezi Dağ quarry. Material from Göllü Dağ, on the other hand, is heterogeneous, with both blades and flakes, including only three blades *plain débitage*. The rest of the assemblage consisted of fragments from different stages of manufacture. What is unusual about this group is the presence of material from different Göllü Dağ outcrops[17], based on visual characterisation of the obsidian. In relation to this, the absence of cores might suggest that the Göllü Dağ material was brought to the site as finished objects. The blade assigned to the Melian Adamas source is a small proximal fragment and was probably not used in the same way as Melian blades in Fikirtepe and Pendik, which often show traces of modification and use along their edges (Figure 6.14).

6.4.4. Aktopraklık

The assemblage that was available for study, totalling 177 pieces, belongs to the LN/EC phase of the site (6000-5600 BC). The earlier (LN) material was not available as it was at the time being studied by someone else[18]. The relative percentage of obsidian from this site is very low, less than 5%, which is in contrast to the relatively high proportion at Barcın Höyük (Table 6.1.). Balcı (2011, 1) reports that, from LN levels, obsidian constitutes only 1% of the lithics assemblage and according to her visual determination, they are likely to come from central Anatolian Göllü Dağ and Nenezi Dağ sources. They are in form of prismatic bladelet cores and bladelets, while preparation flakes are only rare and, Balcı concluded that they were probably brought prepared and knapped onsite (*ibid.*, 4).

---

[17] This is based on macroscopic discrimination having ‘transparent with white flecks, ‘dark blue sprinkled’ and ‘transparent’ types. These different Göllü Dağ types are known in central Anatolia and, more specifically at Çatalhöyük.

[18] Semra Balcı, Istanbul University.

Flint was extracted at local sources and worked on-site (*ibid*.). The industries represented at the site include both flake and blade manufacture, although the former is associated with the local flint working. Single-platform pressure flaked blades and bullet cores are known in flint and obsidian (Figure 6.17, 6.18).

The material that was analysed comes from stratified levels, although mainly from the ditch or courtyard and rarely household contexts (M. Bertan Avcı pers. comm.). The amount of obsidian recommended for analysis by the excavators is 39, of which 33 were chemically analysed and the remaining six were too small to use with the pXRF accurately. The remaining material was examined macroscopically.

6.4.4.1. Provenance

Three major sources are represented with a higher proportion of Nenezi Dağ obsidian, 27 (70%) than Göllü Dağ, 10 (25%), and Melos, all from Adamas, was represented by 2 (5%) pieces (Figure 6.15). I have also visually characterised the artefacts (n=136) that were not chemically analysed because they were not found in stratigraphically secure contexts. According to this visual determination, 72 pieces (53%) are of presumably Nenezi Dağ origin, while 64 pieces (47%) came from the Göllü Dağ source. The interesting point is that the majority of Göllü Dağ material is of the 'completely transparent' type.

6.4.4.2. Technology

Aktopraklık has a distinct obsidian assemblage which is especially determined by the large quantity of bullet cores found, in total 12 (Figure 6.16). These cores were not only manufactured in obsidian but another 18 were made of flint and chert (Figure 6.18), suggesting that similar blades were being manufactured from each of these materials. Prismatic and bullet cores are common for the sites in the Bursa region (Gatsov 2009, 87), however this concentration at Aktopraklık is quite unusual. Balcı (2011, 5) recorded four cores from the LN phase of the site. It is possible that the cores were brought to the settlement in an already prepared form and most of them were discarded in their final stage (see Balcı 2011, for the LN levels). As suggested by Gatsov (2009, 125), micro-blade pressure technology implies a strong Anatolian connection.

Nenezi Dağ is the main obsidian source with eight cores worked in this raw material (average 3.7x1.2x0.9cm), while one is from Göllü Dağ. Nenezi Dağ cores were worked by pressure-flake technology to produce regular blades and bladelets (the latter when the core is exhausted). They are usually knapped around the entire circumference, although all have either one side or the platform or both rejuvenated. Almost all the cores were found in the ditches that surrounded the settlement, where they were disposed after use. The rest of the Nenezi Dağ material is in the form of blades (n=12), mainly small prismatic pressure-flaked ones, although one context contained a group of five small flakes (chips) that could belong to core-trimming during blade manufacture (OB 238; Figure 6.17). The Göllü Dağ core (OB 248) is less regular than the standardised Nenezi Dağ ones (Figure 6.17). It was noticeable that other Göllü Dağ material consists mainly of manufacturing debris and some pressure-flaked blades, similar to those made of Nenezi Dağ obsidian. The form of the Göllü Dağ core and the production debris indicate that this was used by less skilful knappers. On the other hand, flint cores seem to be more carefully knapped, in a similar technique as the Nenezi Dağ cores. Neither Nenezi Dağ nor Göllü Dağ blades show traces of use-wear. Melos (Adamas) material is very rare, unlike at Pendik and Fikirtepe, and represented by two blades that are of different type than from the aforementioned sites - smaller and with no use-wear or retouch visible (Figure 6.17).

6.4.5. Other Marmara assemblages

6.4.5.1. Ilıpınar

Gatsov (2009, 29) recorded that the percentage of obsidian decreases from 7.36% in Phase X to around 2.5% in Phase V of the tell. As with the other sites in the region, the existence of obsidian core fragments and blades indicates that the prepared cores were brought and processed on the site (*ibid.*, 29). In Phase X, a small number of crested pieces and debris were found, implying *in situ* core preparation. Retouched pieces include perforators, notches, truncations and retouched blades and flakes.

6.4.5.2. Menteşe

The lithics assemblage consisted of small quantities of flint and obsidian. The specifics of the exact percentage of the obsidian component are not given in publications, although it can be presumed that it does not exceed 5%. Obsidian appears in the form of bullet cores in their final stage and blade and bladelets. Flint cores are similar, of bullet and prismatic type. The blades were detached by pressure, punch and soft percussion. As a result of the advanced state of core reduction, the majority of blades produced are regular in form (Gatsov 2009, 89). The tools are mainly blades - denticulated and marginally retouched are the most common forms, followed by perforators, drills and end-scrapers.

6.4.6. Flint assemblages in the region

The main raw material for the production of chipped stone in the entire region is flint. It represents 90-99% of assemblages, the rest being obsidian from central Anatolia or Melos. Sources of flint existed in the area around Bursa, not far from the sites of Aktopraklık and Barcın Höyük (Balcı 2011). In the excavated settlements, there were no *in situ* workshops exposed, although there is an assumption that knapping areas existed in the vicinity of the settlements (Gatsov 2009). Flint appears to be transported to sites in the form of blocks and worked into cores by local craftsmen (Balcı 2011). For flint knapping, at least two distinct operational chains can be identified. One is related to the exploitation of multi-directional flake cores, less skilled and standardised. This was probably done using direct percussion with a hard hammer. The other technique is pressure-flake technology for the production of fine prismatic blades and bladelets from single-platform prismatic or bullet cores. Most of the flint cores were found in an exhausted stage and particularly good example is a group of bullet cores from Aktopraklık (Balcı 2011; Gatsov 2009; Gatsov *et al.* 2013). This technology is also used for knapping obsidian cores, particularly those from Nenezi Dağ, at most of the Marmara settlements.

Modification by retouching is done mainly on flakes and to a lesser degree on blades, forming a range of tools. In the whole region, the most common are flat flake end-scrapers, followed by a variety of other scraper types (end scraper, circular scraper, double-end scraper, etc.). Other tools are perforators, sickle-blades, drills, notched and denticulated tools and simply retouched flakes and blades (Balcı 2011; Gatsov 2009; Gatsov *et al*. 2013). Flint arrow- and spearheads are mentioned as coming from Barcın Höyük (Gatsov *et al.* 2013, 134, Table 4), but there is no other evidence for the presence of projectile points or spearheads in the Marmara assemblages. So far, the most western appearance of these objects is documented at sites in the Lake District (e.g. Kuruçay, Höyücek, Bademağacı, Hacılar; after Duru 2012; Mortensen 1970).

6.5. Beyond the outer zone - occasional pieces

These are the regions and settlements whose obsidian assemblages are described in detail in Chapter 7 since the majority of the obsidian found at these sites derives from the Melian sources. These regions have been, at the beginning of this thesis, characterised as ‘overlap’ areas with the assumption that the obsidian exchange networks extend in two directions - one towards Anatolia and the other towards the Cyclades. The analytical examination, to a certain degree, confirmed this but was able to determine the intensity of each of these interactions and to group these sites principally within one or the other distribution zone.

6.5.1. The northern Aegean: Uğurlu and Hoca Çeşme

The exchange of Cappadocian obsidian decreases when we reach the Aegean zone, while in Thrace it disappears entirely. The Melian obsidian that circulates in these areas is completely absent as one goes farther inland into the Balkan and Anatolian peninsulas (Figure 7.1). In the Troad (Çoşkuntepe) and the northern Aegean islands (Uğurlu) and mainland (Hoca Çeşme), obsidian is very rare (c. 1%), however, material from both Melian and central Anatolian sources is identified.

Two obsidian blade fragments were mentioned as coming from Aşaği Pınar, a site in the Turkish part of Thrace. These were sent for analyses, but the results of this are as yet unknown (Gatsov 2009, 27).

Gatsov (2009) noticed that at Hoca Çeşme and Aşaği Pınar in eastern Thrace, there is a big change in lithics technology from that observed at the sites in the Marmara. Especially noticeable is the lack of bullet-core technology. In flint assemblages, punch and direct percussion are practiced rather than pressure-flake technology.

Table 7.1. in section 7.4. contains the basic information about obsidian assemblages from these regions.

6.5.1.1. Uğurlu V-IV

At Uğurlu, Cappadocian obsidian represents 16%, 10 pieces in total (Göllü Dağ, 8 pieces; Nenezi Dağ, 2 pieces) of all obsidian (Figure 7.22). Central Anatolian obsidian appears in the earliest occupation of the island, Uğurlu V an IV, dated from the mid-7th millennium BC. From these phases, there are 8 central Anatolian pieces (6 Göllü Dağ and 2 Nenezi Dağ), the remaining two Göllü Dağ blades come from Chalcolithic phases (Phase III and II). Göllü Dağ material is all in the form of regular prismatic blades and bladelets, with no macroscopic use-wear or retouching (Figure 7.24). Significant is the presence of Nenezi Dağ obsidian, represented by one crested blade and a bullet core OB 692; Figure 7.24). Bullet-core technology used on obsidian from central Anatolia, particularly Nenezi Dağ, is typically used by Marmara communities (e.g. Aktopraklık). It is unusual that the core has one polished side that must have occurred through its use in perhaps some secondary activity.

6.5.1.2. Hoca Çeşme

At Hoca Çeşme ten pieces of obsidian were found, of these eight were analysed, while two were too small for analyses. Three pieces (18%) are sourced to Göllü Dağ source, the rest is Melian (described in section 7.5.2.). Three Göllü Dağ artefacts were recovered and possibly come from Phases II (two pieces) and III (one piece) dated to the period between 6000 and 5700 BC. Unfortunately, obsidian blades belong to the layers that could have been disturbed, particularly in Phase II. All three blades are regular prismatic bladelets (Figure 7.28).

The further discussion, maps and figures on obsidian from Uğurlu and Hoca Çeşme are given in Chapter 7, section 7.5.

6.5.1.3. Çoşkuntepe

Perlès and colleagues analysed obsidian assemblage from this LN (Aegean EN) site in the Troad (Perlès *et al.* 2011). Obsidian assemblage includes 118 pieces, of which eight blades and flakes (7% of total obsidian) were determined to come from central Anatolia (possibly Göllü Dağ) on the basis of their “highly transparent” appearance (Perles et al. 2011, 43). The remaining 111 pieces are discussed in section 7.5.3.

6.5.2. Eastern Aegean sites: Ulucak, Yeşilova, Ege Gübre and Ayio Gala

The settlements in central-western Anatolia belong to the eastern Aegean and the obsidian component of the assemblages is almost entirely comprised of Melian obsidian. This is very significant considering that many other aspects of the material culture show close parallels with Anatolian settlements (see Chapter 9; also Chapter 5). The information about obsidian assemblages is given in Table 7.1., section 7.4.

6.5.2.1. Ulucak

Ulucak is the tell settlement that has been the best explored to date, with 285 obsidian objects coming from LN/EC levels, all of which have been analysed. These are Levels V-IV, dated to the period between 6400-6000 BC (Level V) and 6000-5700 BC (Level IV). For this chapter, it is significant that only one artefact is provenanced to the Göllü Dağ source. It belongs to Level IVb and it is a fragment of a blade-like-flake or irregular blade (Figure 7.10).

6.5.2.2. Yeşilova

The site has a Late Neolithic (Phase III, sub-phases 1-8) and a Chalcolithic (Phase II, sub-phases 1-2). In total, 86 pieces were analysed, four pieces were identified as central Anatolian, one from Göllü Dağ (Phase II) and three from Nenezi Dağ (Phase III). The Göllü Dağ artefact is a fragment of a bladelet (OB 843; Figure 7.15). The Nenezi Dağ group is unusual with one small (2.05x1.08x1.08cm), exhausted core for manufacture of bladelets, a bladelet and a flake (OB 868; Figure 7.15). These objects, although more variable than at other sites, do not indicate that any knapping had taken place at the site, but that they were likely imported to the community in this very form. Certainly of interest might be the Nenezi Dağ core, as this represents an unusual appearance of an Anatolian object in the Aegean. This might also be related to the exchange of the core as an object *per se*, as may have been the case with Uğurlu core.

6.5.2.3. Ege Gübre

The LN/EC (between 6200 and 5700 BC) assemblage analysed in this study includes 68 pieces. Similarly to Ulucak, only one complete flake showed a chemical signature that matched Göllü Dağ source samples (Figure 7.19).

6.5.2.4. Ayio Gala

A small obsidian assemblage comes from this cave site on Chios and was studied only on the basis of macroscopic characteristics (due to sampling permit problems). Eight artefacts from the Upper Cave were available for study, of which two bladelet fragments were separated visually as possible Göllü Dağ obsidian. Their distinctive completely transparent glossy appearance showed close visual resemblance to the Göllü Dağ obsidian (Figure 7.20).

6.5.2.5. Dedecik-Heybelitepe and Çukariçi Höyük

The assemblages were not examined for this research but they reveal a similar picture to the study sites. At Dedecik-Heybelitepe obsidian represents at least 50% of the chipped stone industry. The chemical characterisation of ten objects has identified one Nenezi Dağ artefact (Herling *et al.* 2008). At Çukariçi Höyük, the richest obsidian settlement in the region (>80%; Horejs 2012; Horejs & Milić 2013), the elemental analyses of a small number of pieces from LN/EC levels (Phase IX and VII) has not confirmed the presence of material from central Anatolian sources (Horejs, pers. comm.). The sample that has been chemically characterised, however, represents a very small portion of the overall obsidian assemblage. This therefore need not exclude the possibility of the presence of one or two pieces from Anatolia, considering that this seems to be the pattern seen at all the other sites in the region. Two flakes of Nenezi Dağ obsidian are found in Phase III (EBA period; Bergner *et al.* 2009). Occasional central Anatolian obsidian continued to appear at these settlements in the region in the EBA period, as confirmed during my work at Ulucak (Level I) and Yeşilova (Level I). This is a part of a different phase (and history) of the site and will not be discussed in this thesis. The majority of obsidian from the sites in the Izmir region comes from Melos, both Adamas and Demenegaki, and is discussed in Chapter 7, section 7.4.4.

6.6. Discussion

The Marmara region in north-western Anatolia is c. 500 km as-the-crow-flies distant from the Cappadocian sources of Göllü Dağ and Nenezi Dağ. The provenancing of obsidian from four assemblages from the area revealed the presence of Melian obsidian, from both Adamas and, to lesser extent Demenegaki. The distances between these communities and the Aegean sources were over 600 km. The initial hypothesis that the regions of western and north-western Anatolia lie in the overlap area between central Anatolian and Melian distribution networks is confirmed. However, the intensity of the interaction between villages in Marmara with those that were supplied by Anatolian obsidian, to the east, and Melian, to the south-west, displays micro-regional diversity that has a meaningful pattern (this will be further discussed in Chapter 9). The inner zone of the central Anatolian sources includes a relatively small number of investigated settlements belonging to the second half of the 7th and beginning of the 6th millennia BC. Çatalhöyük's LN and EC settlements used both Nenezi Dağ and Göllü Dağ obsidian as their main raw material (over 95%). The importance of the sources is seen in the every-day consumption of a range of tool types. There are some indications that at the beginning of the 6th millennium BC, the exchange of obsidian and salt in Anatolia became more intensive leading to the establishment of settlements in the vicinity of the sources (e.g. Köşk Höyük).

Farther from the sources, the quantity of obsidian drops, as well as the range of tools that were made in this material. In the Lake District, 350-400 km distant from the sources, the proportion of obsidian is only 10-15%, while only the Hacılar community procured a higher proportion. It is noticeable that, at these sites, obsidian exists in the form of cores and regular blades, while various other tool types are made from flints and cherts. Obsidian is brought as preformed cores and knapped *in situ* by pressure-flaking into regular blades, only occasionally retouched. Projectile points are generally rare in the Lake District and as one goes farther westward, the demand for this type of tool practically disappears. To date, there have been no characterisation programmes for obsidian from these sites, although the macroscopic characteristics indicate a central Anatolian origin.

Following a western and north-western route, obsidian is exchanged with communities that lived in the areas surrounding the Sea of Marmara. Obsidian artefacts found at Pendik, Fikirtepe, Barcın Höyük and Aktopraklık represent the core of this chapter. Even though they were roughly contemporary, these communities lived in different types of settlements and employed different subsistence strategies. Barcın Höyük and Aktopraklık were inland farming communities that lived in tell settlements, while Fikirtepe and Pendik were located on the coast of the Marmara relying mainly on hunting and fishing. Özdoğan (1999, 215) believes that these differences reflect different origins and that "two alternative models of Neolithisation were developing simultaneously, one through immigration and the other through acculturation" (Chapter 2). Pendik and Fikirtepe were descendants of the local Epipalaeolithic Ağaçli group that adopted some of the 'Neolithic package', while the others are possibly of central Anatolian origin (Çilingiroğlu 2005; Gatsov 2009; Özdoğan 2011).

The lithics assemblages also seem to vary and, according to Gatsov (2009) are much more diverse at Fikirtepe and Pendik than at Ilıpınar. The study of obsidian revealed some interesting and dynamic patterns, not only in terms of settlement grouping, but also in relation to the obsidian sources used. The reduction strategies and techniques used appear to vary according to the type of obsidian, Göllü Dağ, Nenezi Dağ or Melos. Communities at Pendik and Fikirtepe obtained obsidian from Melos where it represented fully one third of obsidian objects. The Pendik sample is larger and here it was possible to identify both Adamas and

Demenegaki material amongst the obsidian. Rare Melos Adamas bladelets are documented at Aktopraklık and Barcın Höyük, but these are of a different character to the Pendik and Fikirtepe examples. Obsidian from Nenezi Dağ and Göllü Dağ is present from the earliest phases in the area (LN, 6400 BC) to the EC (mid 6th millennium BC), as seen from Barcın Höyük and Aktopraklık, as well as Fikirtepe and Pendik (although these are not well stratified). Technology does not change much and bullet core pressure flaking is practiced throughout this time.

If taken separately, three sources, Melos (here Adamas and Demenegaki are considered together), Göllü Dağ and Nenezi Dağ, revealed that possibly at least two separate processes brought these objects to the sites (Table 6.2.). The most common obsidian at all settlements, Nenezi Dağ, is brought in the form of prepared bullet cores and pressure-flaked *in situ* into regular blades and bladelets. Some rejuvenation pieces, flakes and chips support this assumption. If these transpire to be of northern Cappadocian (Galatia-X) origin, it likewise shows the social dynamics of the Marmara region sites. On the other hand these sources would have been on the way from central Anatolia to Marmara and confirm the contacts that existed with inland Anatolia, as well as the Aegean, through acquisition of Melian obsidian. In terms of obsidian characterisation, future field and analytical work on Galatia-X sources will be able to fully clarify provenance questions. Social matter, however, reveals dynamic relations of the Marmara communities with other communities in Anatolia and possibly those in the northern Aegean.

The industries of Göllü Dağ obsidian seem to differ in Pendik and Fikirtepe from those at Aktopraklık and Barcın Höyük. At the first two sites, Göllü Dağ material occurs as fine prismatic blades produced from bullet cores, although the cores were not available for study. The Pendik collection did contain a rejuvenation blade removed from a face of a regular pressure-flaked core. Göllü Dağ material core technology at Aktopraklık is not as well developed as the Nenezi Dağ material, based on the small dataset available. Cores and blades are not as regular and there is more waste documented from this source.

The third industry is represented by Melian obsidian. Even though the Demenegaki source is identified in the Pendik assemblage, Adamas appears in all the other cases as the only obsidian from the Aegean. The Pendik and Fikirtepe material once again showed similarities that were to some degree in opposition to the characteristics of the inland tell sites. The artefacts seem to be imported in the form of finished blades, sometimes more robust than central Anatolian, indicating that some are made using percussion technology. In addition, these blades are more extensively used and some have edges modified implying that they could have been used in different activities than the finer central Anatolian blades that rarely show traces of use-wear.

site	source	cores	flakes	cortical flakes	rejuve-nation	irregular blade	prismatic blade
Pendik	Göllü Dağ				2		12
	Nenezi Dağ		2		1		11
	Melos						16
Fikirtepe	Göllü Dağ						1
	Nenezi Dağ	1			1		5
	Melos						2
Barcın Höyük	Göllü Dağ		2		1	2	3
	Nenezi Dağ				4	5	14
	Melos						1
Aktopraklık	Göllü Dağ	1	2		3	2	2
	Nenezi Dağ	8	1		2	3	12
	Melos						2
Uğurlu V-IV	Göllü Dağ						6
	Nenezi Dağ	1				1	
	Melos A		7			2	16
	Melos D		4			2	11
Hoca Çeşme	Göllü Dağ						3
	Nenezi Dağ						
	Melos A						3
	Melos D						2

Table 6.2. Presence (grey) or absence (white) of basic stages of the reduction sequence at each site by source. The numbers indicate sample size

The knapping areas for flint and obsidian were not found in the excavated areas of the settlements, although they are most probably located nearby. Gatsov (2009, 29) observes that it is uncertain who was in charge of knapping obsidian "local people or the ones who brought them to the site". In his opinion, the skilful flint knappers were probably able to operate with the obsidian cores. However, it could be reasonable to assume that the knappers responsible for material from one source (i.e. Nenezi Dağ) were not necessarily responsible for the other (i.e. Göllü Dağ). The Nenezi Dağ material has parallels with the reduction of pressure-flaked flint cores and these could be the product of the same crafts person, while the acquisition of Göllü Dağ material could be a separate event. Unfortunately, this would be very hard to recognise in excavation records. In the case of Pendik and Fikirtepe, the procurement of material from the three sources differs, Nenezi Dağ artefacts were produced *in situ* using pressure-flaking, while Göllü Dağ and Melos artefacts were imported as regular blades. In addition, it could be suggested that the cores and some blades, flakes and rejuvenation pieces from Ilıpınar and Menteşe are probably of Nenezi Dağ origin, if we follow the pattern produced from the other sites in the region.

Most of retouched tools in the Marmara region site assemblages are made of locally procured flint. All four sites show some similarities, the exploitation of single platform blade cores including bullet cores, multi-directional flake cores, the presence of flat circular scrapers, end-scrapers, sickle blades and perforators. Any type of obsidian, on the other hand, is exogenous to this region, but it should not be considered as a part of a single exchange strategy. It is well illustrated for the Marmara settlements, that even though it represents a minority component of the assemblages, obsidian was procured from at least two source regions, including (at least) four outcrops. Furthermore, it is significant that these were not procured in the same quantities, forms, for the same purposes, or by the same people and at the same time. At Çatalhöyük, in the inner zone, obsidian was procured directly from the sources and it was estimated that, at this large settlement (3500-8000 people, 900 households at any given time), between c. 100 and 300 kg were consumed per year (Cessford & Carter 2005). The amount received in the north-western sites would, in comparison, be the result of occasional events. Since the material appears throughout the different phases of multi-layered settlements, the contacts could have been maintained occasionally, through longer periods. The other possibility is that obsidian, rarely used, could be once procured as a prepared core and then re-used for the production of blades when needed.

Central Anatolian obsidian sporadically occurs beyond the Marmara region, where Melian obsidian is predominant. In Thrace (Hoca Çeşme), in the Troad (Çoşkuntepe) and in the northern Aegean (Uğurlu), Anatolian obsidian is usually in form of fine regular pressure-flaked blades, often not used. A Nenezi Dağ bullet core at Uğurlu was noted above as being of particular interest because it had polished edges. The blades associated with this core were not found. The technology used for knapping this core is related to the bullet core technology distinctive at Marmara region sites, as most clearly documented at Aktopraklık where 12 cores made of Nenezi Dag obsidian were found (until this study in 2010). The presence of bullet core at Uğurlu could suggest a link with the Marmara communities, although here it could be possible to speculate a one-off episode and an unusual artefact rather than a pattern.

The occurrence of Cappadocian obsidian in the eastern Aegean is rare in quantity but obsidian from these sources usually appears as one or two pieces per site and in the form of not very sophisticated artefacts, i.e. as irregular bladelets or flakes. These examples, on the other hand, could not be characterised as eccentric since their appearance at almost every site in the region, creates a certain pattern. The pattern is interrupted in one instance in Yeşilova where a small bullet core made of Nenezi Dağ obsidian was found. This is an unusual artefact, and as in the case of the Uğurlu core, might indicate a link with communities either in the Marmara or the Lake District. Even though sites in the eastern Aegean receive obsidian almost exclusively from Melos, they practice technology that is used for Cappadocian obsidian in the Lake District and the Marmara regions. Bullet and prismatic cores made of Melian obsidian and flint are found at Ulucak, Yeşilova, Ege Gübre, Çukarici Höyük and Dedecik-Heybelitepe (detailed in Chapter 7). Here, again, we see the assimilation of two traditions, Aegean and Anatolian, that is seen not only in lithic technology but also in other elements such as architecture and material culture.

The bullet core and prismatic core technology, used both for flint and obsidian raw materials, are characteristic of the Marmara region as well as the eastern Aegean, but are completely absent in Thrace, for example at the sites Aşaği Pinar and Hoca Çeşme. Gatsov (2009) emphasised that Marmara assemblages are very different to those in northern and eastern Thrace. Pressure-flaked blade technology possibly originates from Anatolia, although the existence of bullet cores could be seen as an element derivative from a local Epipalaeolithic tradition that was assimilated through aspects of Neolithisation processes. The similarities with central Anatolia are in the prismatic cores, flat scrapers, end-scrapers and perforators, while large difference is the complete lack of projectile points in north-western Anatolia. The implications of these differences will be returned to in Chapter 9.

Chapter 7. Distribution of Melian obsidian in EN and LN periods

7.1. Introduction

This chapter addresses the use of obsidian from the Aegean island of Melos, with attention to further distinctions between two well-defined sources at Adamas and Demenegaki. As in the previous chapter, the study sites considered here are located in the outer zones of circulations, as defined in Chapter 5, and so they might potentially also contain obsidian from other sources. Unlike other chapters however, this chronological and regional framing of this one is a little more complicated when addressing Melian obsidian use in two different parts of the Aegean and in two different periods of the Neolithic. The first of the two distinct study areas deals with EN communities (second half of the 7th to first half of the 6th millennia BC) and the second deals with the LN groups (mid-6th to mid-5th millennia BC). The reasons for this organisation have been discussed in Chapters 1 and 5. The first part of the chapter deals with EN sites located in the eastern Aegean (Ege Gübre, Yeşilova and Ulucak, section 7.4.) and in the northern Aegean (Uğurlu and Hoca Çeşme, section 7.5.; Figure 7.1), and these areas are of particular interest because they were also supplied with central Anatolian obsidian (detailed in Chapter 6). The second part (section 7.8.) deals with LN communities at Makriyalos, Paliambela, Thermi B, Kleitos, Vasilara Rahi and Dispilio, which are located toward the north-western limits of the Melian obsidian distribution, in Macedonia, where this material appears as a rare raw material and is not the only obsidian type present. Of particular interest at the outset of this project was the discovery of Carpathian obsidian at the site of Mandalo in western Macedonia (Kilikoglou *et al.* 1996), where obsidian from both Melos and the Carpathians was found. The aim was to explore the potential existence of other sites with obsidian from more than one source and, through this, to trace the nature and intensity of relationships between Aegean communities and those in the Balkans. To be clear, the settlements discussed in this chapter were defined by their use of Melos as a main obsidian source, while the sites dominated by Carpathian sources are discussed in Chapter 8, and the ultimate relevance of the overlap of sources is discussed in Chapter 9. In summary, the discussion of EN assemblages allows us to consider an overlap between Melian and Anatolian sources in a potential interaction zone, whilst similarly the LN assemblages allow us to consider overlaps in the distribution of obsidian from Melian and Carpathian sources.

7.2. Quantity vs. distance: The history of Aegean seafaring

In contrast to Anatolian and Carpathian continental sources, the sources discussed in this chapter are located on the island of Melos. Another distinctive feature of the Melian sources is that this and other neighbouring islands in the Cyclades were not permanently settled until the LN period.

The exploitation of Melian obsidian is documented long before the island itself came to be inhabited, when obsidian was acquired during occasional visits to the island. Obsidian is found in Epipaleolithic and Mesolithic layers at several locations in the Aegean. The first evidence of contacts between mainland Greece and the Cyclades is the well-known appearance of Melian obsidian at Franchthi Cave in the southern Argolid dated to Upper Palaeolithic period (11^{th} millennium BC; Perlès 1987). In the Mesolithic period (9^{th} and 8^{th} millennia BC), obsidian still appears at Franchthi Cave, but there are also a few other cases of the use of Melian obsidian around the Aegean. These include inhabitants on Kythnos, Youra, Ikaria and Crete. Some later Mesolithic assemblages have also been identified on the islands of Naxos and Chalki. The Adamas source was possibly exploited by the early explorers as it was much more easily accessible in the sheltered Melos Bay than the Demenegaki exposure located on a cliff edge on the opposite side of the island. The Mesolithic assemblages consisted of partly decorticated pebbles that were used for the manufacture of bladelets and microliths used as inserts for tools (Kaczanowska & Kozlowski 2013). The cores were found in an exhausted state. Later Mesolithic material is similar to the earlier assemblages although the microlithic bladelet industry tradition for the manufacture of regular bladelets is also present. Common retouched tools are perforators, end-scrapers, denticulated and notched tools, backed pieces and retouched flakes (*ibid*.).

The percentages of obsidian in relation to other chipped stone found at these early sites varies (Figure 7.2, A), the lowest are at the mainland (e.g. c. 1% at Franchthi and Klisoura caves, c. 150 km distant as-the-crow-flies), then in the Sporades c. 8%, located some 300 km from the sources (Kaczanowska and Kozlowski 2013). In the Cyclades (Kythnos and Ikaria), obsidian assemblages are around 30% in the early Mesolithic, although it is a predominant raw material in the Later Mesolithic at nearby Naxos and Chalki. Early Mesolithic Livari on Crete contained 1.5% obsidian (Carter et al. *forthcoming*), while in the earliest levels at Knossos (Knossos X), obsidian represents 70% and increases in the later periods (Kaczanowska & Kozlowski 2011, 2013).

In the EN and MN periods, the number of sites that contained Melian obsidian in and around the Aegean grows significantly (Figure 7.2, B). The inner zone of obsidian supply is still not settled although the frequency of obsidian in some regions becomes very high. Some settlements on the mainland either side of the Aegean (southern Greece, Thessaly and western Anatolia) with a large proportion (50-90%) of obsidian could represent part of this inner zone and their communities, or their itinerant representatives, appear to have acquired obsidian directly from the island of Melos. The distances as-the-crow-flies of these settlements from the sources are upwards of 100 km in the case of Attica and the Peloponnese and 300 km or more for Thessaly. On the other side, the eastern Aegean littoral was c. 250 km as-the-crow-flies from Melos. Most noticeable is the presence of Melian obsidian in areas 600 km away from the Cyclades, in the Marmara settlements, and this phenomenon is described in section 7.6. It is clear, however, that these straight line distances are not an accurate measurement of actual routes and social connectivity and so earlier research that considered movement around the Aegean is described below (section 7.2.1.).

In the following LN and FN, the number of settlements that used Melian obsidian not only increased but the distribution extended further to the north-west (Figure 7.2, C). Conversely, the distribution in the eastern Aegean is not well-known due to abandonment of many settlements in the Anatolian mainland after c. 5700 BC. The settlements are known from the eastern and north-eastern Aegean islands of Chios (Emporio), Samos (Tigani) and Gökçeada (Uğurlu) and Gülpınar in the Troad peninsula. A further significant change taking place in this period is that new settlements in the Cyclades created a clearer inner distribution zone for Melian obsidian. These are the settlements ascribed to the Saliagos culture (including Saliagos on Antiparos, Mavrispilia and Ftelia on Mykonos, Zas Cave on Naxos, Minoa on Amorgos and Akrotiri on Thera) which were located on islands 60-150 km distant from the Melian sources. Most importantly, obsidian was the main raw material in their chipped stone industries (over 95%) and comprised various stages of the *chaîne opératoire*: on-site knapping of blocks, cores, preparation debris, rejuvenation, quantities of blades, and a range of tool types, including bifacially retouched projectile points and arrowheads, slugs, notched pieces and end-scrapers. Southern Greece, Thessaly and the Peloponnese belong to an intermediate zone and there was no noticeable decrease in obsidian presence at these communities in comparison with the earlier Neolithic phases. The sites that were located farther to the north in Macedonia and Thrace became an outer zone of circulation on the basis of the relative proportion of obsidian to other chipped stone types and these are detailed in this Chapter (section 7.10.).

7.2.1. Aegean sea routes: distance and maritime knowledge

The location of obsidian sources on an island means that early procurement involved seafaring. The boats used for these early travels are not archaeologically documented, but it is assumed that they were reed-rafts or dugout canoes. These were simple crafts that could carry light cargo and only limited numbers of people and livestock. Experimental work has shown that these boats could travel up to 20 km per day and that a journey from Attica to Melos via the chain of islands, might take two weeks (with likely stopovers due to rough seas), suggesting at least a month for a return trip to the mainland (Agrourides 1997, 2; Broodbank 2000, 287, 2013, 125-6). The important factors therefore for travelling around the Aegean are stepping stone islands and distance between two land masses that are not be more than 25 km (Broodbank 2000, 74). Thus, the estimated route between Franchthi Cave in the Argolid and Melos passes via Kea, Kythnos, Seriphos and Siphnos. It is worth noting in this context that, Maroula on Kythnos is another site with the Early Mesolithic obsidian material.

Sea travelling in the Aegean can be made easier or more difficult by prevailing winds and currents at certain times of the year. It also has a clear season in the Aegean with the period between May and September particularly suitable for travelling. Short voyages were generally possible in each direction while those across open seas required stable weather conditions and greater seafaring experience. Broodbank has shown (2000, 289, fig.94) that, in the Aegean, 'maritime deserts' existed only in the northern parts, for example when travelling from Lemnos towards the south, and between the Cyclades and Crete. In these expanses, sight of land was lost entirely and some navigational knowledge using natural phenomena was required. Along the other routes, particularly east-west, travel would have been less difficult. If the crossing was from the western Anatolian coast to the Cyclades, it would run via Samos and Ikaria, or from Bodrum via Kalimnos and Amorgos. In the southern Aegean, the Anatolian coast is connected to Crete via Rhodes and Karpathos and with the Cyclades via Kos and Astypalia (Agourides 1997; Broodbank 2000, 137). The route from the Cyclades to the northern Greek mainland is facilitated either through the aforementioned western Cycladic chain (Melos - Attica) or through Mykonos, Tenos, Andros, Euboea and on to the Greek mainland. Going from the eastern Aegean (Samos, Chios, Izmir region), sailing towards the northern Aegean islands (Lemnos, Gökçeada) and the Troad would have been achieved without much difficulty in terms of winds and currents and without losing sight of land (Agourides 1997).

To summarise, seaborne movement around the Aegean is well documented through early occurrences of Melian obsidian at several locations dated to the Upper Palaeolithic and Mesolithic periods, and the distribution of obsidian becomes progressively more visible in spatial extent in the EN/MN and LN periods. For the EN and MN periods, Perlès (1990; 1992) suggested that travelling craftsmen (skilful in seafaring and knapping) were directly bringing obsidian from the sources to coastal mainland settlements and from there it would be exchanged to the farther regions. In the LN, settlements in the inner areas, near the sources were established, although there is so far no evidence for settlements on Melos itself. Exploitation of obsidian was presumably by communities on Naxos, Paros, Mykonos and Thera amongst others, and was direct and uncontrolled. From there it could have been exchanged to more distant consumers.

In the following sections, I will discuss obsidian consumption in the EN period when the inner zone of islands was still largely uninhabited and obsidian was likely procured by itinerant individual or groups. Our knowledge about the consumption of obsidian in this period is based on the studies of assemblages mainly in Thessaly, the Peloponnese and Crete (Knossos) (Conolly 2008; Kaczanowska & Kozlowski 2011, 2013; Perlès 1990). This thesis offers a new contribution to our understanding of the procurement of those EN (LN/EC) communities pattern in the eastern Aegean (section 7.4.) and also in the northern Aegean (section 7.5.), on the margins of the distribution zones. Moreover, for the LN period, the study of assemblages from the peripheral sites in northern Greece (section 7.10.) aims to explain the character of obsidian artefacts c. 500 km from the sources, where the circulation of obsidian in the Aegean reaches its spatial maximum.

7.3. Obsidian in the EN period

This section begins with a description of EN assemblages in Peloponnese, Thessaly and Crete that contained obsidian in larger amounts. These sites were not part of the primary study but serve to give an overview of the obsidian procurement in the EN period and to compare and contrast with those assemblages that were included in the primary material study, i.e. eastern and north-eastern Aegean and Marmara.

7.3.1. The inner zone?

This thesis has placed great emphasis on the fact that, during the EN and MN periods and before the establishment of the Saliagos culture sites in the Cyclades, settlements in the southern Greek mainland, Thessaly and the Peloponnese nonetheless belonged to what might be called an inner zone of obsidian supply. This is largely based on the quantities of obsidian at EN settlements in these regions. There are, however, other implicit parameters that make one region an inner zone as it is described in section 5.1.2. These communities may be situated in such close proximity to the sources with the intent of being able to obtain large amounts of obsidian which was then distributed to distant communities. The obsidian was procured in blocks or prepared nodules to be knapped into tools by specialists within these settlements. The obsidian repertoire usually contains a variety of retouched tools (e.g. different types of projectile points). Obsidian in Thessaly and the Peloponnese is abundant but the quantity varies from site to site (from 50 to 95%), and does not decrease down-the-line in any obvious way (Perlès *et al.* 2011, 47) (Figure 7.3). Perlès (1990; 1992; 2001), however, pointed out that even though obsidian in these regions represents the majority raw material, it is exogenous and was brought from significant distances, in many cases over 200 km as-the-crow-flies. In fact, seafaring via the islands and following the coast to Thessaly, the travelling distance extends to c. 400 km (Perlès *et al.* 2011, 47). This means, that particularly in the case of inland communities, obsidian may not have been procured directly but from itinerant craftsmen who were experienced in sea voyaging. Settlers of EN Knossos also consumed Melian obsidian (94.4%; Kaszanowska & Kozlowski 2013, 24) that was possibly brought, independently, directly from Melos, crossing over 150 km of open sea.

7.3.2. The western extension: the Peloponnese and Thessaly

Tell settlements of the Peloponnese and Thessaly received large amounts of obsidian from Melos during the EN and MN periods. The material was brought in as fully or partially decorticated blocks that were knapped on a site. The initial manufacture was done using direct and indirect percussion while, in the later stages, the core was knapped using pressure-flaking for the manufacture of fine prismatic blades (e.g. Argissa; Figure 7.4). The cores are rarely found at sites, and when they are, they are often exhausted. Perlès (1990; 2001; also Kozlowski *et al.* 1996 for Lerna I) believes that the origin of pressure-flaking should be traced to Anatolia (described in Chapter 6). It is significant that these blades and bladelets were often left without retouch on their cutting edges. Occasionally they show traces of gloss and denticulated retouch (Perlès 2001, 203). Perlès also compared this situation to central Anatolian sites where obsidian blades were retouched with invasive pressure-flake retouch (e.g. for projectile points) and this is not documented in EN Thessaly and the Peloponnese. There are rare trapezes made on prismatic blades by abruptly retouching the truncations of blades, called transverse projectiles, although typical Anatolian spear- and arrowheads were not found. One barbed point was identified in the Lerna I assemblage (Kozlowski *et al.* 1996, 305; fig 3.2), although Perlès (2001, 205) believes that this might be intrusive from later layers. The other tools, end-scrapers, notched and denticulated pieces, are sporadic in the assemblages (Kozlowski *et al.* 1996; Perlès 2001, 205).

The work in these areas has shown that other raw materials were used for different tools and purposes. For example, imported good quality honey flint was used for sickle-blades produced by indirect percussion, while the local poor quality chert was used for flakes and irregular blades that were often retouched and used as perforators, drills and small points.

7.3.3. The southern extension: Knossos

The inhabitants of the earliest settlement at Knossos (Stratum X) used Melian obsidian as their main raw material (c. 70%), while in the subsequent settlement (Stratum IX) this proportion is even greater (c. 95%). The other materials exploited are local chert and radiolarites (Conolly 2008; Kaczanowska & Kozlowski 2013). It is noteworthy that even though obsidian is plentiful, only a few small blade cores were found, the rest being objects that were probably initially used as flake and blade cores, and when exhausted they were turned into *piece esquillee* or 'splintered' type tools (Figure 7.5). Therefore, flakes and chips are more common, while blades and bladelets are less well represented. In contrast to Thessalian practice, blades are here small and unstandardized, produced by percussion, and there is no firm evidence for pressure-flake technology on site (Conolly 2008, 80). According to Conolly, there are two possible pressure-flaked blades found at IN Knossos and there is a suggestion that these blades were produced and brought from somewhere else. Overall, the entire obsidian industry shows less skilful knapping than that at the same time known in Thessaly and at western Anatolian sites. On the basis of lithics and other materials and habits, Conolly (2008, 87) suggested that the Knossos settlers were not involved in wider Aegean exchange networks.

7.4. The Eastern Aegean: Ulucak, Yeşilova and Ege Gübre

A number of tell settlements in the Izmir region on the eastern coast of the Aegean have been discovered during large-scale excavations in the 1990s. In section 5.4.6. and Appendix 1, I describe in more detail the relevant settlements patterns, material culture and the chronology of this group of sites.

For sites on the east coast of the Aegean (Figure 7.1) obsidian percentage, similarly to Thessaly, vary substantially from site to site, ranging from c. 5 to 80% of all chipped stone products. This is also the area where the distribution to the east, to a large degree, ends. Figure 7.6 shows that Melian obsidian becomes less frequent moving into the north-eastern Aegean and quite rare in the Marmara region. It is therefore clear that these settlements could belong to an intermediate zone of distribution, while those farther to the north are the outer zone. The question is whether the settlements in the eastern Aegean also belong to the circuit of the travelling craftsmen that were distributing Melian obsidian? One site that is of particular interest is Çukuriçi Höyük near Izmir that contained over 80% of obsidian in the lithics assemblages. This site could have acted a 'gateway community' (Horejs 2012) that received obsidian directly from Melos and from there circulated it to other neighbouring settlements. The assemblages studied belong to the EN (LN/EC late 7th and early 6th millennia BC) occupation levels of Ulucak (V-IV), Yeşilova (III-II) and Ege Gübre (III). These sites contain very occasional artefacts that were sourced to central Anatolian Göllü Dağ and Nenezi Dağ and details about these pieces have already been given in Chapter 6 (section 6.5.2.). Table 7.1. provides information about the number and percentage of obsidian finds from the sites described below. In the 'Remarks' section, I explain the reasons for the sampling of objects for pXRF analysis. As already emphasised, the aim was primarily to select material that had been recovered from secure LN/EC contexts. In case of very small assemblages (e.g. Hoca Çeşme), all obsidian artefacts available were studied for characterisation.

Site	Site date	Obsidian total No	Obsidian % to other lithic	No of pieces analysed with pXRF	Seasons included	Remarks
Ulucak V-IV	LN/EC 6400-5700 BC	2863 (from all seasons, including 2013 and all periods (Aceramic to EBA)	15-20	285	Until 2012	Analysed are artefacts from levels V and IV. They are selected on a basis of their secure contextual deposition
Yeşilova	LN/EC 6500-5700 BC	c. 1000 (2005 excavation)	c. 35	86	All	The exact number of pieces is unknown; currently, it is not separated from other lithics
Ege Gübre	LN/EC c. 6200-5700 BC	c. 200	c. 3	68	All	The selected samples are securely dated LN/EC periods
Ayio Gala	LN mid-6th millennium BC	8	7 or less	/	All	I studied only material from upper cave (9 in publication), while the obsidian from the lower cave (7 in publication) was not available
Uğurlu V and IV	LN/EC 6500-5800 BC	80 from all levels and surface	0.7	51	Until 2012	Analysed are artefacts securely dated to levels V and IV
Hoca Çeşme	LN/EC 6300-5500 BC	10 (?)	0.5 or less	8	All	Contexts are not detailed. Possibly more obsidian is mixed with flint or previously sent to analyses (possibly Rhodes?). Two objects were too small for analyses.

Table 7.1. EN eastern and north-eastern Aegean sites discussed in the chapter - basic information about obsidian assemblages

7.4.1. Ulucak

The relative proportion of obsidian recovered from this tell site is around 15% in level V and c. 20% in level IV (Ç. Çilingiroğlu, pers. comm.). It is important that a small amount of obsidian (c. 3%) first appears in level VI (6700-6400 BC), which is reported as a typical Anatolian aceramic phase characterised with the lack of ceramics and red plastered floors in the houses (Çilingiroğlu *et al.* 2012). Levels V and IV (6400-6000 BC and 6000-5700 BC) are the focus of this study and within these 285 artefacts were examined. I have also analysed 17 pieces that belong to the earliest settlement at Ulucak, although this assemblage is not directly related to the thesis timeframe, it is significant as it represents the evidence of the earliest use of Melian obsidian in the eastern Aegean and I will return to this in Chapter 9 discussion.

7.4.1.1. Provenance

Elemental analyses were conducted on the assemblages excavated up until the 2012 season (Table 7.1.). PXRF results identified three sources represented in levels V and IV, of which the principal are Melian Adamas and Demenegaki with 99%, one (0.6%) Göllü Dağ piece (Figure 7.7). Four blades (1.4%) remained unknown due to higher Rb concentration; although other elements overlap with the Melian sources and this will need further investigation. The Göllü Dağ blade-like-flake is described in Chapter 6. Melian obsidian was obtained in almost equal quantities, Adamas totals 122 (42%) and Demenegaki 158 (56%) pieces. Furthermore, this proportion is the same in each phase, V and IV. Melian artefacts were distinctly separated from other sources on the basis of trace elements (Zr-Sr-Rb) while the two Melian types were discriminated using Ti and Fe elements (Figure 7.8).

7.4.1.2. Technology

There are four cores and core fragments amongst the Melian obsidian; one is from Adamas and three from Demenegaki. From the Adamas source, there is only one core fragment (OB 944; Figure 7.10.1) which might be an unsuccessfully rejuvenated side of an exhausted core. A core and two core fragments are ascribed to the Demenegaki source. The only complete core (OB 1101; dimensions 3.87x1.53x0.9cm) is a very exhausted blade core with a crest preserved on one side. It is possible that this crest was also used for scraping as it is covered with heavy use wear (Figure 7.10.2). Another core fragment is from a small broken core for blades (OB 1144). The second fragment is a broken core / chunk that also has heavy use wear, likely used for scraping after the core was exhausted (OB 1181; Figure 7.10.3). The lack of cortical pieces implies that both Adamas and Demenegaki cores were brought to Ulucak decorticated and possibly only a small amount of preparation had taken place at the settlement. This is indicated by the presence of flakes, blade-like-flakes and some possible preparation pieces (Figure 7.9; Figure 7.10.1 three bottom rows for Adamas; Figure 7.10.3 for Demenegaki). The blades were detached from a single platform using the pressure-flaking technique which created regular, parallel-sided blades. Some wider blades, from the initial stages of core reduction are likely to have been knapped by indirect percussion. Prismatic blades represent the majority of artefacts: 69% (n=85) within the Adamas group, and 73% (n=114) of Demenegaki pieces.

The platform of all of the cores examined was prepared by removing the overhang. The length of the only complete core is under 4cm, however, two complete prismatic blades (OB 1005 - 6.38cm long and OB 988 - 8.95cm long) suggest that the initial size of the cores was at least double what is preserved. The sides and platforms of the cores were then rejuvenated for the final exploitation of the cores. The presence of exhausted and broken cores suggests that obsidian was not wasted, moreover, broken core fragments were occasionally consumed as scraping tools (e.g. OB 1144 and 1041; Figure 7.10). In terms of retouched / modified artefacts, around 10% (Adamas 11%; Demenegaki 8%) can be characterised as formal tools. The majority of these are prismatic blades with simple linear retouch, while some have denticulated retouch and heavy use-wear along the edges (e.g. OB 904; OB 1121; OB 1173). Apart from the retouched blades, scrapers are occasionally found. They occur in Adamas and Demenegaki obsidian. Some examples (OB 1041; OB 1105; OB 1144) were thick flakes suitable for scraping due to their shape. More conventional are end-scrapers on a prismatic blade (OB 1122) and two round scrapers on flakes (OB 1104; OB 1110). Finally, at least two thirds of artefacts contain traces of use-wear, possibly from cutting softer materials

7.4.2. Yeşilova

From the LN/EC period of the site, two phases are recognised, Phase III (sub-phases 1-8) and Phase II (sub-phases 1-2). Obsidian is common at Yeşilova and represents c. 35% of the chipped stone tools (Z. Derin pers. comm.), however, to determine the exact proportion is problematic as obsidian is often not separated from the other raw materials during excavation and preliminary study. Material that was found in the 2005 season was studied as a part of an

MA thesis at Ege University (by Filiz Ay) and the general overview on the obsidian and flint assemblages from this study will be referred to herein.

7.4.2.1. Provenance

In total, 86 pieces were chemically analysed, of which, 82 belong to Melian sources and four are of central Anatolian origin (Figure 7.11). Melian obsidian (Figure 7.12) represents 95% (n=82) of the obsidian assemblage, including Adamas 33% (n=28) and Demenegaki 63% (n=54). The preference towards the Demenegaki source is here more noticeable than at Ulucak. This proportion remains the same in all phases and sub-phases. Four artefacts made of central Anatolian obsidian are phase specific - a Göllü Dağ piece belongs to Phase II, while three Nenezi Dağ objects are from Phase III. Obsidian was not found within distinct archaeological contexts, and mainly came from within fills (Z. Derin, pers. comm).

7.4.2.2. Technology

At Yeşilova, a number of obsidian cores were recovered from both LN/EC phases (Figure 7.13). Most of them are recorded as small exhausted cores, bullet, cylindrical or pyramidal, used for the manufacture of small blades and bladelets (Ay 2008; Figure 7.14). In the analysed group, three cores were recorded and all three are ascribed to the Demenegaki source (Figure 7.14). The lack of Adamas cores need not imply that this obsidian was only brought as finished blades, since there is evidence for the rejuvenation of an Adamas core on site. The best examples are rejuvenation of the complete face of a blade core (OB 842) and a core tablet (OB 811) with preserved blade scars (Figure 7.15). Demenegaki core OB 821 (5.1x1.67x1.18cm) was originally used as a blade core for the production of regular blades. At its last stage, the core’s back and sides were heavily rejuvenated from the opposed platform. After rejuvenation, the core seemed to be discarded and not further used. Well-preserved is bullet core OB 865 (4.23x1.25x1.1cm), which is regular and has a small prepared plain platform for pressure-flaking of regular blades. It also has a rejuvenated back. The third core OB 850 (1.53x2.19x1.88cm) is very small, and fully exploited. It had been entirely rejuvenated, including the platform, and used for further knapping. The rejuvenation and complete use of cores is seen in all examples. In most cases the cores appear to have been brought already prepared for knapping, with only occasional crested blades found. The main knapping products are regular blades, pressure-flaked and of various sizes, depending on the reduction stage. It is possible that here, as at Ulucak, the knapping was initially done by indirect percussion before employing the pressure technique. Some larger and less regular blades suggest this was the case (e.g. OB 819; OB 830; OB 851 - Adamas; OB 813; OB 827; OB 872; OB 883 - Demenegaki). The other end of the blade spectrum consists of narrow, regular bladelets obtained from smaller size cores (e.g. OB 815 - Adamas; OB 814; OB 844; OB 858 - Demenegaki). Flakes are sporadic and often used as some form of tool. Tools represent some 20% of the assemblage. The majority of retouched artefacts are prismatic blades with marginal or denticulated retouch, and they are occasionally notched (e.g. OB 857; OB 853; OB 827). Scrapers made both of Adamas and Demenegaki obsidian are common. Two out of three Adamas scrapers are made using thick flakes (OB 847 and OB 876) while one is an end-scraper on a large blade (OB 869). Three scrapers were made of Demenegaki obsidian. One is retouched on the distal end of probably a large blade (OB 878), one is regular type made on a flake (OB 879) and the third is made on a thick flake with retouch on one end and heavy use-wear all along the edges (OB 887) (Figure 7.15.1). As with other sites in the region, no other tool types were documented in obsidian.

7.4.3. Ege Gübre

This settlement, dated between 6200 and 5700 BC, is contemporary with Ulucak V and IV although it displays distinctive architectural characteristics (including stone built round structures and rectangular mud-brick houses) different from those seen at other settlements in the region. The chipped stone assemblage has not been part of any detailed study to date, although the relative proportion of obsidian is estimated to be small, probably less than 5% (H. Sağlamtimur, pers. comm). Before this study, obsidian pieces were not separated from the other stones, and my provisional assessment indicates that there are less than 200 pieces in total.

7.4.3.1. Provenance

I have analysed 68 artefacts, and amongst these one flake was sourced to Göllü Dağ source (Chapter 6). The rest (99%) are obsidian from Melian Adamas and Demenegaki (Figure 7.16). The proportion from the two Melian sources (Figure 7.17) differs from the assemblages at Ulucak and Yeşilova. At Ege Gübre, Adamas is the main source with 56% (n=38), while Demenegaki represents 43% (n=29). The difference in the Adamas : Demenegaki ratio is not extreme, although it is interesting that this settlement, which differs in architectural practices from others in the region, is also located farther to the north towards the Troad. As will be described below, communities in the northern Aegean (e.g. Uğurlu and Hoca Çeşme), also contain a higher percentage of Adamas obsidian. Section 7.6. deals with the communities in the Marmara region that occasionally consumed Melian obsidian and there also is a documented preference for Adamas obsidian.

7.4.3.2. Technology

Three cores were recovered, two made using obsidian from Adamas and the other using Demenegaki material (Figure 7.18). The Adamas cores OB 807 (3.4x2.3x1.3cm) and OB 808 (3.29x1.25x0.78cm) are bullet cores used for the manufacture of regular pressure-flaked blades. The preparation included removing the over-hang from the platforms (Figure 7.19). They were worked around the entire circumference, although the back of core OB 807 has been rejuvenated. The core from Demenegaki (OB 770) is also an example of a complete bullet core (2.76x2.9x1.18cm), and this was worked all around its circumference, although this piece had a platform and part of its back surface was rejuvenated. Cores from this settlement represent good examples of the bullet-core technology that is common in north-western Anatolia, even though in these cases it is employed using material from Melian rather than Anatolian sources. Core tablets and rejuvenation flakes were also found in both Adamas and Demenegaki types. The most numerous are regular prismatic blades, of which 59% come from Adamas and 69% from Demenegaki (Figure 7.18). Most of the blades are fragmentary, and only are example is complete (OB 792; 5.5cm long). They are regular with parallel edges and they have a small plain platform indicative of pressure-flake technology (e.g. OB 775; OB 792; OB 797). When larger examples occur (OB 743; OB 763; OB 754), as was the case in Ulucak and Yeşilova, these tend to be wider and less regular, probably being knapped at the beginning of the core reduction sequence. Retouched blades and flakes are particularly rare at Ege Gübre. Only two Adamas blades (5%) and three Demenegaki blades (10%) are modified with a simple retouch along the edges. There were no other formal tools in this assemblage.

7.4.3.3. Ayio Gala

Finds from the cave at Ayio Gala on Chios were dated to approximately the same period as the sites in the eastern Aegean mainland. In the publication dedicated to this site, it had been noted that obsidian represents c. 6% of the chipped stones (Hood 1981). I have recorded the obsidian finds that belong to the Upper Cave of the site, although these artefacts were not elementally characterised due to bureaucratic problems. In total, eight objects were available for the study, of which two could be ascribed to the Göllü Dağ source on the basis of macroscopic observations. The other six are of grey mat appearance, typical for Melian sources (Figure 7.20). The two sources are, however, difficult to separate on the basis of visual properties and the relative representation of Adamas and Demenegaki material is presently unknown. There were four prismatic blades, probably pressure-flaked, and two blade-like-flakes from the early stages of core reduction made from probable Melian obsidian. The small sample size and unstratified contexts of these pieces do not allow reliable interpretation. On the basis of the retained assemblage, these pieces appear to have been brought to Ayio Gala as finished artefacts, likely through contacts with the mainland communities that were the main obsidian suppliers.

7.4.4. Other assemblages in the region

Melian obsidian has also been identified at the sites of Çukuriçi Höyük, Dedecik Heybelitepe Altınkum Plajı/Didim, Moralı, Loryma and Latmos (Herling *et al.* 2008). Some of these assemblages were not elementally or extensively examined and so while detailed publication is lacking, the available data indicate the presence of obsidian primarily from Melian sources.

7.4.4.1. Çukurici Höyük

Çukuriçi Höyük is located close to the Aegean coast, opposite the island of Samos. This location might be the explanation for the very high percentage of obsidian at this site - 86% in the LN/EC period (Horejs & Milić 2013). Due to these results, the Çukuriçi Höyük has been described as a ‘gateway community’ for obsidian distribution in the region (Horejs 2012). The provenancing of a small number of obsidian artefacts from this site has been conducted using NAA, indicating that all the material comes from Melian sources (Horejs & Milić 2013). The exact percentage of Adamas and Demenegaki occurrences is not available at the moment. Material from Anatolian sources is rare in this region, as demonstrated by the recurrent pattern of one or two pieces per site. It could also be expected, therefore, that limited examples from these obsidian sources would occur at Çukariçi Höyük, although a much larger sample needs to be examined. Two Nenezi Dağ flakes have been identified from the EBA phase of the tell (Bergner *et al.* 2008). In terms of technology, the study of obsidian assemblages is on-going. The major class of objects is blades (c. 70%) detached from cores by pressure-flaking, while the majority of obsidian cores are unidirectional conical and bullet cores (Horejs & Milić 2013). The assemblage also contained flakes and debris from knapping production, although it is currently unknown whether some of this material is cortical and, in turn, the form in which nodules were brought to the site - prepared cores or cortical blocks. Some 20% of obsidian objects have been retouched and the main types are simple retouched blades and some denticulated and notched tools. Scrapers (end-scrapers and round scrapers) are also present amongst the tools (*ibid*.).

7.4.4.2. Dedecik-Heybelitepe

Another site in the region with obsidian as the major raw material is Dedecik-Heybelitepe. Lichter (in Herling *et al.* 2008) reported that obsidian represents two-thirds of the chipped stone. NAA analysis was conducted on 10 artefacts of which four were ascribed to Adamas, five to Demenegaki and one piece to Nenezi Dağ. In the report on the obsidian assemblages from this site, it was stated that two exhausted cores and a few rejuvenation flakes were found. The blades and bladelets are the main product of the pressure-flake technology used on unipolar bullet cores. The range of blade sizes indicates that cores were procured in larger sizes and used until completely exhausted at the end of knapping process. With preparation flakes only occurring very occasionally, it can be suggested that obsidian was brought to this community as prepared nuclei ready to be knapped in the settlements. Retouched blades and end-scrapers are recorded in the tool repertoire (Herling *et al.* 2008, 28-37). On the basis of the analyses of a small number of pieces, it can be suggested that the earlier stages of the *chaîne opératoire* are represented only in material from the Melian sources, while the Anatolian material only includes occasional blade or flake pieces.

7.4.4.2.1. Moralı

Moralı is a site documented by surface survey located to the north of Izmir, where obsidian from Melos is identified in the original characterisation work in the region (Renfrew *et al.* 1965). The exact percentage of obsidian could not be established although it seems to be relatively abundant, but it was not the major material for stone tools. Obsidian cores were not found during the survey (Takaoğlu 2004, 745). Takaoğlu believes that besides Melian obsidian, other sources might be also recognised, since obsidian of different appearance is also present in the collection (*ibid.*).

7.4.4.3. Assemblages made using other raw materials

The quantity and variability of other raw materials seems to vary from one settlement to another. Apart from Çukuriçi Höyük and Dedecik Heybelitepe, cherts and flints are more frequently used than obsidian, while quartz is present in small amounts. What seems to be common for the entire region is that chert was exploited locally and worked within settlements into a variety of tools. The types of cores suggest at least two industries used in flint and chert consumption. Some cores are multi-directionally knapped for flake production, while the others, similarly to obsidian, are knapped uni-directionally for the manufacture of regular prismatic blades. The latter are usually in the form of bullet or prismatic cores (Figure 7.21) (Ay 2008; Lichter 2008; pers. obs. at Ulucak). Some chert cores do not show careful preparation before use and the presence of cortex is still visible on the surfaces. This generally indicates that chert and flint were procured differently than obsidian, possibly from shorter distances and with less stress in time and effort for their acquisition. Flint blades are very comparable to those made from obsidian (Figure 7.21). The diversity in tool types is, however, greater, with flints being modified into a variety of scrapers on blades and flakes (end- and side-scrapers, circular and heavy-duty scrapers), sickle blades, retouched and denticulated blades, perforators, borers and occasionally even points (Horejs & Milić 2013; Lichter 2008, 42; Takaoğlu 2004).

7.5. Outer zone: North-eastern Aegean

Sites dated to the EN period in the northern Aegean are not numerous. Equally, obsidian in the region is scarce, often around 0.5% of assemblages. Obsidian artefacts from two sites were analysed - Uğurlu on Gökçeada (Imbros) and Hoca Çeşme in Turkish Thrace, on the Aegean coast. The third site that is considered here, although not examined first-hand, is Coşkuntepe in the Troad.

Although located in an intermediate area between Anatolia and the Aegean, bullet cores are lacking in the northern Aegean, which makes assemblages distinctly different from the Anatolian and eastern Aegean EN assemblages. Similar to mainland Greece, three types of raw materials were consumed, although in different amounts. At Hoca Çeşme and Uğurlu, the main materials are local chert and quartzite, while exogenous flint (c. 0.5%) and obsidian appear in small quantities. Flint is imported as finished blades, probably from northern Thrace (Gatsov 2009, 25; Guilbeau & Erdoğu 2011). At Hoca Çeşme, local chert is used for the manufacture of tools on-site into flakes from multi directional cores, i.e. not in a skilful manner. Blades were knapped using indirect and direct percussion, rarely employing pressure-flaking. The tools made from these flakes and blades are not diverse, mainly being simple retouched pieces, perforators and end-scrapers (Gatsov 2009).

7.5.1. Uğurlu V and IV

At the site of Uğurlu, a total of 80 pieces of obsidian were recovered from all levels. Occupational Phase V is dated to c. 6500-6000 BC and Phase IV to c. 6000-5800 BC, while Phases III and II belong to the Chalcolithic period, starting from the mid-5th millennium BC. The material was studied in 2012 and the above total number includes artefacts that were found until the middle of the 2012 field season. The assemblage (n=51) discussed in this section belongs to Phases V and IV while 19 pieces dated to Phases III and II are detailed in section 7.9.2. A further eight pieces were analysed, but they are currently chronologically undetermined.

7.5.1.1. Provenance

Melian sources represent 84% (n=43) of obsidian material, while Anatolian (both Göllü Dağ and Nenezi Dağ) are 16% (n=8) (Figure 7.22). Three Anatolian pieces are dated to Phase IV, while five to Phase V. Two Göllü Dağ artefacts belong to Chalcolithic Phase III. These objects of Anatolian origin are described in Chapter 6 (section 6.5.1.1). Adamas is the main source with 26 pieces (51%), 19 is from Phase IV and eight from Phase V. Demenegaki is represented with 17 artefacts (33%); Phase IV contained 13 pieces, while four were found within Phase V (Figure 7.23).

7.5.1.2. Technology

Blades are the main category of objects that occur on the site (Figure 7.24). Most of these are regular prismatic blades, 17 made of Adamas obsidian and 11 of Demenegaki obsidian. Prismatic blades are mainly fragmented, in dull condition, and without of traces of use-wear or retouching. Other classes of material are a number of flakes and preparation pieces, but no cores made of Melian obsidian are found at the settlement (Figure 7.25). On-site knapping could be suggested on the basis of occasional waste material, although this could be a result of work done by a visiting specialist, whereby the cores were further exploited at another place and not left at Uğurlu.

7.5.2. Hoca Çeşme

The occurrence of obsidian in Thrace is typically infrequent, although this area is generally not well explored archaeologically. Only ten pieces of obsidian were recovered from the settlement, and of these eight were analysed, two fragments were too small to be examined.

7.5.2.1. Provenance

Göllü Dağ is represented by three pieces (37.5%; described in section 6.5.1.2) and Melos by five (62.5%) (Figure 7.26), of which three come from Adamas and two from Demenegaki (Figure 7.27). Two pieces that were not elementally characterised showed visual similarities to Melian sources. Consumption of Melian obsidian along with sporadic Göllü Dağ obsidian is similar in Thrace and the northern Aegean (Figure 7.6).

7.5.2.2. Technology

The character of production of obsidian blades from here shows a high level of technical knowledge. Even though they are represented by only a few pieces, they are provenanced to Melian and Göllü Dağ sources. They are also typical for their characteristics, i.e. Melian as wide blades that had been used, Göllü Dağ as small fine unused bladelets (Figure 7.28). All artefacts are produced by pressure technology. On the basis of the current evidence and the presence of blades only, it could be suggested that blades were exchanged in finished form rather than knapped on-site. The question is whether they might have been brought from nearby places like Gökçeada or Coşkuntepe?

7.5.3. Other assemblages - Coşkuntepe

Perlès et al. (2011) reported that 118 obsidian artefacts were found at Coşkuntepe, an EN settlement located on the Aegean coast of the Troad. The relative frequency of obsidian at the site is expectedly low, c. 0.5% of all chipped stone. The elemental analyses on three artefacts showed that two derived from the Adamas and one from the Demenegaki source (Perlès *et al.* 2011, 45). The authors of the study believe that, through macroscopic examination, it is likely that the rest of the assemblage is also from Melos (grey in colour and rougher texture), while eight blades (c. 7%) might be of central Anatolian, possibly Göllü Dağ origin (transparent and very fine texture) (*ibid.*, 43).

The character of obsidian artefacts from Coşkuntepe shows similarities to those from Uğurlu. Both Göllü Dağ and Melian obsidian appear in the form of pressure-flaked prismatic blades, and some Melian flakes. Perlès et al. (*ibid*.) suggested that they were brought to Coşkuntepe either through exchange of preformed cores or as finished blades (Figure 7.29).

All three sites in this region have similar proportions of central Anatolian to Melian obsidian. In the case of Melian obsidian, however, it could be inferred that these were the work of traveling craftsmen, particularly for Coşkuntepe and Uğurlu, while the Hoca Çeşme community might have received only finished blades. Transparent Göllü Dağ blades, on the other hand, perhaps are indicative of relationships maintained other than these apparent Aegean contacts.

7.6. Beyond the outer zone: Melian obsidian in the Marmara region

The presence of Melian obsidian in the second half of the 7th millennium BC in the Marmara region is the earliest evidence for the appearance of Melian obsidian outside of the strictly Aegean zone proper[19]. This suggests that certain type of contact was established between Aegean communities and those that lived by the Marmara Sea. Through this study, Melian obsidian was documented at some sites in unexpectedly high proportions. At Pendik and Fikirtepe, these sources represented a third of obsidian artefacts, while at Barcın Höyük and Aktopraklık, there are possible occasional occurrences of Melian obsidian. In Chapter 6, I described central Anatolian assemblages, while below the Melian artefacts from these sites are described.

7.6.1. Pendik

7.6.1.1. Provenance

As highlighted in section 6.4.1. and Table 6.1., the number of obsidian artefacts analysed from this site is 42, which includes four distinctive obsidian types: Göllü Dağ (n=14; 33%), Nenezi Dağ (n=14; 33%), Melos Adamas (n=9; 21%) and Melos Demenegaki (n=5; 12%). Pieces of Melian origin were grouped with Melian source material in a single cluster (Figure 6.6).

---

[19] The most eastward Melian obsidian is found at Late Chalcolithic Aphrodisias.

7.6.1.2. Technology

All artefacts from Melos are in form of prismatic blades (Figure 6.7). There is no noticeable difference in preservation, size or use between Adamas and Demenegaki blades. Most of them were probably produced using pressure-flaking, with parallel edges and plain prepared platforms. The contrast between the Melian blades and those from central Anatolian sources has been discussed in the previous chapter. This is mainly related to the heavy use-wear, retouching and dull surfaces of Melian blades (e.g. OB 266; OB 283; OB 285; OB 287) that is not observed on Anatolian artefacts. One of the objects (OB 283, Figure 6.8) has even preserved a sickle-gloss on the ventral side that is usually hard to see on the shiny surface of obsidian, thus indicating the likely use of this object for cutting plants. Perlès (2001, 205) pointed out that this gloss on working edges can be produced in a number of everyday activities such as plant cutting, matting and weaving, but also hide and clay working.

7.6.2. Fikirtepe

7.6.2.1. Provenance

Melian obsidian was also represented in the ten obsidian artefacts that were characterised from Fikirtepe (Table 6.1.). Two blades from the Adamas source were identified (OB 303; OB 305; Figure 6.9). The absence of Demenegaki material in such a small assemblage is not surprising, which is also argued for Hoca Çeşme and the sites in the Marmara region

7.6.2.2. Technology

Two proximal fragments of blades (Figure 6.11) are 'typical' Melian blade products, often with the use-wear along the edges and dull surfaces. Similar to the Pendik examples, these blades were exchanged as finished products. It is, therefore, surprising that they were brought to Marmara from such a distance to be used in ordinary activities, especially if the sites had different types of cherts and other material from obsidian sources readily available. On the other hand, it is possible that these 'exotic' Melian blades were extensively used somewhere else in the Aegean before they arrived at Marmara in this condition. The dull surfaces of the objects could be the results of a faraway movement from hand to hand.

7.6.3. Barcın Höyük and Aktopraklık

One blade fragment from Barcın Höyük (OB 199) and two from Aktopraklık (OB 229; OB 235) appear to be of Melian origin (Figures 6.14 and 6.17). The elemental composition of these objects matched the data from the Melian Adamas source (Figures 6.12 and 6.15). All three artefacts are proximal fragments of small prismatic blades.

7.7. Discussion of the EN assemblages

In Section 7.4. I have described the quantity and the character of obsidian assemblages that belong to several eastern and northern Aegean communities. The discussion of the EN assemblages complements the discussion of the central Anatolian obsidian described in Chapter 6. In both chapters it has been shown that the presence of obsidian from two source areas overlaps, although in very different concentrations in each micro-region, i.e. the eastern Aegean, northern/north-eastern Aegean and Marmara region. The assemblages detailed in this study predominantly contain Melian obsidian, while central Anatolian pieces only occasionally occur. Only in the Marmara region, the Melian obsidian is rare, while central Anatolian dominates in obsidian assemblages. In the EN (Anatolian LN/EC) sites in Izmir region, the presence of Melian obsidian varies considerably, e.g. c. 5% at Ege Gübre, c. 30% at Yeşilova and over 80% at Çukuriçi Höyük. In the north-eastern fringes of the Aegean, the percentage of obsidian in chipped stone assemblages is very small although a slightly higher rate of Anatolian obsidian is noticeable.

Of importance to this study was the capacity to quantify and qualify Melian obsidian within lithics assemblages. In the eastern Aegean, the character of obsidian at each site has been considered in relation to that site's location along with how it relates to other sites in the region, and in relation to the other sites in the north-eastern Aegean. Additionally, the technical characteristics of artefacts have provided more specific insights into the variable character of exchange mechanisms.

As many times suggested, in the EN and MN periods the central Aegean islands were not permanently inhabited but communities that lived in the Peloponnese and Thessaly were procuring obsidian in sufficient amounts it was the main raw material for making knapped tools. However, obsidian acquisition at 200-300 km from the source required coordination and effort, and so we must ask whether obsidian was procured directly from the sources on

Melos or was it obtained by expeditions by specialised groups? For Thessaly and the Greek mainland, Perlès claimed that in the EN period, pressure-flaking technology allowed the production of a large number of blades from each core and this did not require huge amounts of nodules and cores from Melos (Perlès 2001, 207). Similarly, the number of pieces found at each site in the Izmir region is too small to justify expeditions to Melos just for obsidian procurement. The weights of analysed obsidian from three study sites are: Ege Gübre 138g (n=68), Yeşilova 260g (n=86) and Ulucak 483g (n=285). At Ulucak, from all levels, there are 2863 pieces and the estimated total weight would be c. 5kg of obsidian. This amount comes from c. 1500m2 of excavated area (the Ulucak settlement size is c. 3ha), suggesting that around 10-20kg of obsidian would be discarded at site during its prehistoric occupation[20].

site	source	cores	flakes	cortical flakes	rejuve-nation	irregular blades	prismatic blade
Uğurlu V-IV	Göllü Dağ						6
	Nenezi Dağ	1				1	
	Melos A		7			2	16
	Melos D		4			2	11
Hoca Çeşme	Göllü Dağ						3
	Nenezi Dağ						
	Melos A						3
	Melos D						2
Ulucak	Göllü Dağ		1				
	Nenezi Dağ						
	Melos A	1	10	2	11	13	85
	Melos D	3	17	3	6	15	114
Yeşilova	Göllü Dağ					1	
	Nenezi Dağ	1	1				1
	Melos A		2	1	2	6	17
	Melos D	3	2			9	40
Ege Gübre	Göllü Dağ		1				
	Nenezi Dağ						
	Melos A	2	4		3	6	23
	Melos D	1	2		5	1	20

Table 7.2. Presence (grey) or absence (white) of basic stages of the reduction sequence at each site by source. The numbers indicate sample size

Technologically, it appears that the blades were carefully manufactured, sometimes at these habitation sites. They show that the platforms are prepared (overhang removed) before the

[20] The later levels of Ulucak are not well explored and it could be assumed that most of obsidian comes from the Neolithic phases V and IV during which the estimated settlement size was 3ha.

knapping, edges and ridges of blades are often parallel and regular. This is particularly visible in the narrower examples but also in the morphology of the cores more generally. Larger and wider blades could have been detached by indirect percussion while the second stage of the core extraction was done using the pressure technique. The cores that survive were small, usually exhausted, which differs only at Çukuriçi Höyük, the settlement with the largest obsidian assemblage (B. Milić pers. comm.). Rejuvenation flakes and core tablets are numerous, indicating full exploitation of cores (Table 7.2.). A similar picture is observed for the consumption of Melian obsidian by communities living on the opposite side of the Aegean (Perlès 1990; 2001). The procurement of obsidian in the eastern Aegean could have been organised through a community such as Çukuriçi Höyük which might have acted as suppliers or receivers of the raw material from Melos. From here, prepared cores could have been distributed to the other villages where they were knapped by local or visiting craftsmen. Moreover, from the sites in Izmir, obsidian could have been brought to the northern communities, by land or sea, either as finished blades (Hoca Çeşme) or even produced there (Uğurlu and Coşkuntepe) on a very occasional basis by visiting knappers. It is notable that the circulation of Melian obsidian in the Aegean is related to the consumption of prismatic blades as the main products. Even in the most remote areas (the Marmara region), the occurrence of Melian obsidian is related to the blade tradition. The Marmara area is beyond the routes along which we might predict the movement of craftsmen who were responsible in the eastern and northern Aegean for travelling, although the blades that they manufactured might have been taken to the Marmara region as a part of activities that had an entirely different purpose. The tool repertoire in the EN on both the eastern and western mainlands display parallels, with simply retouched blades and sporadic examples of end-scrapers represented, while projectile points and arrowheads do not occur at this time in any part of the Aegean world. Instead, in the Aegean sling missiles were commonly found and one of the suggestions is that they were used to control animals in herding activies. This change might have been related to differences in subsistence practices between the Anatolia and the Aegean (Kolankaya-Bostancı 2014).

The presence of obsidian from both Adamas and Demenegaki is documented at all sites in similar numbers. Obsidian from both sources appears simultaneously throughout many settlement levels, and so there is no reason to assign them to two temporarily distinct episodes. Clearly, the procurers of obsidian from Melos had good knowledge of the lay of the land on that island. At the same time, they could also have been part of collaborative relationships between distinct groups of suppliers and craftsmen, one that brings obsidian from Adamas and the other from Demenegaki. We may also take account of potential seasonal, tidal issues or prevailing wind conditions that affected landing conditions on Melos when people arrived in their small boats.

7.8. Obsidian in the LN period

Similarly to the discussion of the EN assemblages, in this section I first describe the obsidian assemblages that were consumed by communities located closer to the sources, on the Aegean islands and immediately adjacent mainland (sections 7.8.1. and 7.8.2.). In the second part, I will present the results of analyses that were conducted on LN material in the outer zone, with the focus on sites in Macedonia (Figure 7.1).

7.8.1. Inner zone: the Cyclades

Traditionally, the starting point in the study of the Aegean LN obsidian has been the assemblages coming from the Saliagos culture sites. This is the period when the settlements were established on Melos and the islands close to Melos. These are communities located on Saliagos near Paros, Mavispilia and Ftelia on Mykonos, Zas on Naxos, Vouni on Antiparos, while settlements of the LN date are still to be confirmed on Melos itself, though numerous locations with lithics scatters and pottery have been recognised (Torrence & Cherry 1982; T. Whitelaw, pers. comm.). Due to their richness, assemblages from southern Attica (Kitsos Cave) and the Peloponnese (Franchthi Cave) are also part of this zone. The novelty of obsidian procurement in the LN is that it was now facilitated through these settlements in the vicinity of the sources, which enabled the flow of larger quantities of obsidian, firstly in the islands and then via the mainland to the north. Obsidian was the main raw material in the assemblages (over 95%), but there are significant amounts of material and diversity of artefacts produced and consumed at these settlements. It is likely that both Melian sources, Adamas and Demenegaki, were represented in the assemblages, although whether one source was preferred over the other has not yet been established through compositional analysis. Macroscopic examination of 24,000 obsidian artefacts from Saliagos indicated a clear predominance of Melian obsidian. Elemental characterisation was conducted for eight objects revealing the presence of material from the nearby source on Antiparos (four pieces) and one piece of Giali obsidian, while another four were ascribed to Giali macroscopically (Renfrew *et al.* 1968a). Chemical characterisation of obsidian from the Kitsos (Filippakis *et al.* 1981) and Franchthi caves (Aspinall *et al.* 1972) verified the presence of Melian obsidian at these mainland sites, and no instances of Giali or Antiparos obsidian, or any from more distant sources.

Perlès (1992, 128) proposed that from the LN period onwards there is an emergence of production centres for core preparation. Accordingly, communities like those at Saliagos and Ftelia acted as the main suppliers and distributors of obsidian from Melos to the more distant consumers. A significant quantity of obsidian was documented at these sites (17.3kg at Ftelia from three excavation seasons, after Galanidou 2002, 318; Saliagos c. 14.5kg, after Evans & Renfrew 1968, 48), although the total quantity that was brought to the sites would have been significantly larger (Broodbank 2000, 158). The material was procured from Melos as partly decorticated nodules or fully prepared cores that were worked on-site producing large quantities of waste material. It is noteworthy that, similar to inner zone sites in Anatolia, obsidian at Saliagos and Ftelia was not wasted and it was knapped carefully. On the other hand, the detachment of flakes and blades appears to be done using hard-hammer percussion technology producing less regular blades, instead of the more efficient pressure-flaking (Cherry & Torrence 1982; Perlès 1990; Torrence 1986). Perlès (1990; 2001) observed that at the Franchthi Cave, obsidian was imported in a less prepared state than it was during the EN and MN phases at this site, with a more common presence of cortical flakes. Apart from occasional large blade cores, the majority are small exhausted multi-directional cores for flakes, blades and bladelets.

The blades, flakes and debris material were further used and modified by retouch into a variety of tools, from simple retouched blades and flakes to different types of projectile points. The latter category consisted of leaf-shaped points, ovates, barbed-and-tanged points, tanged points and points without tang and barb (Evans & Renfrew 1968, 50 and fig. 16; Galanidou 2002). They are carefully knapped into symmetrical bifacially flaked forms (Figure 7.30). The other typical artefacts are slugs, end-scrapers, notched blades, burins and discs. The most diagnostic category of objects is projectile points, although in general terms, they represent only a small percentage of the total lithic assemblages. At Saliagos, Evans and Renfrew (1968, table 14, 49) listed in total c. 400 projectiles (just over 1% of the entire assemblage) while at Ftelia 115 projectile points were recorded (c. 2%; Galanidou 2002, 319). The projectile points are common at other LN settlements in the Aegean islands and Attica (Bevan & Conolly 2013) and to a more limited degree on the mainland, but they are very sporadically found in the eastern Aegean (e.g. Tigani; Felsch 1988). Some obsidian barbed-and-tanged arrowheads are reported on sites in the Latmos region in central-western Anatolia (Peschlow-Bindokat & Gerber 2012; fig. 40).

Barbed-and-tanged and tanged projectile points are particularly distinctive for the LN period and are wide-spread in the Aegean (Bevan and Conolly 2013). Other forms such as large bifaces, ovates and leaf-shaped points appear only at certain island settlements (Saliagos, Ftelia, and on Melos) and are completely absent on the mainland. There are suggestions that these large bifaces may be linked to Cycladic subsistence strategies that are not practiced in the mainland (Cherry & Torrence 1982, 27), particularly used in activities such as tuna fishing where they could have been used as spearheads (Broodbank 2000, 148). However, ovates might indicate those communities that are involved in obsidian distribution and exchange, especially if they are considered from the production rather than functional aspect. In Anatolia, similar bifacially flaked points were found in early settlements at Çatalhöyük (levels J-M). They were produced at the Göllü Dağ workshops from which they were distributed to the settlements where they were used as blanks for the manufacture of projectile points (Carter *et al.* 2005a, 223; Carter & Milić 2013a). The occurrence of ovates is limited to only a few sites in the Aegean, likely those serving as obsidian distribution centres. The same sites could also act as workshops for the manufacture of tanged and barbed-and-tanged points, and these were then exchanged as finished objects with the consumers in the Aegean. Another element that also supports this possibility (ovates = projectile preforms) is that ovates are often larger in size than other projectiles, but their edges / tips seem to be relatively blunt to serve as projectiles or spearheads *per se* (Figure 7.30).

At the end of the LN period, tanged and barbed-and-tanged points stopped being consumed and a new type is introduced, a triangular bifacially flaked point, typical for the FN period in the Aegean (Galanidou 2002; Jacobsen 1973, 82; Perlès 1981).

7.8.2. Intermediaries in the Peloponnese, Thessaly and the Eastern Aegean (Chios and Samos)

In the LN Aegean, the inner zone settlements are located on the Cycladic islands and immediate coastal mainland, and their inhabitants were involved in the production and distribution of obsidian. As for the intermediary sites in the Aegean, there are some inconsistencies in terms of the frequency of obsidian in relation to the variable distances between different mainland and island locations and Melos (Figure 7.31). The proportion of obsidian often does not decline proportionally with distance from source, and obsidian imports do not seem to be worked more intensively in more distant places (Perlès 1990, 114). Geographically, these intermediary regions would be the Peloponnese and Thessaly to the north-west from Melos, and Samos and Chios to the north-east from Melos. The distances of the Peloponnese from Melos are c. 150 km, while coastal Thessalian sites were located 300+ km from the Melian sources. In the eastern Aegean, another two settlements could be attributed to this intermediate zone, Emporio VIII on Chios and Tigani I-II on Samos, situated 215 km and 245 km as-the-crow-flies from Melos respectively.

The Peloponnese is a region where large quantities of obsidian (c. 90%) occur in site assemblages, but the character of material varies from site to site. For example, at Lerna II, unlike the Franchthi Cave, material is brought in as decorticated, fully prepared cores which are reduced into blades on site. Some chips and flakes are recorded, and they are likely associated with the rejuvenation, not preparation, of cores on the site (Kozlowski *et al.* 1996).

In Thessaly, the frequency of obsidian at sites is linked to environmental and topographic factors, such as closeness to the sea. The proportion of obsidian to other chipped stone ranges from 90-95% to less than 10%. Some communities near the coast (e.g. Dimini and Pefkakia) consume around 90% obsidian, while going westwards, this amount decreases to 79% at Ayia Sofia (located c. 65 km from the coast) to only 7% at Platia Magula Zarkou located c. 80 km inland from the Aegean. In terms of technology, it is possible that coastal sites (e.g. Dimini) with a high obsidian presence also acted as places for tool production. There, the waste flakes and products from core manufacture were found and from there material may have been distributed to the inland settlements that only consumed finished objects (Karimali 1994; Perlès 1990).

The eastern Aegean islands of Chios and Samos are also home to settlements that could have been intermediaries between the Melian sources and more distant consuming communities to the east and north, although this is difficult to trace in western Anatolia, due to the general lack of contemporary assemblages there (Figure 7.2, C). At Emporio X and IX, there are only eight pieces of obsidian reported, however level VIII contained 65 obsidian artefacts, or 48% of all lithics (Hood 1981). The presence of cores but the lack of cortical flakes indicates that obsidian was imported in a preformed state to be knapped into blades. Similar to the Peloponnese and Thessaly, it is possible that the cores were initially knapped by percussion and then by pressure as the core size decreased (Figure 7.32). Rejuvenation of cores was done on site. In the Tigani I and II assemblages obsidian artefacts are numerous (c. 70%) with a range of production stages represented. Cores were fully or partially decorticated before being brought to the settlement. Together with core preparation flakes and some crested blades, rejuvenation pieces are also documented. The prismatic blades range in size and uniformity from wider examples, possibly detached by percussion, to more standardised pressure-flaked examples. The retouched artefacts are well represented by a few arrowheads, scrapers, borers and retouched blades and flakes (Felsch 1988, 223-261)[21]. If production practices and chronological parallels allow, it could be assumed that the Tigani and Emporio communities could be linked through an obsidian circulation chain, the former being the main supplier for the region, although this is uncertain due to the dearth of settlements in the region.

Interestingly, Melian obsidian was the only type identified at the two sites, based on macroscopic observations (Emporio, pers. obs.; Tigani, R. Felsch pers. comm.). Anatolian obsidian (transparent glossy, probably Göllü Dağ) is visually identifiable in the earlier phase on Chios, at the Ayio Gala Cave.

Site	Site date	Obsidian total No	Obsidian % to other lithic	No of pieces analysed with pXRF	Seasons included	Remarks
Emporio VIII	LN Late 6th millennium BC	c. 100 from LN-EBA	48	/	All	Material was not available for pXRF examination
Gülpınar	LN Second half of the 6th millennium BC	13	c. 0.5	13	Until 2011	All material is analysed, although the contextual information is not currently available

[21] During my visit to the archaeological museum in Pythagoreio where the Tigani material was stored, I was able to look at obsidian material that was found during the 1920s excavations by W. Wrede. Unfortunately, this material was lacking any chronological and contextual information (often entirely unlabelled). Originally, I had permission from Prof. R. Felsch to study the assemblage from his excavations (1967 and 1968), however I was not able to find this material as it seemed to have been misplaced during the museum renovation.

Uğurlu III and II	LN c. 5500-4500 BC	80 from all levels and surface	c. 0.5	19	Until 2012	Analysed are artefacts securely dated to levels III and II
Makriyalos	LN c. 5400-4500 BC	39	0.4	37	All	6 of 39 pieces do not have contextual information. All the material is previously analysed by INAA and appear to be slightly cut from the original size of objects
Paliambela	LN	177	ca. 7	66	Until 2011	Selected are artefacts that should belong to securely dated deposits
Thermi B	LN c. 5500-4500 BC	106	c. 2.5	101	All	All material was available for analyses; five pieces were too small. The exact contextual information about the finds is currently unknown
Kleitos	LN c. 5500-4500 BC	200	ca. 3	60	All	80 of 200 from mixed contexts
Vasilara Rahi	LN	5	0.5 or less	5	All	No contextual information. All material given by the excavators is analysed
Dispilio	LN (?)	58	c. 2.5	58	All	All obsidian artefacts provided by the excavators were examined

Table 7.3. LN north-western and northern Aegean sites discussed in the chapter - basic information about obsidian assemblages

7.9. Outer zone: Northern Aegean

In the area of the Troad, the northern Aegean and Thrace, obsidian artefacts are scarce in lithics assemblages. In the following section I will provide details of analyses of very limited groups of material that belong to LN settlements at Gülpınar in Troad and Uğurlu III on the island of Gökçeada.

7.9.1. Gülpınar

This LN settlement is located in the south-west corner of the Troad peninsula on the Aegean coast. The chipped stone assemblage mainly consists of various types of flint and only 13 pieces of obsidian (material excavated until 2011).

7.9.1.1. Provenance

Even though the obsidian assemblage is quantitatively small, it is diverse and contains obsidian from both Melian sources and central Anatolian Göllü Dağ and Nenezi Dağ (Figure 7.33). Interestingly, Anatolian sources at Gülpınar are predominant (61%; n=8) while Melian obsidian represents a smaller proportion (39%; n=5), though again, the absolute numbers are small. When broken down into outcrops, the results show that Göllü Dağ and Nenezi Dağ are equally well represented, despite counting only four pieces (31%) from each of the sources. Similarly, two artefacts (15%) come from Adamas and three (23%) from the Demenegaki source (Figure 7.34).

7.9.1.2. Technology

Technologically, the obsidian artefacts are also not standardised. The Göllü Dağ pieces are all in the form of production debris, including two preparation pieces (thinning of a core) and a rejuvenation piece. The Nenezi Dağ obsidian occurs as two the prismatic blades and two flakes. Melian Adamas obsidian is typically in form of prismatic blades, one with frequent heavy use-wear along the edges (OB 647). The Demenegaki material, just as at Uğurlu, contains both blade and flake component (Figure 7.35). It is noticeable that the Melian material shows distinctive features (see Uğurlu below) that were present in this region since the EN period. On the other hand, the presence of Anatolian raw materials as the majority is not common, and the appearance of debris material instead of standardised blades is striking. Takaoğlu (2006, 310) noted that the heterogeneity in manufacture is also present for chipped lithics made of different types of flints.

7.9.2. Uğurlu III and II

Here I discuss a small assemblage of 19 artefacts that are dated to Phases III and II of the site (mid-5th millennium BC). The EN material (n=51) is presented in section 7.5.1.

7.9.2.1. Provenance

Artefacts ascribed to Melian sources represent 90% (n=17) of the Chalcolithic assemblage, while two prismatic blades come from Anatolian Göllü Dağ outcrop (Figure 7.36). The Melian assemblage in this phase exhibits somewhat higher consumption of the Adamas source (Figure 7.37); pieces made of Adamas obsidian are 67% (n=10) while Demenegaki are 37% (n=7).

7.9.2.2. Technology

As expected, Melian obsidian is found mainly in the form of blades, the majority being prismatic blades. However, the assemblage is too small to expect any knapping evidence, which potentially could be seen in the previous phases on the basis of more abundant and diverse material. Adamas obsidian consists of eight blades (seven regular prismatic and one from the beginning of the knapping sequence) and one rejuvenation piece (OB 733) that was probably used as a scraping tool or even a perforator (Figure 7.38). Demenegaki obsidian is represented with three prismatic blades, while the rest are flakes and knapping debris.

7.10. Outer zone: Macedonia

This is the area of the north-western Aegean with a number of settlements excavated in the vicinity of Thessaloniki, and in Pieria and Kozani regions. As stated in section 5.4.7., in the area, both large flat-extended and tell settlements are excavated. I have analysed obsidian from seven settlements: Makriyalos, Paliambela, Thermi B, Kleitos, Vasilara Rahi, Dispilio and Mandalo (Figure 7.6). Makriyalos, Thermi B and Kleitos are large flat-extended settlements that were excavated in the last two decades as rescue excavations due to the development of the area. The other sites are managed as research excavations of the Aristotle University in Thessaloniki.

The northern Greek sites fall into a distant zone where obsidian frequency is characterised by a sharp fall-off, the presence of finished products and, arguably outside action of middleman traders (Perlès 1992, 146). It was previously argued (e.g. Perlès 1992) that these regions were supplied by obsidian only from the LN period, at the time when the circulation of Melian obsidian becomes wide-spread due to the intensive exploitation of the sources. However, we now know that in Paliambela, for example, and possibly other settlements, we have obsidian from the EN period (K. Kotsakis pers. comm.). Nevertheless, the expansion in the distribution of Melian and Carpathian obsidian in the later Neolithic phases was a reason for me to examine the obsidian in this region. The assemblages from above mentioned sites, apart from Mandalo, are detailed in this chapter. Trace elemental analyses of obsidian from Mandalo revealed the presence of Carpathian 1 obsidian at this site (Kilikoglou *et al.* 1996). During my research, I have re-analysed these artefacts and the results are detailed in Chapter 8 (section 8.5.1.). PXRF analyses of the Dispilio assemblage confirmed another 11 pieces of Carpathian 1 obsidian in this region and, for this reason, the results from this site are divided between Chapter 7 (section 7.10.6.) and Chapter 8 (section 8.5.2.).

7.10.1. Makriyalos

This large flat-extended settlement, dated to the Aegean LN period (mid-6th - mid-th millennia BC), produced only 39 pieces of obsidian, which represents 0.4% of the whole lithics assemblage (Skourtopoulou 1999, 121). The small obsidian assemblage at this settlement, located close to the Aegean coast, is perhaps surprising, particularly when the frequency of obsidian on settlements farther from the coast is higher. Interestingly, almost all obsidian artefacts come from Makriyalos II, sectors H and Θ, probably from refuse deposits.

7.10.1.1. Provenance

Trace elemental analysis of 27 artefacts from this site have shown that Melian obsidian is exclusively used by the Makriyalos community (Figure 7.39). The results revealed that 19 pieces (70%) come from Adamas, while eight (30%) are from the Demenegaki source (Figure 7.40). Noticeable is the predominance of Adamas raw material, which is visible in all LN assemblages in the region.

7.10.1.2. Technology

The small percentage of obsidian (0.4%) in relation to other chipped stone artefacts supports the idea of this being a distant zone (in supply terms), but it seems that the two Melian sources might have been treated differently here (Figure 7.41). The material from Adamas includes a small exhausted fragmented core (OB 337), a rejuvenation piece and a chunk (probably from a broken core) that could be associated with on-site blade manufacture. The majority of the artefacts are prismatic blades, very fragmented, but they do not seem to be products of standardised production. On the other hand, Demenegaki is represented only by finished blades and one flake. The technology used for reduction of the two sources and the preservation of blades does not show any dissimilarity (Figure 7.42).

7.10.2. Paliambela

The total number of obsidian artefacts is 177, around 10% of the chipped stone assemblage from the site. Even though Paliambela is situated farther away from the Aegean coast, its chipped-stone assemblage contains a much higher proportion of obsidian than Makriyalos, where 6 ha of the site were excavated (Table 7.5.). Most of the studied obsidian comes from fills and middens, never from a deliberate deposit. The study material is mainly ascribed to the Middle and Late Neolithic levels of the mound.

7.10.2.1. Provenance

The provenancing of the raw material showed that 100% of obsidian comes from Melos (Figure 7.43). From this assemblage, I have analysed 64 pieces and it is noticeable that there is a larger amount from the Adamas source, as represented by 51 (80%) artefacts in contrast to 13 (20%) Demenegaki pieces (Figure 7.44).

7.10.2.2. Technology

Adamas dominates, with a diverse repertoire that includes a core fragment (OB 384), a number of flakes, and core rejuvenation pieces from both the back and the face of the core (Figure 7.45). Core tablets are, however, absent from the material. Prismatic blades are the most numerous (n=26/51) although very fragmented. The (ir)regularity of the edges of most of the blades could suggest that they were knapped using the percussion technique. The edges of blades are occasionally modified by simple retouching or sometimes denticulated, but never in the form of more standardised tools such as scrapers or arrowheads. Obsidian from Demenegaki also appears as blades (five prismatic blades) and flakes that could have been introduced to the settlement as finished objects (Figure 7.46). Conversely, despite the small sample size, it could be suggested that material from the Adamas source might have been knapped on-site. If we look at the entire obsidian assemblage, there is a clear predominance of blade components (67%), while one third consisted of waste flakes, debris and rejuvenation material. This implies that either one (Adamas) or both obsidian types were introduced to the community as prepared cores that were knapped by local or visiting craftsmen.

7.10.3. Thermi B

Thermi is a large LN flat-extended settlement that contained architectural features (large pits, cobbled courtyards, etc.) that appear at a few sites in the region (e.g. Makriyalos). The significance of this site is the presence of chert and quartz workshops located in the courtyards (Skourtopoulou 1993). At Thermi B, the obsidian assemblage includes 106 pieces (c. 2.5% of all chipped stones), of which 101 were elementally characterised.

7.10.3.1. Provenance

The results of the PXRF characterisation showed that the entire obsidian assemblage can be sourced to Adamas and Demenegaki (Figure 7.47). The binary plot of Ti and Fe elements has shown that Adamas obsidian is again preferentially consumed, totalling 71% (n=72), while material from Demenegaki represents 29% (n=29) (Figure 7.48).

7.10.3.2. Technology

Blades dominate both the Adamas and Demenegaki assemblages (Figure 7.49). Material made of Adamas obsidian consisted of prismatic blades (n=51/72) and numerous flakes. Cores and core fragments are missing, while only one rejuvenation piece was recovered (OB 573). The regularity of the edges of blades implies that indirect percussion or pressure techniques were used during the knapping process. The modification of blades is not common; only 10 pieces have retouched edges (e.g. OB 636). Demenegaki artefacts are less frequent although not entirely dissimilar to those assigned to the Adamas source. Prismatic blades are predominant (n=19/29), while the rest are waste flakes and a rejuvenation piece. Generally, it could be argued that Thermi obsidian was either acquired as finished objects or the cores were brought to the settlement, knapped and then taken to another community where they were further used for blade manufacture (Figure 7.50).

7.10.4. Kleitos

Kleitos is another LN flat-extended settlement located in western Macedonia, where there was a possibility for the presence of Carpathian obsidian on the basis of its geographic proximity to Dispilio and Mandalo. It has a relatively rich obsidian assemblage totalling 200 pieces (ca. 3% of all chipped stones), of which I was able to analyse 60 artefacts (Table 7.3.).

7.10.4.1. Provenance

The data clearly indicate that 99% comes from two compositional groups (Figure 7.51); the larger group of 52 artefacts (87%) is sourced to Adamas and 7 pieces (12%) to Demenegaki (Figure 7.52). Here we also have one piece that visually and chemically does not fall into any of the known source groups and this remained ‘unknown’, since its trace elements do not match with any other pieces analysed during this study[22]. It appears that this anomalous raw material contains small spherulite-like inclusions and does not have very good knapping qualities. This might have belonged to an undiscovered source (maybe somewhere in the mainland Balkans) that was not widely or not at all used for tool production.

7.10.4.2. Technology

Kleitos produced a large amount of chipped stone, and although obsidian represents only a small proportion, its appearance in such high numbers is quite uncommon considering its distance from the sources and position inland. The proportion of Adamas obsidian was around 90% and ranged from cores to debris to finished blades (Figure 7.53). Cortical material is very rare implying that the cores have been brought already prepared for reduction. After production, they were rejuvenated and used until exhausted (OB 439 and OB 464). The production of blades, presumably by pressure technique, was the main goal. The blades are rarely modified into formal tools; only one end-scraper was recorded (OB 452). Even use-wear is visible only on a small number of objects. Interestingly, Demenegaki obsidian is very rare with only seven objects - five prismatic blades and two flakes (Figure 7.54). The one ‘unknown’ object is recorded as a flake, but it is of amorphous nature, i.e. the quality of obsidian does not seem to have permitted any further modification of the piece, due to small inclusions, similar to those found in Giali obsidian.

7.10.5. Vasilara Rahi

As with Kleitos, Vasilara is located in western Macedonia, but unlike Kleitos, it did not generate a large obsidian assemblage with only five pieces (>0.5%) recovered. Apart from the obvious explanation that obsidian was not desired as a raw material, there can also be

[22] Comparisons with other known sources, including central Mediterranean ones, might help its identification in the future.

practical reasons why obsidian is not recognised. The five obsidian artefacts analysed were treated as ‘possibly obsidian’ by the excavators and so it will be necessary in future work to check the whole chipped stone assemblage in case some obsidian has been overlooked. Obsidian is relatively rare in this area and because Melian obsidian is grey and matt, it could be very similar to good quality dark fine-grain flints and so not yet be identified.

7.10.5.1. Provenance

The five pieces from Vasilara showed again that Adamas is the major source with four pieces (80%) while Demenegaki is represented by one (20%) piece (Figures 7.55 and 7.56).

7.10.5.2. Technology

This site is in the vicinity of Kleitos, and was a small excavation project that produced five obsidian artefacts. Of the four pieces coming from Adamas, three were blades and another a flake. Demenegaki obsidian is represented only by a flake (Figure 7.57).

7.10.6. Dispilio

This is a lake-side settlement located near Kastoria in western Macedonia. This site was also located in an area where the presence of another obsidian type, likely from the Carpathian sources, could be expected. The total of 58 obsidian artefacts were found at the site and the entire assemblage was elementally analysed. Unfortunately, the stratigraphic relationship of obsidian finds is not entirely precise, although they are chronologically associated with the LN and FN periods of the site.

7.10.6.1. Provenance

All 58 obsidian artefacts were analysed showing the highest variability of obsidian types represented in the region. Obsidian that originates from Melos dominates the assemblage with 81% (n=47), while the remaining 19% (n=11) matched the chemical composition of the Carpathian 1 source (Figure 7.58). This is the second site in the Aegean zone where Carpathian 1 is identified, together with the Mandalo examples. However, unlike the case of Mandalo in which the LN/FN community exclusively used Carpathian 1 obsidian (Chapter 8, section 8.5.1.), at Dispilio there is simultaneous consumption of this obsidian and Melian raw material. The Melian sources are both equally represented, Adamas with 41% (n=24) the

Demenegaki with 40% (n=23) (Figure 7.59). This balanced proportion is also unique in the region, since at all other analysed sites, Adamas obsidian is far more common than Demenegaki.

7.10.6.2. Technology

Adamas material is represented by 24 pieces, of which only nine are in the form of prismatic blades. The other artefacts are waste flakes and some rejuvenation pieces. There are no cores associated with this source (Figure 7.60). The material is only occasionally retouched (n=4); one artefact is an end-scraper (OB 499). Artefacts made of Demenegaki obsidian show similar characteristics. Blades are present but they do not represent the majority; seven are prismatic blades although in most cases not of skilful manufacture. Four objects have the edges modified by retouch (Figure 7.61). The Dispilio obsidian seems to be brought to the site as finished objects, however it is puzzling the motivation for their procurement. The question is whether this and the presence of C1 obsidian is related to the interaction with other communities in itself rather than practical requirements of resource acquisition, especially when the concentration of other esoteric objects is also documented (e.g. various types of ornaments, Ifantidis 2011).

7.10.7. Assemblages made using other raw materials

Other raw materials are much more frequent than obsidian in the lithics assemblages in Macedonia, usually represented over 90% of assemblages. The majority of research has been conducted through Skourtopoulou's work at Makriyalos, Thermi, Stavroupoli and Vassilika (Skourtopoulou 1993, 1999, 2004). She identified a variety of raw materials used at the sites with a large predominance of local low-quality quartz and cherts and limited presence of better quality jasper and flints. The production of tools, however, seem to vary at these settlements, with more *ad hoc* 'unspecialised' production at Makriyalos and Stavroupoli, and more specialised production in workshops documented at Thermi B and Vassilika C. Possible working areas were located on stone-paved courtyards that contained material from all production stages. We can note in this context that local chert and quartz quarries were located not far from these two sites (Skourtopoulou 1998). At Makriyalos, the most common raw materials are quartz, followed by chert and jasper. High quality flint is present in smaller quantities, similar to obsidian. The production of tools from the most frequent raw materials took place at the settlement. The quartz cores, waste flakes and only occasional blades are made by direct percussion. Jasper is used for on-site manufacture of blades and bladelets with a quantity of exhausted blade cores found. Finally, high quality flint was found in the form of finished blades, with no evidence for in situ knapping (Skourtopoulou 1999). End-scrapers, sickle blades, notched and perforating tools and retouched artefacts are commonly found in the region. The research in northern Greece (Perlès 1990, 1992; Skourtopulou 1999) has shown that different types of raw materials were procured, manufactured, retouched and used in different ways. Local quartz and chert rarely show traces of modification, the better quality stones were often carefully retouched, and sometimes re-sharpened for further use and usually in specialised activities (e.g. sickle blades for plant processing) (Skourtopoulou 1999, 124).

7.11. Discussion of the LN assemblages

The settling of the Cycladic islands in the LN period must have had a significant impact on the expanding use of obsidian, extending from Melos and its immediate neighbours to almost all areas in the Aegean. The establishment of production centres is documented for Saliagos and Ftelia, amongst other sites. At these places, we see the influx of raw material from Melos, and from here the distribution of material to other locations in the Aegean. Long-term research on the consumption of Melian obsidian has shown that the quarries were exploited by these nearest groups while direct procurement by more distant communities has been considered to have been less convenient due to the travel distance (sea journeys) and overall small quantities of material that were used at these sites (Perlès 1990, 1992; Torrence 1986). For these more distant communities, it probably seemed more beneficial to acquire prepared, decorticated, cores and finished objects from suppliers in the islands, or more likely, the intermediaries. At the intermediary sites, obsidian was very common, often representing c. 90% of lithic assemblages, even though the sources were located at considerable distances, at minimum 200 km away. The amount of obsidian and form of artefacts, however, seem to vary from site to site. It should be noted that even in this zone, there are settlements, mainly coastal, where cores were locally prepared and knapped and from here, finished products could have been distributed to those that lived further inland. This activity could be in the hands of local - site or regional - craftsmen who might be operating within a village or a group of villages. Similar practices may also have been taking place at the EN sites in Izmir region.

This finally leads to the outer zones that are the focus of this research. In sections 7.9. and 7.10. I have described obsidian artefacts found at sites on the edges of the Aegean, firstly in the northern/north-eastern Aegean with only two small assemblages available (Uğurlu and Gülpınar) and at six sites in the north-western Aegean in Macedonia. The percentages of obsidian at sites in these outer zones range from 0.5 (and less) to c. 3%, even if occasionally some have higher concentrations (e.g. 20% at Stavroupoli, after Skourtopoulou 2004). This is not unusual as we see that in each zone there are settlements that would acquire more obsidian than others. The potential reasons are numerous - geographical location (close to the coast and easily accessible), or social factors (production and redistribution centres), but this also might be determined by the nature and varying focus of recent excavation. The significance of these communities is not only in their association with long-distance acquisition methods and interactions, but also in their position between two obsidian distribution zones, where we might expect overlap through long-distance contacts extended in different directions.

In the north-eastern Aegean, even though present only in the form of a hand-full of obsidian artefacts, obsidian from two source areas can be identified. At Uğurlu, two prismatic blades can be ascribed to the Göllü Dağ source and the rest are of Melian origin. In contrast, at nearby Gülpınar, a variety of obsidian fragments from Melos and Anatolia is found. The interesting feature here is their occurrence in unstandardized form which, as at Dispilio, could reflect the use of obsidian as a marker of exotic contacts rather than being brought primarily to sites for its cutting properties. It should be noted however, that this speculation is based on only small available samples and no comparable assemblage in the region.

In Macedonia, some of the discussion above has raised at least the possibility that obsidian from the two Melian sources might have been treated differently. The samples from many of the study sites are too small to be able to confirm the existence of two different exchange patterns, but when looked from the perspective of a site such as Kleitos, it is clear that the consumption of Adamas material is more common than that of Demenegaki (Table 7.4.). This situation might not have been the choice of Macedonian or Thessalian communities (as the two sources have the same technical and visual properties) but of those in the inner zone that were going to Melos and then re-distributing obsidian.

site	source	cores	flakes	cortical flakes	rejuve-nation	irregular blade	prismatic blade
Makriyalos	Melos A	1	2		1	2	11
	Melos D		1			1	7
Paliamblela	Melos A	1	13		7	4	26
	Melos D						
Kleitos	Melos A	3	12	1	6	7	23
	Melos D		2				5
Vasilara Rahi	Melos A		1			1	2
	Melos D		1				
Thermi B	Melos A		16		1	5	51
	Melos D		6		1	3	19
Dispilio	Melos A		4		6	5	9
	Melos D		11		1	4	7
	C1		7			2	2
Uğurlu III-II	Melos A				2	1	7
	Melos D		3		1		3
	Göllü Dağ						2
	Nenezi Dağ						
Gülpınar	Melos A						2
	Melos D		2				1
	Göllü Dağ		3		1		
	Nenezi Dağ		2				2

Table 7.4. Presence (grey) or absence (white) of basic stages of the reduction sequence at each site by source. The numbers indicate sample size

The model of ‘itinerant knappers’ proposed for Thessaly and southern Greece could be used for Macedonia and Thrace although in a more restricted scope (Skoutropoulou 1998). According to the distribution of cores and waste material, it could be argued that either local or itinerant craftsmen performed the knapping of a core that could have arrived from another village and then passed on to the next place for further use. In some instances, undeniably, obsidian might have also circulated as finished products, particularly artefacts made of Demenegaki obsidian.

The patterns in obsidian consumption could not be correlated to the settlement types. At Makriyalos, a flat-extended coastal site, obsidian is scarce, while at Kleitos, the obsidian component is equally low although much more frequent considering the position of this settlement c. 65 km as-the-crow-flies from the coast (Table 7.5.). Skourtopoulou (1998, 1999) noted that at some Macedonian settlements there are contexts in which material was manufactured (e.g. workshops at Thermi) and deliberately disposed (e.g. Pit 24 at

Makriyalos). This is, nevertheless, related to the production and deposition of tools made from local raw materials, while the contextual evidence for the lifespan (production-use-discard) of obsidian artefacts is not possible to recognise due to small sample and taphonomic processes in which obsidian is not stable.

Site	Site size	Excavated area	Obsidian % to other lithic	Total No. of pieces
Makriyalos	50 ha	6 ha	0.4	39
Kleitos	7.5 ha?	2 ha	3	200
Thermi	6 ha	1.4 ha	c. 2.5	101
Dispilio	?	0.14 ha	c. 1	58 (47 Melian)
Mandalo	0.2 ha	0.017 ha	c. 1	12 (0 Melian)

Table 7.5. The number of obsidian finds within the excavated areas of sites in Macedonia[23]

The number of sites and obsidian artefacts in circulation in the LN indicates that Melian obsidian is more extensively used by the western and north-western communities than by north-eastern. The data for the eastern Aegean is sparse. The linear distance of the northern and north-eastern regions (Troad and Thrace) from Melos is 350-450 km, and Thessaly and Macedonia are 300-500 km, however it is noticeable that obsidian in the latter regions is much more frequent. This might be due to the more intensive investigation in Thessaly and Macedonia but also a greater need for obsidian if the other raw materials are not of suitable qualities or easily accessible. The obsidian could equally suggest that members of these communities more frequently travelled by boat, which put them into greater contact with obsidian users or potentially the sources. Finally, this could be determined by social requirements that were practiced by the communities and/or individuals in each (micro) area. The social context in which obsidian was used in long-distance exchange (e.g. travel for status and prestige) might have more significance than the objects themselves (e.g. Dispilio and Gülpınar).

[23] Most of the data comes from Kalogiropoulou (2014).

Chapter 8. Carpathian obsidian in the Balkans

8.1. Introduction

In this chapter, I discuss the last set of results of pXRF and technological analyses of obsidian assemblages, with an emphasis on the pieces provenanced to Carpathian sources. The geographic scope includes sites located in the northern, central and southern Balkans, more specifically Serbia and northern Greece (Figure 8.1). Geographically, this encompasses the major arterial river corridors, particularly the north-south routes through the Balkans, along the Tisza, Danube, Morava and Vardar (Axios) rivers. Chronologically, the sites belong to the Middle and Late Neolithic periods dated to c. 5500 to 4500 BC[24]. I will discuss 14 assemblages in this chapter, although only Mandalo and Dispilio in the southern Balkans and Belovode in the central Balkans were part of the primary study conducted during the timeframe of this thesis. The other material belongs to a (as yet unpublished) characterisation programme I conducted prior to this PhD research, in 2007. This involved analyses of obsidian using EDXRF instrumentation in the Geoarchaeological Laboratory, University of Berkeley, California. Standard methods were used there in line with the established laboratory protocols and calibrations of their obsidian analysis techniques (see Shackley 2011). The results of these analyses are described separately in sections 8.3. and 8.4, while Mandalo and Dispilio (section 8.5.) were analysed using the same methods and equipment as the other sites in this thesis. These sites are located on the periphery of the Melian obsidian distribution. The discovery of Carpathian obsidian at Mandalo (Kilikoglu *et al.* 1996) implied that communities in the southern Balkans may have interacted with those resident in the Aegean to the south and the central Balkans (and from there linking to communities in the Carpathian basin) to the north. The extent of these Aegean-Balkan contacts could be measured through examination of the character of obsidian found at Neolithic settlements in Serbia as well as those mentioned in the Aegean. Obsidian from the site of Belovode (section 8.4.2.1.) was found during recent excavations at this site and included with analysis from other sites in Serbia.

[24] The sites are contemporary to the LN I and LN II northern Greek sites described in Chapter 7.

8.1.1. Southward distribution through the Pannonian plain

The sources of Carpathian obsidian are found in an area of the northern Carpathian arc, on the northern fringes of the Pannonian plain (Figure 8.1). Outcrops and scatters of obsidian were exploited since the Middle Palaeolithic period and finds are known to be widely distributed in the Neolithic period, being found 500 km and over 1000 km away in unusual instances (Figure 8.2) (Biró 2014). According to Williams-Thorpe et al. (1984), unlike Anatolian or Aegean sources, there was only a relatively small 'supply' zone for Carpathian obsidian, which they argued might be relate to the accessibility of various good quality flints in that region, while obsidian is found usually in smaller nodules which result in small blades. It is also argued that the distribution of Carpathian obsidian is strongly influenced by the riverine communication networks and the depletion of the sources in LN period.

The distribution patterns of obsidian from the Carpathians are linked with the varying geographical position of sites in the plain, their chronology and the social circumstances characterising different phases of the Neolithic, as described in detail below. Early Neolithic exchange shows patterning that is similar to established down-the-line exchange models in which the amount of obsidian decreases commensurate with distance from source. During the Middle and early phase of the LN, a number of sites with 'preferential access' to the sources appeared (Chapman 1981; Williams-Thorpe *et al.* 1984), and these exhibit a higher frequency of obsidian at greater distances from the sources (e.g. Vinča-Belo Brdo). The later part of the LN is a period of decline in the use of obsidian, although, will be shown below that its use was, while infrequent, still rather widespread.

Returning to the geographical distribution of Carpathian obsidian, it is noticeable that whilst the circulation from these sources was multi-directional, spreading to the north, west, south and south-east (Figure 8.2), fall-off patterns differ in each of these directions (Biró 1998, 2013; Kaczanowska & Kozłowski 2008). The most complete data comes from the southern distribution throughout the Great Hungarian Plain (GHP). This is a vast, flat region in the eastern parts of the Pannonian plain, between the sources in the Carpathian Mountains and the middle Danube region, covering over 400 km north-south. The entire region is interconnected by a complex network of major rivers (the Danube, Tisza, Mureş, Körös) and their tributaries.

The fall-off plots (Figure 8.3) show that, outside the inner zone where the obsidian sources themselves are located there are a number of settlements that contain a higher percentage of obsidian that we might otherwise expect based upon their distances from the sources. These communities are usually situated close to one of the major waterways (O'Shea 2011) which in part enabled a more intense obsidian supply (e.g. Szarvas on the Körös with 95% at 180 km and Vinča-Belo Brdo on the Danube with 70% at 400 km distance from the sources; Biró 1998, Kaczanowska and Kozlowski 2008). In other places in the GHP, obsidian is found in various proportions as indicated in Figure 8.1. The outer zone that is of particular interest in this thesis is situated south of the Danube (central Balkans), where obsidian occurs in small absolute and relative quantities. Even though obsidian is rare at these sites (c. 1% and less), it is consistently found at settlements covering a wide area (Figure 8.1), often within easy reach of major river corridors (e.g. the sites of Supska, Slatina and Drenovac in the Morava valley).

Movement through the Pannonian plain is related to the flow and behaviour of a number of rivers. Riverine communication and transportation could represent one of the main means of travel, especially following the route of the Tisza river from the Carpathians to the Danube confluence. From there, the movement could have led east or west, following the Danube and Sava rivers, as well as south via the Morava river valley. The Danube and Morava rivers, together with the Vardar (Axios) river in the southern Balkans have long been recognised as a potential arterial north-south route connecting the Balkans and the Aegean region (e.g. Chapman 1981; Garašanin 1979). Crossing over land, on the other hand, takes approximately the same amount of time (Marić 2015) although numerous marshlands, smaller rivers and seasonal or regular floods could have been major obstacles to this movement (Nandris 1970; O'Shea 2011).

8.2. The inner zone in the 6th and 5th millennia BC

There are several differences that distinguish this obsidian-using region from the others. One is the quantity of obsidian that is found at the sources. Here, unlike obsidian-rich Anatolia and Melos, the sources are now all exhausted and only small scatters are found in the plough-zone of this landscape. The sources, however, seem also to have been largely exhausted in Neolithic times and it is generally believed that only small size nodules were then available for consumption and exchange (Biró 1998, 2013; Thorpe & Nandris 1977). Secondly, the Carpathian region is rich in raw materials for stone tools, with a variety of good quality flint, radiolarites and limnoquartzites also available to local and distant communities (Biró 1998, 2013). Obsidian is, therefore, just one of the choices in the exchange process.

During the early phases of the Neolithic (the first half of 6th millennium BC) obsidian nodules were collected from the surface at the scatter sites. They were then transported to the settlements in the vicinity where they would have been prepared into cores and then knapped into small blades, by pressure-flaking technology. Most of these sites contained cortical and partly-cortical debris material as well as the finished blades. One of the settlements described as an early centre was Méhtelek which had over 60% obsidian in its chipped-stone assemblage. Both C1 and C2 material seem to be present at this site (Kaczanowska & Kozłowski 2008; Kalicz *et al.* 2011). According to the excavators, this community was engaged in the procurement and the distribution of obsidian to south-eastern Europe (Kalics *et al.* 2011, 37). Obsidian was found in the form of corticated and de-corticated nodules, flake material and small blade cores and prismatic blades (Figure 8.4). Apart from obsidian, the site contains considerable amount of tools made of locally accessible limnoquartzite and more distant flints and radiolarites.

The expansion and climax of obsidian use was during the MN and the early phase of LN, middle LBK (Linearbandkeramik) pottery culture (with variants Bükk, Tisza, Vinča A-B). Biró (1998) explains that this could be the result of the movement of artisans close to the sources and more specialised exploitation of obsidian in the MN period. Biró's position is supported by the recognition of workshops (Kašov and Cejkov) and core deposits such as those in Nyírlugos and Kašov (Biró 1998, 15; 2013; Kaczanowska & Kozlowski 2008). The hoard from Nyírlugos contained 12 large obsidian prismatic blade cores (Figure 8.5). Compositional characterisation of the cores determined that the raw material used comes from the C1 source, specifically the Viničky sub-group (Kasztovszky *et al.* 2014). At the workshops, knappers produced regular conical or cylindrical cores using punch or pressure techniques (Kaczanowska & Kozlowski 2008). Interestingly, standard tool types apart from retouched blades were not made in obsidian. This certainly is related to the presence of various raw materials that were exploited by the communities in the region, which makes this inner zone distinct from the previously described cases. Moreover, in this period the wider exploitation and exchange of obsidian is attested, although not all Carpathian communities appear to have had an interest in its consumption. Kaczanowska and Kozlowski (2008) have shown that some Bükk culture sites, located only 35-40 km from the sources, were using proportionately less obsidian in relation to the other raw materials. Hoards with cores and blades consisting of raw materials other than obsidian (limnoquartzites and radiolarites) are commonly found. At the site of Sarisske, a number of hoards were found, but only one deposit contained a single obsidian piece (a core). This has some correlation with the quality of obsidian in these regions (relatively small nodules) and the good quality radiolarites and limnoquartzites which enabled the production of useful objects (e.g. long blades), which in most cases could not be made using obsidian. Thus, the situation here is quite complex and obsidian supply is not solely dependent on proximity to the sources. It could have been related to factors such as physical communication (closeness to the river), or the hierarchy of settlements, or raw material choices, which may all have had varying degrees of importance. Vinča-Belo Brdo is therefore not in the geographical core but during phase A-B1 can be considered a 'social' core in relation to distribution networks. Previously sites such as this have been defined as central places for redistribution (Williams-Thorpe *et al.* 1984) or preferential exchange (Chapman 1981, 81).

The decline in obsidian use started after the time of the Bükk culture in the north part of the Carpathian basin. In the LN period significant, though not total, exhaustion of sources occurred, and large nodules, cores and tools are not documented in archaeological contexts thereafter in this part of the GHP. The decrease of obsidian in the Tisza communities coincides with an increase in obsidian use in the territory of the Lengyel culture, in north-eastern Hungary. At the time when Lengyel sites became rich in obsidian and several new distribution centres can be identified, sites in the south, particularly south of the Danube, do not appear to have had wide access to obsidian. Settlements in the central Tisza region, formerly well supplied, now used less than 20% obsidian in their chipped stone industries. Biró suggests that Lengyel communities became intermediaries in the obsidian trade, even taking control over the sources and restricting movement of this raw material south to Tisza communities (Biró 1998, 7). This situation affected the distribution of obsidian in the Balkans as seen during two major LN phases. In the early LN (early Vinča phase; Vinča A-B), the centres of distribution emerge at the fringes of the overall distribution (e.g. Vinča-Belo Brdo, Potporanj Kremenjak and Šamatovci). In the later LN (late Vinča phase; Vinča C-D), these centres disappear and the quantity and nature of obsidian exchange changes considerably, as will be demonstrated below.

8.3. The intermediate zone: Balkan settlements with preferential access?

Vinča-Belo Brdo and sites near to the modern town of Vršac are located c. 400 km as-the-crow-flies south from the Carpathian sources. Obsidian is an exogenous raw material and therefore its frequency in relation to distance should not exceed 10% of total chipped stone assemblage, based on regression analyses (Williams-Thorpe *et al.* 1984, 198). In contrast, the group of settlements described below contain amounts of obsidian that range from c. 20-40% in the Vršac region (the northern Balkans) to 70% at Vinča-Belo Brdo (the central Balkans). Great significance is given to the site of Vinča-Belo Brdo because lithics there have been well studied and published, including technological studies (Radovanović *et al.* 1984) and provenance characterisation of obsidian (Tripković & Milić 2008).

8.3.1. Vinča-Belo Brdo

In the long history of the site, the main Neolithic occupation spans c. 5500-4500 BC, and this includes four main phases. The depth of relevant cultural deposits is 10m, and this can be divided as follows: Vinča A (9.3m-8m), B1-2 (8m-6.5m), C (6.5m-4.5m) and D1-2 (4.5m to the top). The phases correspond to the Middle Neolithic and early Late Neolithic (phases A and B), and later Late Neolithic and Early Eneolithic (phases C and D). Obsidian from this site represents an important assemblage for several reasons: a) the unusually rich obsidian assemblage plays a significant role in revealing inter-settlement relations; b) the social change that affected obsidian supply in inner zone (as described above) can be followed through Vinča's stratigraphic sequence; c) the site is located south of the Danube, and so this belongs geographically to the central-Balkans, a border region between the Pannonian Plain and the Aegean. The importance of obsidian at Vinča-Belo Brdo, nevertheless, changes in each phase of the history of the settlement. Radovanović et al. (1984, 14) give exact percentages of the obsidian frequencies at each metre (depth) of the tell[25]. The absence of obsidian from the latest phases is related to the methodology employed in the early excavations which produced some of the material included in this study. During more recent excavations at the site, dry and wet soil sieving has been employed, and sporadic pieces of

[25] This study includes only material from the 1929-1934 excavations by M. Vasić. The percentages of obsidian in relation to arbitrary layers is given below (after Radovanović *et al.* 1984, 14): 9-10m – 21,2%; 8-9m – 69.7%; 7-8m – 69.9%; 6-7m – 5.7%; 4-5m – 4.1%; 3-4m – 0%.

obsidian have also been recovered in later levels (Tripković & Milić 2008). The highest proportion of obsidian, 70% of the chipped stone, is recorded between 7 and 9m depth. In relative and absolute terms, this is Vinča A-B1 or MN/LN (c. 5300-5000 BC). In the following levels (7-5m, Vinča B2-C-D1), during LN (c. 5000-4700 BC) obsidian represents c. 5% of the chipped stone. Finally, after 4700 BC (Vinča D2; 4-3m), obsidian becomes very rare, representing less than 1% of the lithics.

The higher amounts of obsidian that were in circulation in the Balkans in the Vinča A-B period (including the sites of Vinča-Belo Brdo and Poporanj Kremenjak) is often linked to the existence of good relationships and direct contacts with communities that lived in the vicinity of the sources, i.e. the Bükk culture (Kaczanowska & Kozlowski 1990, 36; Radovanović *et al.* 1984; Voytek 1985, 249). This in turn implies that people at the sites were directly procuring obsidian from either the sources or communities living close to them.

8.3.1.1. Provenance

The first characterisation work on obsidian from Vinča Belo-Brdo was conducted in the 1960s and 1970s[26] providing results that indicated a Carpathian origin of these objects. Another 60 artefacts from this site were analysed using EDXRF (Tripković & Milić 2008). The pieces chosen for examination came from all levels (3-10m) of the tell, and while these represented the entire Neolithic sequence (Vinča A-D)[27], the contexts were largely unstratified apart from depth measurements. Examination of the clustering of trace elements Zr, Sr and Rb showed that all objects came from the C1 source (Figure 8.6). Pieces from Carpathian 2 or any other source were not identified within the obsidian assemblage, which was also confirmed through macroscopic examination of material that was not chemically provenanced.

---

[26] Four pieces analysed by OES (Cann & Renfrew 1964; Renfrew *et al.* 1965, 234-237, Fig. 1, Fig. 4.) and another 14 pieces by NAA (three by Aspinall *et al.* 1972, 334; eleven by Thorpe 1978, 259, 329).

[27] Number of pieces per level: 3.0 – 3.9 – one piece; 4.0 – 4.9 – seven pieces; 5.0 – 5.9 – eight pieces; 6.0 – 6.9 – eight pieces; 7.0 – 7.9 – twelve pieces; 8.0 – 8.9 – eleven pieces; 9.0 - 9.9 – six pieces; 9.13 – 10.30 – one piece; final occupational phase, Vinča D – six pieces (after Tripković & Milić 2008, 76).

8.3.1.2. Technology

As has been emphasised, the majority of obsidian from this site is dated to early phases that belong early in the LN (second half of the 6th millennium BC). As expected with the large assemblage, the complete operational chain is represented including key stages indicating the on-site reduction of cores. All of the cores are small, micro-cores (average length c. 1.7cm), and they are pyramidal in shape enabling the manufacture of fine unipolar pressure flaked blades and bladelets (Figure 8.7). The cores were rejuvenated to be able to produce as many blades as possible. Blades are the most numerous category of lithic (c. 80% of the assemblage), and these are usually regular parallel-sided tools, with little or no traces of use or modification by retouch (Figure 8.8). Debris from production is also present (20%), although the cores were occasionally prepared before they were brought to the site. The exact form in which nodules were transported from the Carpathians remains unknown (Radovanović *et al.* 1984, 20; Voytek 1985). In the LN period dated to c. 5000-4700 BC obsidian is much scarcer, although it seems that it was still used for blade manufacture using small blade cores. This situation changed in phase D when only occasional pieces were found. They are mainly found in the form of flakes, rejuvenation pieces or irregular blades (Figure 8.8). There is, however, no indication that during this period obsidian was worked at the settlement (pers. obs.). Tools made of obsidian are retouched blades and occasionally flakes (Radovanović *et al.* 1984).

8.3.2. Vršac sites: Potporanj Kremenjak, Potporanjske granice, Vršac-At and Opovo

Thorpe (1978) observed that in the later Neolithic and Copper Age, clusters of sites appear that might have exchanged obsidian and interacted on an inter-site level. This might be the case with northern Balkan sites located in the region of Banat, near modern town of Vršac (north-eastern Serbia). The assemblages analysed come from Potporanj Kremenjak, Potporanjske granice and Vršac-At (Figure 8.1), but there are also other sites (e.g. Kozluk Kremenjak and Selište) that are rich in obsidian finds, although they seem to belong to earlier phases of the Neolithic and are not discussed in detail in this thesis. Potporanj Kremenjak and Potporanjske granice are dated to the earlier phase of the LN (roughly contemporaneous to Vinča B), while Vršac-At belongs to a later phase, Vinča D (Chapman 1981, 19). A common feature of these settlements is that the records from the initial excavations in which obsidian was recovered do not provide accurate contextual information (Milleker 1938). In the following section, the nature and origin of obsidian from these sites are discussed together. Another obsidian rich site, Opovo, located some 50 km southwest from the Vršac region is also included. This site belongs to the later Neolithic phase (4700-4500 BC). The estimated relative frequencies of obsidian in the Vršac region are c. 30% (Šarić 2002; Tripković 2003), however, the quantities are as yet provisional as these sites were not systematically excavated and recorded. This high number is not negligible, and there are several hundred or thousands of pieces in some cases (e.g. Potporanj Kremenjak and Potporanjske granice; Tripković 2003). The concentration is, in any case, high considering the distance of almost 400 km as-the-crow-flies from the Carpathian sources. At Opovo, 7% obsidian represents a significant proportion and indicates a noteworthy degree of connectivity between this community and those closer to the source areas.

8.3.2.1. Provenance

The analyses of assemblages from Potporanj Kremenjak, Potporanjske granice, Vršac-At and Opovo were done using EDXRF as described above and do not represent part of the primary work on the thesis[28]. The number of artefacts selected for provenancing from Potporanj Kremenjak is five, from Potporanjske granice, two and from Vršac-At, four. The small sample size was due to bureaucratic procedures which presented pragmatic limitations to gaining results that would be representative for large assemblages (issues discussed in Chapter 4)[29]. The material was selected on the basis of colour and form within the reduction sequence. The results of the chemical analyses (Figure 8.9) and macroscopic properties (colour and transparency) showed that the majority of obsidian comes from the C1 source. There are, however, two pieces that are ascribed to the C2 source, a pressure-flaked blade and a micro-core, although the overall occurrence of material from this source should not be more than 1 or 2% of the obsidian. From Opovo, 24 artefacts were chemically examined and all are assigned to the C1 source. The visual properties of the entire assemblage (c. 100 pieces) also suggest this raw material is the only one represented.

---

[28] They are part of an ongoing collaborative project with Boban Tripković, University of Belgrade.

[29] Obsidian from Potporanj Kremenjak, Potporanjske granice, Vršac-At is stored in the Vršac museum; Opovo material is kept in the Pančevo museum.

8.3.2.2. Technology

At the Vršac sites, obsidian appears to be brought in as unworked nodules and processed into blades on-site. The obsidian artefacts from these settlements are numerous and include forms that belong to different stages of manufacture (Figure 8.10). The material consists of an abundance of waste flakes: cortical, preparation and rejuvenation pieces, proportionately even more rich than at Vinča-Belo Brdo (Radovanović *et al.* 1984; Voytek 1985). The cores are very small in size and were used for the production of unipolar micro-blades (Figure 8.11). The size of nodules and micro-cores indicates that the sources of obsidian were much exhausted at the time of this utilisation. The production of micro-blades is performed using the pressure flaking technique by skilful craftsmen (Chapman 1981; Voytek 1985). The micro-blade tools differ from the blades of the Vinča-Belo Brdo obsidian industry, with the most frequent tools including trapeses and truncated pieces. This is distinctive for the settlements located in the eastern parts of the so-called Vinča culture (Radovanović *et al.* 1984, 67-68; Voytek 1985). The above technological characteristics are related to the consumption of C1 obsidian. The form in which C2 obsidian was procured and exchanged is indeterminable at this point in research due to the character of the finds. The analysis has shown that there are exhausted cores and blade fragments, although it is not clear whether the preparation of nodules or reduction of cores took place at Potporanj Kremenjak or outside of this settlement. The sporadic appearance of C2 obsidian is likely to indicate that it was imported to certain sites at least as finished objects.

At Opovo, there are suggestions that obsidian cores were brought to the settlement in prepared form (Tringham *et al*. 1985, 443) and that it was treated carefully to extend its use life. The material includes micro-cores, some decorticated flake material and pressure flaked micro-blades. It can be presumed that prepared cores were brought here from elsewhere, possibly the Vršac region, and knapped locally into blades.

8.4. The outer zone: central Balkans

This section describes the assemblages that are located farther south, mainly in the central Balkans. There are numerous settlements from which Carpathian obsidian has been identified within more diverse lithic assemblages (Figure 8.1). The earliest evidence for obsidian consumption in the Balkans relates to the EN and MN Starčevo culture communities of the late 7th to mid-6th millennia BC. The provenancing of some EN assemblages (e.g. Donja

Branjevina, Starčevo, Golokut, Lepenski Vir and Blagotin) has shown that obsidian, during this period, comes from both C1 and C2. C2 material is much less well represented although it sporadically occurs in the northern Balkans and at some settlements south of the Danube (e.g. Lepenski Vir and Blagotin; pers. obs.). As expected, C1 is in many cases the only obsidian consumed. Early procurement of obsidian is mainly in the form of unstandardised debris that might have been exchanged as flakes, and is not associated with evidence from on-site manufacture.

During the LN period, the number of sites with Carpathian obsidian increases, but most of the assemblages contain only a handful of artefacts (commonly up to 10 pieces). In this section, only certain assemblages are presented, including those that were previously analysed by EDXRF, NAA and pXRF methods. The sites are Šamatovci, Gomolava, Masinske njive, Banjica, Selevac, Belovode, Supska, Slatina and Drenovac (Figure 8.1). Belovode is the only site that I studied as a part of this thesis, using pXRF. In terms of chronology, the sites presented here belong to early and late Vinča periods (early LN and later LN / EE, roughly between 5300 and 4500 BC; Figure 5.4). Appendix 1 details individually the chronology of sites, if this has been specified in available excavation records and publications.

Site	Site date	Obsidian total No	Obsidian % to other lithic	No of pieces analysed with pXRF	Seasons included	Remarks
Belovode	LN (Vinča C-D)	7	>1	7	2012-2013	All obsidian artefacts provided by the excavators were examined
Mandalo	LN (?)	10	>1	10	All	All obsidian artefacts provided by the excavators were examined
Dispilio	LN (?)	58	c. 2.5	58	All	All obsidian artefacts provided by the excavators were examined

Table 8.1. Central and southern Balkan sites - basic information about obsidian assemblages analysed with pXRF

8.4.1. Provenancing of obsidian by EDXRF, NAA, PGAA and pXRF

The Obsidian analyses discussed in this section have been undertaken as parts of several characterisation programmes including the work of Williams-Thorpe in central Europe (Thorpe 1978; Williams-Thorpe *et al.* 1984), Težak-Gregl and Burić (2009) in continental Croatia and Milić and Tripković (2008) in Serbia. The data produced from analyses of obsidian from all the sites has provided consistent results - Carpathian 1 is the only obsidian in circulation (Figure 8.12). Carpathian 2 is absent, except in the already mentioned instances of EN date. Undeniably, the larger assemblages might have contained C2 obsidian, although their identification requires systematic visual and chemical examination of much larger samples than would have been allowed by export permits in the past.

8.4.2. Technology of obsidian

As shown on map 8.2, the supply of obsidian from the Carpathians to the Balkans is continuous but not uniform through time. The most intensive circulation is related to early LN settlements (e.g. Vinča-Belo Brdo, Potporanj Kremenjak and Šamatovci), while it decreases in quantity in the later LN period (Voytek 1985) which can sometimes be traced through the stratigraphy of a single site. The extension of the circulation range in the later part of LN, however, increased and extended all the way to the southern Balkans.

8.4.2.1. Šamatovci

There are several sites located in the Sava region where C1 obsidian was represented indicating the region was part of the networks within which obsidian was moving. Šamatovci in Slavonia (Croatia), just like the Vinča A-B sites in Serbia, is seen as a micro-regional centre for the redistribution of C1 obsidian, since it contains higher proportion than it is documented at nearby sites, even though the overall obsidian percentage is not as high as at Vinča-Belo-Brdo and the Vršac sites. The site produced a large number of micro-cores and small regular prismatic blades. Obsidian appears at a few other sites in the region of the Sopot culture, with cores and blades being recorded at some, although in smaller frequencies (less than 1%) (Dimitrijević 1979, 291; Težak-Gregl & Burić 2009).

8.4.2.2. Gomolava

Gomolava is located on the bank of the Sava river. Obsidian from this site represents only a minute proportion (0.8%, six pieces) of the lithic assemblage. Interestingly, all obsidian artefacts are found in level Ib contemporary with Vinča D (late LN). Gomolava Ia levels do not contain obsidian and this is the period with the highest concentration of obsidian at Vinča-Belo Brdo, Šamatovci and Selevac (Kaczanowska & Kozlowski 1990, 36). This suggests that social processes affecting the desirability and / or access to obsidian were potentially related to different chronological sequences. The form in which obsidian occurs also differs from the industries from the earlier LN phases. Fine blade cores and micro-blades are lacking. The Gomolava assemblage is rather heterogeneous containing a fragment of a core and the rest of the pieces are waste material from knapping and the rejuvenation of cores, without any end-products identified thus far (Figure 8.12).

8.4.2.3. Banjica

The occupation of the site includes all phases of Vinča chronology. Even though it was located relatively close to Vinča-Belo Brdo, obsidian has only been sporadically found, and reported as 'a few small pieces' (Todorović & Cermanović-Kuzmanović 1961, 50). The contextual information indicates that obsidian is mainly found within structures that belong to the later phases of LN (Vinča D) (Tripković 2007, 81). Obsidian is recorded as less than 1% of the chipped stone tools. Four pieces were analysed with EDXRF and all came from the C1 source. Technologically, they are irregular blades and one is a fragment of prismatic bladelet, which appear to have been imported as finished artefacts (Figure 8.12).

8.1.1.1. Masinske njive

Masinske njive is a large site located near one of the Sava river tributaries, characterised by horizontal stratigraphy that includes MN, LN and Copper Age occupations. Relatively high numbers of obsidian artefacts have been found, even though the overall percentage within the lithics is not high (c. 2%). The obsidian assemblage is dated to late phase of the LN (Vinča D). The analyses of 15 pieces determined them as C1 type. Almost all material can be described as production waste, including cortical and non-cortical flakes and rejuvenation pieces, but there is a lack of cores or core fragments (Figure 8.12). There are also four fragments of prismatic blades. On the basis of the nature of these artefacts, it is probable that they were brought to the site as finished objects.

8.4.2.4. Selevac

The site of Selevac belongs to the group of settlements that geographically were located in the central Balkans, i.e. south of the Danube. It has horizons dated to all Vinča phases. The study of the chipped stone (Voytek 1985) has shown that obsidian frequency varies through time. Early levels, contemporary with the relatively rich Vinča-Belo Brdo horizons, contained most of the obsidian finds (c. 5% of lithics). The early acquisition was in the form of cores, reduced on-site into micro-blades and waste, similar to Vinča-Belo Brdo and Šamatovci, but in smaller quantities. After this period, the percentage of obsidian decreases to less than 1%. Voytek (*ibid.*, 206-207), however, noted that after this decline, in the final building horizon, a number of finished blades were recovered, but there is no evidence for working obsidian in the settlement at this time. This is probably a result of new exchange networks amongst late Vinča settlements (*ibid*., 207).

8.1.1.1. Belovode

The site is located close to a tributary of the Morava river in the central Balkans. Belovode contains early and late Vinča phases. Obsidian is rare, possibly less than 1% of the lithics assemblage, although the material is yet to be studied systematically. I have analysed seven obsidian artefacts that were found during recent excavation seasons (2012-2013). It should be stressed that the obsidian pieces described in this chapter were found within only a small excavated area at the edge of the settlement. Six pieces stratigraphically belong to the later LN phase (Vinča C-D, dated to the period between c. 4900-4500 BC), while one piece is dated to to the earliest horizon, Vinča B1 (late 6th millennium BC). PXRF results (Figure 8.14) identified the C1 source as the origin of these artefacts. Technologically, the assemblage consists of four blades (three are prismatic) and three flakes (Figure 8.12).

Morava valley region: Supska, Drenovac, Slatina

These settlements are located in the Morava river valley and represent the southernmost LN sites in the central Balkans that are discussed here. All sites were occupied during early and late LN (Vinča A-D). The amount of obsidian found at each settlement is very low (probably up to five pieces per site), representing less than 1% of chipped stone assemblages. Three pieces from Supska, two from Drenovac and three from Slatina have been analysed for provenance, and the trace elemental analyses identified C1 as the only source. The artefacts appear to have been brought to the settlements mainly in the form of flakes (Figure 8.12), though again, such small samples allow no certainty.

8.4.3. Assemblages made of other raw materials

The northern, central and southern Balkans represent the very fringe of the distribution of Carpathian obsidian. This entire region, as well as the areas with obsidian sources to the north, is rich in raw materials suited to making tools including radiolarites, different types of flint, cherts, quartz, etc. The major industry includes the manufacture of blades and micro-blades (Kaczanowska & Kozlowski 1990). The nodules are knapped into unipolar blade cores, while unstandardised flake cores occur in raw materials that were not of good quality for tool production (e.g. quartz). Blade cores made of flints occur at most sites and these were regular, often pyramidal in shape. Micro-cores are also common for the earlier part of the LN (Voytek 1985). Most of the retouched tools are made on blade blanks. The variety of tool classes includes different types of scraper, simple retouched blades, truncations and sickle blades, followed by retouched flakes and perforators (Figure 8.15). Scrapers are the most dominant group and they typically appear as end-scrapers on blades, double end-scrapers on blades, round scrapers and as end-scrapers on flakes. There is also a notable microlithic component, which is typical for settlements in the eastern part of this region (e.g. Potporanj Kremenjak) and these are represented by geometric forms such as trapezes, rectangles, truncations and backed blades (Kaczanowska & Kozlowski 1990; Radovanović *et al.* 1984; Voytek 1985). Very occasionally, tanged points of various stone types are found at central Balkan sites, and they are considered to be imports from the Adriatic region (Kaczanowska & Kozlowski 1990, 44).

The frequency of retouched and used tools made of flint is very high (c. 65% of lithic assemblages), although certain tool types are associated with particular regions and occupational phases. It has already been noted that there was a preference for geometric microliths in the eastern regions of the Vinča culture, while scraping and cutting tools are more used by central Balkan communities (Kaczanowska & Kozlowski 1990).

It seems apparent that at the margins of the circulation of Carpathian obsidian, there is a rather different pattern than in other fringe obsidian zones, which was a result of the abundance of good quality alternative raw materials that were used for the manufacture of variety of tools. Voytek (1985, 248) believes that the need for fragile obsidian micro-blades was negligible, suggesting that they could have been exchanged as non-utilitarian items. On the other hand, when we think of utilitarian roles, then fine sharp blades could certainly have had particular uses in archaeologically less recognizable activities, such as surgical acts (e.g. circumcision) or scarification, and so transmission could have facilitated functional needs.

8.5. Results from analyses of southern Balkan obsidian from Mandalo and Dispilio

This section is dedicated to two sites located in Greek western Macedonia (Figure 8.1), although in the geographic terms used in this chapter, they fit within the southern Balkan ambit. At this stage, it could be argued that Dispilio and Mandalo are the most southerly sites of the Carpathian obsidian distribution. The starting point for the research in this particular region was the recognition of C1 obsidian through chemical characterisation (Kilikoglou *et al.* 1996). This was exceptional since the site is located in what may have previously been considered to be the Aegean obsidian zone. Through analyses of other assemblages in Macedonia (described in Chapter 7), Carpathian obsidian was subsequently only identified at the site of Dispilio. Using a pXRF instrument, I have also re-analysed the Mandalo obsidian and, therefore, this site is included as a part of this original study with due recognition of the original analyses.

8.5.1. Mandalo

Mandalo was the first site in the broad Aegean region where obsidian from the C1 source has been identified. The total number of obsidian fragments appears to be 12, associated with LN/FN and Bronze Age occupations of the tell (Kilikoglou *et al.* 1996, 347). The exact proportion of the obsidian to other raw materials is not available, but it could be expected that obsidian does not exceed 1% of the total lithics component.

8.5.1.1. Provenance

The NAA analyses of 12 objects showed that ten artefacts from the LN are C1 obsidian, while one Bronze Age piece comes from the C1 source, and the other from the Melos Demenegaki source. In Chapter 5 (section 5.2.3) I have discussed some issues regarding the contextual and stratigraphic character of obsidian finds from this site. Accepting the excavators' interpretation, during the LN there is no overlap between C1 and Melos material, implying that C1 is the only obsidian consumed by the Mandalo community. PXRF analyses of the same obsidian further confirmed the C1 origin of all of these artefacts (Figure 8.16), which constitute 100% of the obsidian assemblage.

8.5.1.2. Technology

This aspect of the Mandalo obsidian assemblage has not previously been discussed. It is, however, a significant indicator of the nature of interaction between this and the northern communities. The ten artefacts of C1 obsidian represent a range of technological classes (Figure 8.17) including a core fragment (OB 483), flakes (OB 476; OB 482; OB 484), preparation (OB 479) and rejuvenation pieces (OB 475) and four fragments of blades, two of which are prismatic (OB 481 and OB 485). In the light of this group, it seems possible that we have evidence of on-site knapping of C1 obsidian, but were this true, we might expect more artefacts to have been found at the site, especially end-products, since the majority of this assemblage is production debris. Considering the distance from the source (c. 800 km) and from other communities that consumed C1 obsidian at the time (the distance to the closest documented use of C1 obsidian is at least 300 km, on a basis of currently known distribution), it is more reasonable to suggest that, perhaps counter-intuitively, these pieces were exchanged in the form that they were found and were not a product of in situ manufacture at Mandalo. The suggestion here is that the material was not procured for making tools, but for other reasons for which the form of the artefact was less significant than the substance (discussed in Chapter 9).

8.5.2. Dispilio

The lake-side site of Dispilio in western Macedonia has already been described in Chapter 7 (section 7.10.6.), since obsidian from the Aegean sources of Adamas and Demenegaki was also documented there. A total of 58 obsidian artefacts were recovered at the site, representing a very small proportion of the overall lithics assemblage (probably c. 2%). As was noted in Chapter 7, the precise contextual information for the obsidian finds is not available, although chronologically they are dated to the LN and FN phases of the settlement.

8.5.2.1. Provenance

All 58 obsidian artefacts were analysed with pXRF and it was possible to identify two major source groups (Figure 7.58). The Carpathian 1 source was represented with 11 pieces (19%), while Melos accounts for 47 pieces (81%). The Dispilio community, however, is unique in the central and southern Balkans because it was being supplied by obsidian from two different sources, indicating contacts with peoples from two distinct regions.

8.5.2.2. Technology

Considering the form in which the C1 obsidian was brought to Dispilio, a strong parallel can be drawn to the assemblage from Mandalo. Here again, the eleven C1 obsidian artefacts include a few types within the *chaîne opératoire* (Figure 7.61). Most common are flakes and debris (e.g. OB 516; OB 518; OB 520; OB 528), while two prismatic blades occur (OB 497 and OB 512). Similarly to Mandalo, it is unlikely that the knapping took place at the site, instead the C1 assemblage appears to represent a form of exchange in which flakes and blades were distributed in the form we find them. It is of particular importance, therefore, that the Melian obsidian found at other Aegean sites represents a different technological tradition which includes more blade products. People here were not only accessing obsidian from two sources, they were consuming it in forms typical of the distinct traditions associated with each circulation area.

8.6. Discussion: connectivity in context

This discussion above has emphasised that the Carpathian sources exhibit certain differences with the other two source areas described in chapters 6 and 7. This is mainly with reference to the way distribution patterns change through time and due to raw material qualities. Numerous scatters at the source areas named C1 and C2 were extensively used in prehistory, although the existence of alternative good quality lithic raw materials in the Carpathian basin affected the intensity of obsidian consumption in the areas close to the sources. Moreover, the occurrence of obsidian in geologically secondary contexts, the small size of the nodules typically consumed and the depletion of sources towards the end of the MN and in the LN, were all factors that influenced the way in which obsidian was used. Considering all of these, it is not surprising that the in inner zone sites with a large obsidian components (>90%) are rare. This is related not only to the proportion of obsidian within the lithics assemblages, but also to the variety of tools that were made in obsidian.

In the Carpathian zone, the so-called re-distribution centres or sites with preferential access, such as Potporanj Kremenjak and Vinča-Belo Brdo in the northern and central Balkans and some other 'outliers' in the Pannonian Plain, benefited from their geographic locations on rivers despite being a couple of hundred kilometres away from the sources. The importance of these centres for the distribution and typology of C1 obsidian artefacts at distant settlements can be understood when assemblages are observed from a combined chronological and technological perspective. In fact, one of the aims of this chapter has been to explain the appearance of C1 obsidian in Mandalo and Dispilio within a wider (Balkan) context before they became characterised as *exotic* or *eccentric* occurrences within the Aegean interaction zone. Considering the chronological aspects, we can note that during the EN there was widespread transmission of Carpathian obsidian across the northern and central Balkans. The amount of obsidian found at such sites is small (up to 5%) and, finds from the C2 source are very sparse but are present at sites north (e.g. the Vršac region) and south of the Danube (e.g. Blagotin and Lepenski Vir; pers. obs.). Carpathian 1 obsidian, on the other hand, is more frequent in all regions, although its procurement in the EN does not appear to be systematic. In Mehtelek, it was procured as nodules and worked on-site into the blades. Obsidian pieces that were found in the EN northern and central Balkans are not standardised and often occur as waste flakes (e.g. Starčevo, Donja Branjevina and Golokut; pers. obs.).

Previous characterisation programmes have demonstrated that during the LN period (c. 5500-4500 BC), only C1 obsidian is present in the Balkans. The occurrence of C2 obsidian in the LN is documented only at some Vršac sites, however, since these assemblages were never systematically collected, the mixing of stratigraphic deposits should not be disregarded. The LN in the Balkans is related to the Vinča culture which includes the four phases mentioned above, A-D. The first two phases, A and B, could be considered as early LN (or LN I in Aegean terms), while phases C and D overlap with later LN (or LN II). This periodisation also corresponds to distinct patterns in obsidian acquisition and distribution. In the early LN, there is an unequal distribution of obsidian amongst settlements. This might be associated with the size, hierarchical position and status of settlements as well as the aforementioned closeness to communication routes. Equally, this could be a question of choice in which not all communities in the region would be attracted to this raw material and in which other good quality raw materials could satisfy their needs. Centres with large obsidian components are known from Vinča-Belo Brdo and sites around Vršac, and to a lesser degree, from Šamatovci in northern Croatia. The obsidian was brought to these sites as nodules to be knapped on-sites into fine prismatic blades and bladelets. The standardisation of micro-cores and pressure-flaked blades may well suggest that these were a product of specialised manufacture. Of course, at long-lasting settlements such as Vinča-Belo Brdo, it still needs to be investigated whether this material is obtained several times throughout the settlement history or was brought only occasionally in larger loads and used over longer periods when needed.

site	source	cores	flakes	cortical flakes	rejuve-nation	irregular blade	prismatic blade
Vinča B-B early	C1	n/a	6	n/a	n/a	1	31
Vinča B-B late	C1		6	2	2	1	11
Potporanj Kremenjak	C1	2	1	n/a	n/a	n/a	2
Potporanjske granice	C1	n/a	n/a	n/a	n/a	n/a	2
Vršac At	C1	2	n/a	1	n/a	n/a	1
Opovo	C1	2	7	4	3	1	7
Gomolava	C1	1	1		3	1	
Banjica	C1					3	1
Masinske njive	C1		4	2	3	2	4
Drenovac	C1		2				
Slatina	C1		2				1
Supska	C1		1		1		1
Belovode	C1		2		1		4
Mandalo	C1		4		1	2	3
Dispilio	Melos A		4		6	5	9
	Melos D		11		1	4	7
	C1		7			2	2

Table 8.2. Presence (grey) or absence (white) of basic stages of the reduction sequence at each site by source. The numbers indicate sample size (n/a – due to export sampling restrictions, certain categories, e.g. cores, were not elementally analysed; their presence is noted in the literature)

At Potporanj Kremenjak, there is particularly strong evidence for in situ manufacture in the form of numerous waste flakes and cores. The nuclei are micro sizes due to the small size of nodules exploited at the sources at this time. They were fully utilised to be able to produce as many micro-blades possible. These blades are narrow and fragile and in most cases without any retouch and use-wear, suggesting their deployment for cutting soft materials (Radovanović *et al.* 1984; Voytek 1985). From these places, obsidian was further transported to other settlements, likely in the form of blades or even prepared and initiated cores that were further knapped. One example is Selevac where a similar blade industry was found together with only one micro-core (Voytek 1985). In sum, the early phases of the LN are characterised by the existence of production sites where micro-cores were used for micro-blade manufacture and from where finished objects, mainly blades, were further distributed.

During later phases of the LN, after c. 4700 BC, the amounts of obsidian visible at Balkan sites decrease considerably. Some settlements to the north of the Danube are still well-supplied (e.g. Opovo and Vršac-At), and there they continue to use the by then long established traditions of blade production (Tringham *et al.* 1985). However, the consumption of obsidian south of the Danube and even at Vinča-Belo Brdo, from phase C, decreases to less than 5% (Tripković & Milić 2008). In small amounts, obsidian is present at settlements south of the Danube, 400-500 km from the Carpathians, at Gomolava, Masinske njive, Banjica, Supska, Drenovac and Slatina, amongst others. At this time of reduced use of obsidian at the site of Vinča-Belo Brdo, we find the spatial extent of its use greatly expanded south of the Danube, though actual numbers remain low and it is used in a manner distinctly different to sites north of the Danube. At all sites south of the Danube, the obsidian assemblages recovered mainly consist of broken blades and a number of unstandardized flakes. In contrast, the sites north of this major river appear to follow earlier established the blade knapping tradition that was also used previously at Vinča-Belo Brdo.

The most southerly sites where C1 obsidian was consumed occur in the Aegean zone and these are entirely consistent with the primarily flake types of assemblages in the central Balkans. These in turn, as discussed, are distinctly different to assemblages north and south of this region, whether this pattern is based on consumption or discard / depositional practices. The networks through which obsidian was brought to exceptionally far-off locations such as Mandalo and Dispilio is related to the use of other intervening sites consuming C1 obsidian in the same time in central and southern Serbia. Firstly, taking into account chronology, the appearance of C1 obsidian at these two sites belongs most likely to the period of late LN (Vinča D), and this relates to new patterns in the circulation of obsidian amongst the above mentioned sites. Secondly, at all sites, the percentage of obsidian is almost equally small, even at Vinča-Belo Brdo, formerly a rich production site, as it is at Mandalo and Dispilio, c. 300 km to the south. As archaeological research develops in today's FYRO Macedonia, it is possible or even expected that we will find LN instances of C1 obsidian, though we may equally expect on the basis of current evidence that the numbers will be low (i.e. no redistribution sites). Finally, it is noteworthy that the form of obsidian that was found at late LN sites is heterogeneous, i.e. usually in form of flakes and irregular blades and not the product of such careful or skilful manufacture, such as pressure-flaked blades. The form in which obsidian occurs at sites is significantly different from the more regular fine cores and blades made in earlier phases of the LN (Vinča A-B). This change indicates that there was a different picture than we are otherwise familiar with, which in turn indicates differences in the social practices surrounding production and consumption. There are suggestions that sites located south of the Danube might belong to a more ‘conservative’ region, oriented towards the utilisation of local resources, while at sites north of the Danube we find better established and developed exchange networks (Tripković 2013). However, in the later part of LN, in the central Balkan area, the growth of metallurgy was taking place which might have had a significant impact upon the worldview of these communities. What we can say with certainty is that whatever the conditions were surrounding the use of obsidian, the archaeological record, as it stands, is unusual and reflects modes of consumption that left non-functional artefacts as their dominant material signature at sites. As Table 8.2. demonstrates, from this point of view, it could be argued that obsidian was exchanged in the form of flakes and not for its cutting properties. It might be also that obsidian was being re-used and recycled from earlier times, and was now often serving as a symbol of connections or as a secondary materialisation of exchange of other artefacts. Overall, a new pattern in obsidian circulation emerges, creating a micro-regional network in central and southern Balkan obsidian exchange and use traditions, which may extend, if very much sporadically, as far as some sites in northern Greece.

Chapter 9. Discussion: Interactions among Aegean, Anatolian and Balkan Neolithic societies

9.1. Introduction

In the preceding eight chapters, I have sought to use technological and compositional characterisation of obsidian as a way of exploring interaction within and between Neolithic societies at the boundaries of different obsidian source areas. My purpose has been to use these datasets as a means to assess how and why communities in these regions were linked into wider communication networks and at the same time to explore how access to related resources affected local patterns of practice and material value. Where such obsidian distributions overlap, different processes and social concerns may be recognised, and by utilising a multi-proxy approach to obsidian characterisation, it is possible to develop an understanding of the varying motivations and mechanisms underlying the procurement of obsidian, from the gateway community of Çukuriçi Höyük to the occasional long-distance contacts of Mandalo. In this chapter, I will draw together some key points that have been raised in previous discussions, and will synthesize the overall contribution that this study makes to our understanding Neolithic exchange and Neolithic society.

There are many reasons why people sought to procure obsidian, as evident from the existing literature on this key topic in early human history. We may ask whether obsidian was used for its physical properties (e.g. sharpness) or for its appearance and symbolic potential to demonstrate travel and contact. This thesis has investigated the modes and scales of interaction that can be measured through characterising obsidian consumption. In all three of the source regions considered in this study, the sites analysed would be placed at the far end of typical fall-off curves (Figures 6.3, 7.3, 8.3) measuring distance from sources versus obsidian frequency relative to other raw materials. When chronology, mode of consumption, location of settlement and relations with neighbours are also taken into account, certain patterns occur, that can be typical for one region or period, but not necessarily for others.

Interactions that can be examined through obsidian exchange engage with three main questions:

a) Directionality - where is obsidian coming from?

b) Intensity - what is the frequency of different obsidian types at any given site?

c) Nature - in what form was obsidian exchanged and consumed?

Characterising, and where possible quantifying, the relative proportion of obsidian to other raw materials was the first step of this study. This was followed by determining the origin of obsidian artefacts through chemical and visual characterisation using a portable XRF device, and finally I examined technological form of obsidian pieces with an emphasis on identifying the *chaîne opératoire* responsible for their manufacture.

One of the main methodological contributions of this study has been the use of large-scale sampling (up to 100% of assemblages) using pXRF as well as visual characterisation to provide a broad basis for characterising consumption. During my research, I have elementally analysed c. 1000 pieces from 20 sites, while the remaining material in assemblages was visually and typologically assessed. The use of a pXRF technique, underpinned by careful calibration based on geologically certain pieces, enabled me to discriminate different geological sources of obsidian in Neolithic assemblages, and critically, to detect rare and uncommon pieces that would not be visible or be under-represented using more common sub-sampling methods. In turn, these analytical advantages were used to quantify major and occasional obsidian types that were represented in the study assemblages. Over two decades ago, Perlès (1992) suggested that different raw materials moved through different exchange systems or networks, probably as outcomes of independent motivations, exchange mechanisms and knapping practices. This became visible even when discussing the appearance of two or more types of obsidian at what I have termed sites in the inner zone, such as Çatalhöyük. Despite everyday use of central Anatolian obsidian at that site, for example, the occurrence of eastern Anatolian Bingöl obsidian demonstrated that someone in the community made other contacts beyond the routine ones (Carter *et al.* 2008a). Likewise, at Saliagos in the Cyclades, Melian obsidian was a central part of the inhabitants' economic life, however, chunks of obsidian from the Giali source found at Saliagos suggest visits between the people in the Cyclades and the eastern Aegean, possibly for the purpose of exchanging Melian obsidian, or other reasons. This leads to the central subject of this chapter - the scale and nature of interactions that we can measure using obsidian. This lithic resource is not only a symbol of contact, but it is significant because through it we can recognise infrequent contacts that are not considered to be the usual relations of communities.

Before considering the general conclusions of the thesis, I will begin by discussing the patterns recognised in chapters 6, 7 and 8 relating to the three major obsidian source areas - Melos, central Anatolia and the Carpathians. The assemblages in question were dated to the

EN (late 7th - mid-6th millennia BC) and LN (mid-6th - mid-5th millennia BC) periods. Of critical importance here is that the periods analysed relate to significant social transformations. In the Early Neolithic, it is believed that farming communities migrated into the coastal parts of Anatolia on the eastern Aegean and Marmara littorals. In the Late Neolithic, there is continued movement of peoples in the Aegean and Balkans, and the intensification of farming settlement and landscape use in all parts of the study area, particularly throughout the Balkans. On the basis of obsidian presence alone, two major areas of interaction in the Aegean were confirmed and their character assessed (Figure 9.1):

a) An overlap of Melian and Anatolian obsidian in the eastern and north-eastern Aegean and in north-western Anatolia in the EN period.
b) An overlap of Melian and Carpathian obsidian in the southern Balkans in the LN period. There is also a sporadic overlap of Melian and Anatolian obsidian in the northern Aegean (case studies of Uğurlu and Gülpınar) in the LN, but these sites in isolation without adequate comparanda from neighbouring areas are not sufficient to produce a meaningful regional picture.

What is significant and common to both cases is that these regions are located in the outer zones, implying that the people that lived there were involved in some form or forms of long-distance interaction. At the same time, they could be on the margin of another zone. This may raises the possibility that their social practices were influenced by communication with communities and regions characterised by differing cultural practices and potentially different values.

By examining the patterns of consumption at each site, it has been possible to define micro-regions which appear to have followed distinct local traditions. For example, in the eastern Aegean, the region of Izmir most commonly uses Melian obsidian amongst other lithics. On the other hand, farther north, in the Marmara region, different obsidian types are predominant. The examination of a number of settlements within micro-regions is important not only for understanding how communities engaged in long-distance communication, but also tells us about the inter-settlement relations and ties that do not strictly have economic or functional motivations. This is most clear in another micro-region, the northern Aegean, where we find influences from both source regions as a tiny minority element in chipped stone assemblages. The striking case, as discussed in Chapter 8, is Macedonia, where distinct technological strategies are used to work the obsidian from the Carpathian and Melian sources. In the LN, the zone of interaction in the southern and central Balkans (with Belovode, Dispilio and Mandalo) is distinct from that in the coastal parts of Macedonia (e.g. Paliambela, Makriyalos, Thermi B) and that to the north of the Danube.

The chapters dealing with the primary data were organised in terms of the obsidian sources exploited, and in the following section these parallel pictures will be placed in an historical framework. Beginning with the EN of the east and west coasts of the Aegean, I will discuss acquisition and technological traditions, and will lead from this into a discussion of the LN material in the Balkans and the Aegean.

9.2. Early Neolithic societies (late 7th and first half of the 6th millennia BC) of the eastern and north-eastern Aegean and Marmara region

In section 2.2. I described the most recent hypotheses related to diverse trajectories during the processes of Neolithisation and movement of groups from central Anatolia to the Aegean and the Balkans. As suggested, particularly based on pottery styles, the movement of people in the EN period across the Anatolian peninsula towards the west and north-west might have followed different pathways that are also chronologically distinct. Analyses of obsidian from some of the EN settlements involved, greatly contribute towards our knowledge about these processes.

Chapter 6 noted that communities in the inner zone used central Anatolian obsidian for the production of a range of tools including projectile points, large scrapers and other objects (e.g. mirrors and amulets), while none of these more specialised items are found in the distant areas to the west. Bifacially flaked projectile points occur only rarely as far as the Lake District. The standard pressure flaking of prismatic blades from unipolar bullet cores, as used in the inner Anatolian zone does, however, occur in the west of Anatolia in the mid-7th and first half of the 6th millennia BC.

At roughly the same time, Melian obsidian was consumed throughout the Aegean, predominantly in the form of prismatic blades. It was typically brought to sites as already prepared cores where it was knapped into regular blades by the pressure-flaking technique. The same technology was used in the western Aegean (Thessaly and the Peloponnese) and the eastern Aegean (western Anatolia), as shown in Chapter 7. The only exception so far is the so-called *piece esquillee* industry practiced at EN Knossos. Here, obsidian was knapped into flakes from small bipolar cores, while prismatic blades do not occur. As with Anatolian obsidian, projectile points were also not manufactured in Melian obsidian. One suggestion for the absence of projectile points in the entire Aegean EN, unlike inland Anatolia, is this might be a result of different subsistence strategies in the two regions (hunting in Anatolia and animal herding in the Aegean; Kolankaya-Bostancı 2014).

The character of consumption of obsidian from Anatolian and Melian sources lends itself to the definition of distinct micro-regions that had markedly different patterns of use while also exhibiting a high degree of similarity among sites within each. This is indicative of localised traditions of consumption in relation to on-site practices, but equally it is indicative of their outward looking perspectives on long-distance communication. The distribution of Anatolian and Melian obsidian in the outer zones defines three micro-regional patterns at the peripheries, which are based on frequency of each obsidian type in conjunction with analysis of the form in which they were imported and produced:

a) The Marmara region

Chapter 6 demonstrated that Anatolian pressure-blades were consumed at settlements located in the vicinity of the Sea of Marmara where settlements of the Fikirtepe culture are characterised by high variability in their layouts and subsistence strategies, but considerable uniformity in their production of pottery, bone and stone tools. Obsidian is not the principal raw material for lithics at such sites (c. 5%), although the presence of both Melian and Anatolian obsidian, particularly at Pendik and Fikirtepe, can be seen to be a product of maintaining diverse contacts. The typological analyses (section 6.4.) show that Anatolian obsidian is knapped on-site from prepared bullet-cores into small blades, in a tradition consistent with other parts of this landmass. On the other hand, obsidian from Melian sources is brought here in the form of finished blades, representing the first appearance of this obsidian outside of the Aegean basin (section 7.6.). What makes this particularly interesting for this area, are the implications for understanding the character of populations occupying Fikirtepe settlements. On the one hand, there are alleged Epipalaeolithic descendants at Pendik and Fikirtepe and, on the other, Anatolian immigrants at tell sites south of the Marmara Sea (Özdoğan 2011; Özdoğan & Gatsov 1998). The knowledge of Melian sources at Pendik and Fikirtepe can contribute to this argument. The exact stratigraphic and chronological location of the Melian obsidian from these sites is unfortunately unclear at present, but it could be assumed that the Melian blades represent contacts between people voyaging in the Aegean and the hunter-gathering-fishing communities in Fikirtepe and Pendik. Obsidian was found at the Epipalaeolithic site of Çalca, although its origin is not known (Özdoğan & Gatsov 1998).

b) The north-eastern Aegean

Another distinctive region can be recognised farther away in the north-eastern Aegean, including eastern Thrace and the Troad. Obsidian in this part of the Aegean is rare (1-5%), but when present, it is dominated by Melian pressure-flaked blades (section 7.5.). A small number of Göllü Dağ obsidian artefacts (section 6.5.) are also found in the form of regular pressure-flaked blades, perhaps emphasising the close contacts of these communities with those in Marmara and other Anatolian regions. At Uğurlu on the island of Gökçeada, a distinctive Nenezi Dağ blade bullet-core characteristic of the Marmara sites also suggests this link. There are some indications that these communities had relations with communities of the Karanovo culture to the north in Thrace, on the basis of the presence of flint macro-blades (Guilbeau & Erdoğu 2011) and painted pottery (more below). On the other hand, the consumption of Melian obsidian indicates that these north-eastern Aegean regions are linked to some Aegean groups, perhaps those in the eastern Aegean, to the south.

c) The eastern Aegean

The third micro-region includes settlements in the eastern Aegean, near to the modern town of Izmir. As discussed in Chapter 5, this region was poorly researched until recently, and the new evidence indicates that a distinct identity emerged here that built upon a central Anatolian background but came rapidly to include seafaring. This links them to other Aegean communities that used Melian obsidian that was also knapped by pressure technology. The limited presence of Göllü Dağ and Nenezi Dağ obsidian is markedly different to what is seen in the northern Aegean and Marmara sites and at the Lake District sites to the east. Interestingly, these Anatolian sources are represented by one or two pieces found at every site I have analysed, irrespective of the location of the settlement and overall obsidian frequency. Furthermore, these one or two Cappadocian pieces are not pressure-flaked blades, as would be expected according to distribution patterns. In both neighbouring regions, the Lake District and the north-eastern Aegean, Anatolian obsidian is knapped into pressure-flaked blades, which is not the case in the Izmir region, according to the existing evidence.

Three micro-regions emerged through the study of EN obsidian, to which we can add the fourth already known case of distinct consumption patterns represented by Knossos with its splintered technology and the lack of pressure flaking of Melian obsidian. Furthermore, another distinctive region could possibly be identified at Thessalian sites where exclusively Melian obsidian was used for the manufacture of pressure-flaked blades (Perlès 1990).

Dividing western Anatolia into smaller regions is not new and has previously been noted amongst scholars (Brami & Heyd 2011; Çilingiroğlu 2009; Lichter 2005; Özdoğan 2011). Pottery styles in western Anatolia are separated into three distinct groups (as described in detail in section 2.2.1.): the dark burnished wares of the Fikirtepe culture in the Marmara region, the red-slipped burnished wares of the Aegean littoral and the painted wares of the Lake District. The distribution of Melian and Anatolian obsidian in this thesis has been used to distinguish another sub-region in the north-eastern Aegean. The sites in this zone are situated on the outskirts of the basin and the obsidian assemblages show similarities with other Aegean sites. Nevertheless, they do seem to maintain contacts with the north-western Anatolian settlers. This was also previously proposed on the basis of pottery styles. The main pottery ware is red-slipped, with strong parallels in the eastern Aegean material. The influence of the Fikirtepe groups is visible through smaller amounts of dark burnished pottery at these sites (Çilingiroğlu 2009).

The appearance of monochrome dark and red burnished wares in the Aegean and Marmara regions, respectively, is related to the period between c. 6400-6000 BC. Around 6000 BC, north-western Anatolia becomes more linked with the Karanovo sites in Thrace, as evidenced through the white-on-red painted pottery. This period also marks the appearance of impressed wares throughout the Aegean (Çilingiroğlu 2010). As described in Chapter 2, they are best represented in the eastern Aegean and to a limited degree in the north-east, while they only occasionally occur at the Marmara sites (Çilingiroğlu 2010). Impressed ware is known also at sites in the western Aegean (e.g. Argissa and Achilleion), though its execution indicates it is a local product (Çilingiroğlu 2010; Reingruber 2011). On the other hand, typical Fikirtepe incised box fragments are found in pottery assemblages in the Troad (Çoşkuntepe) and even to the south in settlements of the eastern Aegean (e.g. Moralı; Takaoğlu 2004).

There are similarities between the circulation of Melian obsidian in the eastern and north-eastern Aegean and the distribution of impressed wares. Interestingly, the appearance of Anatolian obsidian at some Izmir region sites, as we currently know, is dated to this later phase, i.e. Ulucak IV and Yeşilova III. Late. It can be argued that this might be a part of an exchange network and interaction that took place between the eastern and north-eastern Aegean communities, possibly around 6000 BC.

In view of the distribution of impressed wares and Fikirtepe boxes, albeit in small quantities, and the other similarities between eastern Aegean and Marmara communities cited above, the occurrence of Melian obsidian at the Marmara sites could perhaps be expected, even if this was not previously recognised. Melian obsidian was likely moved along the eastern Aegean following the coastline of the western Anatolian mainland. These or other groups were then moving along the northern coast with obsidian changing hands during interactions, which may have varied from chance encounters to more regular interactions.

For the EBA, Şahoğlu proposed (2005) that the network of routes from inland Anatolia towards the west broke into several branches - the north-western route reaches Marmara and the Troad and continues to Thrace, and the central-western route goes to the eastern Aegean. To account for the mosaic of EN traditions it is suggested that these areas are settled through the movement of groups from their ancestral land that then followed different trajectories and each group "would have retained some, but only some, of their most valuable symbols and techniques" (Perlès 2001, 62). Özdoğan (2011) believes that ceramic types are part of different Neolithic packages which are an outcome of independent processes of Neolithisation. These developments are uneven and can be characterised as a part of the assimilation and adaptation of newcomers to their new setting. In the case of the eastern Aegean, north-eastern Aegean, Thrace and Marmara regions, hybridisation is seen in all aspects of life, through different settlement and building types, pottery, bone and stone tools and subsistence practices.

Obsidian assemblages additionally suggest that these communities were involved in integrating diverse traditions in single settings. The location of the eastern Aegean sites can be seen as favourable for creating social and cultural contacts with the islands and the western Aegean mainland through intensive actions requiring maritime mobility. The newcomers developed knowledge related to obsidian procurement and fishing practices that might have been known by some occupants of the region even before the arrival of farmers from the east. Melian obsidian was used by hunter-fishers in the islands and coastal zones since the 9th and 8th millennia BC (and earlier at Franchthi Cave), however, we currently do not have evidence for the occupation of the eastern mainland in this period. The earliest contact between the western Anatolian mainland and the Aegean island of Melos belongs to the first half of the 7th millennium BC, as evidenced from Ulucak VI. This is an aceramic phase with typical Anatolian houses with red-painted plastered floors, a lack of clay objects and a subsistence economy consisting of developed herding and agriculture (Çilingiroğlu *et al.* 2012). From this level of the site, there is also a small amount of obsidian, amounting to 3% of the chipped stone assemblage, all provenanced to Melian sources (section 7.4.1.). It is interesting that the artefacts were in the form of pressure-flaked prismatic blades (Figure 9.2), a technology widely used in Anatolia at the time. There are not many contemporary assemblages that can serve as a parallel to this group of blades. In other parts of the Aegean, the same technology was used for the manufacture of blades, for example in Thessaly (e.g. early Argissa; Perlès 2001, 5.3). However, the contemporary assemblages from Knossos level X and the Franchthi Cave appear to be of a different character (Figure 7.5), which themselves have some apparent technological similarities (Conolly 2008; Kaczanowska & Kozlowski 2011). One of the explanations is their relation with the local Mesolithic tradition (Carter *et al. forthcoming*; Kozlowski & Kaczanowska 2011, 2013). There is no doubt that groups of Anatolian migrants came into contact with people who had seafaring knowledge, who shared their knowledge about the resources on Melos, while farmers introduced their pressure-flaking skills. It is possible that through future research, particularly at sites like Çukuriçi Höyük, we will gain more information about the contacts between Anatolian and Aegean based groups.

During the pottery Neolithic phase, from the second half of the 7th millennium BC, obsidian is common in all eastern Aegean settlements. Cores made of Melian obsidian are reduced by pressure-flaking which appears to be a pattern that can be identified across a wide area, including Thessaly, the Peloponnese (including Franchthi Cave) and the north-eastern Aegean. Knossos remains different and people there continue using splintered technology in the EN phase (Kozlowski & Kaczanowska 2013). Apart from the common raw material and production technology, there are other features that directly link the eastern and western Aegean. These are the absence of arrowheads and the use of sling missiles, impressed pottery, ear-studs, figurines, stamps, etc. (Çilingiroğlu *et al.* 2012; Perlès 2001).

The available data from Ulucak and Yeşilova show that rare central Anatolian obsidian pieces were being brought to these sites only from around 6000 BC. This might be related to the expansion of communities who started building more substantial mud-brick houses, and used the full repertoire of material culture associated with well-established settlements. Fully settled, they started regular contacts with other parts of the Aegean, as seen through the amount of obsidian that was being consumed at Çukuriçi Höyük, but also other communities. From here, obsidian may have been transported farther to the north-east Aegean. The presence of Anatolian obsidian artefacts might be a sign of stability, with greater circulation of material in which people are now meeting with distant groups enabling them to use these connections in new ways. In fact, the appearance of Anatolian obsidian in the eastern Aegean could be in some ways a product of reciprocal exchange with the north-eastern communities in which materials such as impressed pottery or bone and shell objects were also involved.

In the north-eastern Aegean, in contrast to Ulucak and Yeşilova, the use of Anatolian obsidian occurs before 6000 BC. There, the best evidence comes from Uğurlu, where Anatolian obsidian is known from the initial occupation of the site, c. 6400 BC. The technological characteristics of the Göllü Dağ and Nenezi Dağ obsidian artefacts there closely mirror the traditions seen in the Marmara region. While this Aegean community retains strong reflections of its Anatolian roots, it also soon develops contacts with other mainland groups in northern Thrace (e.g. the Karanovo group), as seen through the exchange of flint macro-blades and the appearance of painted pottery (Erdoğu 2013; Gatsov 2009; Guilbeau & Erdoğu 2011).

9.3. Late Neolithic societies (mid-6th - mid-5th millennia BC) in the southern and central Balkans

The Late Neolithic period is characterised by population expansion accompanied by the enlargement of settlements, specialisation in tool manufacture and distribution, and more visible social inequality as a product of developing intra and inter-community competition (Halstead 1999). This development is cautiously implied in the previous section on the Early Neolithic, through the occurrence of Anatolian obsidian in the eastern Aegean as part of expanding communications networks as communities gained greater stability and grew in population. It is unfortunate that it is not presently possible to follow the expansion of contacts in the Aegean-Anatolian region after the mid-6th millennium BC. As discussed in Chapter 5, settlements in the eastern Aegean and Marmara regions seem to be abandoned after 5700 BC (Çilingiroğlu 2009, 386). This dynamic period was marked with a high degree of inter-connections as indicated through black-burnished pottery, *Spondylus* shell, marble, flint and, finally, the exchange of copper objects at around mid-5th millennium BC (Chapman

1998; Perlès 1992). This can also be explored using another case study of obsidian-using societies, those of the southern and central Balkans.

That Melos in the Cyclades was a source of obsidian known to seafaring groups since the Upper Palaeolithic period has long been known (Broodbank 2006, 208; Renfrew & Aspinall 1990). In the Mesolithic, groups from various parts of the Aegean were making their way there but more extensive exploitation began once Neolithic settlements were first established in the vicinity of the sources in the later Neolithic (section 7.8.1). These settlements on the islands close to Melos (e.g. Antiparos, Naxos and Mykonos) contained activity areas for core preparation and blade production, and at this time novel forms of tools (Perlès 1992). Notable amongst the latter are the projectile points found at many settlements throughout the Aegean, where they were probably required for hunting and fishing. Farther away from the Aegean inner zone, prepared cores and blades were acquired by inhabitants of the mainland Peloponnese and Thessaly, and also a few are currently known to have been consumed in the eastern Aegean (e.g. at Tigani and Emporio; section 7.8.2). Remote Macedonian communities (section 7.10.) had access to small amounts of exhausted cores and blades, conceivably obtained for the most part from Thessalian groups rather than directly from the Melian sources or Cycladic communities.

In seeking to understand the reasons behind the distribution of obsidian in Macedonia, there were less complex exchange networks, or at least fewer distinct groups interacting, than we find in the eastern Aegean. In the LN period in the western and northern Aegean mainland, the Peloponnese, Thessaly, most parts of Macedonia and Thrace, obsidian from Melos is the only type used. To the east, in the north-eastern Aegean and Troad, although not very well explored area, we still have evidence for the acquisition of central Anatolian obsidian, at the sites of Uğurlu and Gülpınar (section 7.9.).

My analyses have demonstrated that, in Macedonia, Adamas obsidian was better represented in the assemblages. Whether there is any significance in this choice, since the two sources are located on the same island, with obsidian that is seemingly of the same quality, needs to be established through a much larger program of chemical and technological analyses throughout the Aegean. For the moment, it can only be speculated that: a) Adamas could have been preferred because it is more easily accessible and this choice depended on local environmental (winds and currents) conditions; b) this could be related to regional (geographical), chronological and socially contingent circumstances. For example, in the EN in the eastern, north-eastern and Marmara regions, Adamas and Demenegaki materials are more or less equally used. Whether there was a preferred Melian source amongst settlements in Thessaly and the Peloponnese, it is not possible to answer due to the current lack of analyses of those assemblages. The regional differences in the balance of Adamas and Demenegaki obsidian could be in the future used as markers to demonstrate different procurement traditions across the Greek mainland. In LN Macedonia, there is a group of settlements where the consumption of Adamas obsidian is much more frequent than Demenegaki (Figure 7.6). This is particularly evident at sites from which I analysed larger samples, Makriyalos, Kleitos and Thermi B, but also at other locations. It is unlikely that this is accidental, as the situation in the north might suggest that the procurement of this raw material is an independent network, distinct to Demenegaki, perhaps more organised, even if this is via intermediary groups or a single gateway community that is yet to be identified.

While there is a certain pattern in the frequencies of Adamas versus Demenegaki obsidian at settlements in Macedonia, and the overall occurrence of obsidian at each site is small, there are some variations. For example, at coastal Makriyalos, excavation of 6 hectares of settlement produced less material than Kleitos located some 65 km farther inland or the much smaller coastal site of Thermi B (Table 7.5.). On the basis of the range of operational stages represented, particularly of Adamas obsidian, it appears that some of these communities were occasionally producing their own tools, presumably by visiting knappers operating outside of the main settlement, while Demenegaki obsidian is imported as finished blades (e.g. Kleitos; Figure 7.54).

While communities located in the Aegean zone were exclusively obtaining obsidian from Melos and utilising the same knapping traditions, the picture is somewhat different inland, in northern parts of Macedonia. The material here indicates that there were connections to the north that emphasise the (physical) Balkan setting of these communities, and this is reflected in the obsidian supply. In Chapter 8 I discussed the cases of Mandalo and Dispilio with their rare occurrences of Carpathian 1 obsidian. This provides new perspectives for understanding the social world of southern Balkan peoples and the ways in which we can recognise or characterise connectivity between them. Traditionally, this would be characterised as an overlap in supply zones, though the technological characterisation demonstrates that the situation is not this straightforward. Mandalo only had a handful of obsidian pieces which were exclusively from the C1 source and no Melian material was recovered from its Neolithic phases (Kilikoglu *et al.* 1996). In section 5.1.3. I discussed the contextual and chronological position of these artefacts. To remind, one C1 artefact is found in EBA levels, while ten belong to the Neolithic phase, dated to c. 4500 BC. The suggestion here is that in the central Balkans we rarely (if at all) see the presence of C1 in Bronze Age levels and for that reason, it is unlikely that one piece from Mandalo could be of that date. One Demenegaki artefact from this site is also dated to the EBA phase and this is not included in the study.

Dispilio on the other hand, contained obsidian from the Adamas, Demenegaki and C1 sources. Melian finds from this site largely consist of flake material, lacking standardisation. In that respect, it is noticeable that assemblages with mixed sources appear to consist of mainly non-standardised artefacts, and this could be compared to the situation we find at Gülpınar in the Troad (section 7.9.1.). At this site, in a very small obsidian assemblage, we find material from Adamas, Demenegaki, Göllü Dağ and Nenezi Dağ, mainly in the form of flake material (Figure 7.35). The unusual form in which obsidian is found at these sites indicates that it is likely not associated with the expected activities that involved cutting, but more with activities of an unusual, perhaps some symbolic character, which I will discuss below.

The late 6th and 5th millennia BC in the Balkans has been characterised in the literature by the appearance of "expressive" materials (Bailey 2000; Chapman 2008), including copper, dark burnished pottery, Spondylus shells and obsidian. However, there are suggestions that there is a distinction between settlements in the northern and central parts of the Balkans. The northern settlements, in the fertile Danube region, tend to be considered to be more competitive in expressing the wealth and status of their residents. They are rich in pottery, decorative objects, symbolic and cult representations (houses with bucrania are also documented in settlements north of the Danube) and contained much exogenous material brought from a distance (most of the Spondylus shell is found at the sites north of the Danube; Dimitrijević & Tripković 2006; Tripković 2013). On the other hand, most communities in the central Balkans, south of the Danube, appear to have been more focused on local resources with little evidence for actively engaging in exchange networks. Their inhabitants use local resources that they have easy access to. Nonetheless, from the first half of the 5th millennium this is the region where new phenomenon related to copper smelting emerges, at sites such as Rudna Glava and here analysed, Belovode (Radivojević *et al.* 2010).

Carpathian 1 obsidian was found sporadically at Balkan settlements from the EN (c. 6000 BC) and, noticeably, mainly at sites in the vicinities of the Danube or other larger rivers, in Pannonia (e.g. Starčevo and Golokut). The most extensive exchange of this obsidian is documented at early phase (A-B) Vinča culture sites, dated to the mid-6th millennium BC. At this time, large tell and flat-extended sites, rich in material culture, developed. Some of them, such as Vinča-Belo Brdo and Potporanj-Kremenjak, well connected with the Carpathians via major rivers courses, are seen as important centres for obsidian distribution. These sites contained well-produced bullet cores and pressure-flaked blades that were consumed at many sites throughout the region. In the later part of the LN (early 5th millennium BC), south of the Danube, the situation changed markedly and it has not been possible to recognise distinct re-distribution centres, even at Vinča-Belo Brdo itself. To the north of the Danube, some communities maintained contacts with the Carpathian basin through extensive exchange networks, of which obsidian cores and blades are still part. To the south, despite the decrease in obsidian assemblages, the spatial extent of consumption actually increases and C1 obsidian seems be taken to its furthermost distance (c. 800 km from the sources), and exchanged amongst groups in the central and southern Balkans.

If we recognise the above pattern with competitive exchange in the north in Pannonia and communities in the central-Balkan region, then we can talk about two different, micro-regional behaviours when it comes to exchange and contacts, as seen through obsidian distribution as well as other proxies. If the ‘richer’ or more materially expressive north is using exogenous objects including obsidian for representing wealth, obsidian in the southern parts of the central Balkans and north Greece might have been replaced with the new trend (namely production of copper artefacts), while the circulation of obsidian could indicate some limited acts of an individual or family (e.g. travel token, dowry, composite objects of which obsidian fragments might be a part).

The appearance of Carpathian 1 obsidian close to the Aegean is currently unique for the inhabitants of Dispilio and Mandalo. The obsidian consumption represented by these two sites is rather puzzling. As previously noted, neither of them contained material that relates to the Melian knapping tradition that is found at sites that were not very far south of them. Instead, C1 material from these assemblages is very comparable to finds in the central Balkans (Figure 8.12), forming a unique sub-network within the south-central Balkans (Figure 9.1). Carpathian 1 artefacts from Mandalo and Dispilio also appear to belong to a later phase of the LN, although through published records it is difficult to confirm the context for these finds. On the basis of the Mandalo dates only, it can be assumed that both assemblages belong to the c. mid-5th millennium BC. Even though C1 obsidian occurs in small overall quantities, it is found at a number of sites south of the Danube (Chapter 8). The form in which these pieces occur is noteworthy, making the connection between these sites more relevant. It was reported that Mandalo, even though a small settlement, attained its regional significance through a number of activities (including textile production and copper smithing) that took place within the village (Kotsakis *et al.* 1989). The parallels with other settlements in the region (Dikili Tash and Sitagroi) and those in the Balkans are observed through similarities in black burnished pottery, figurines and clay cylinders (Kilikoglou *et al.* 1996; Kotsakis et al. 1989). Dispilio contained a variety of artefacts, some of which were obtained from far-away places (Spondylus and Glycymeris shells, Naxian marble, boat-shaped vessels, bone flutes, etc.; Hourmouziadis 2002; Ifantidis 2011). Therefore, it is not surprising to find Melian and C1 flakes within this unusual collection of artefacts.

In summary, in the LN of Macedonia, two different and independent exchange networks meet but they do not seem to overlap. One connects southern Macedonian sites with the maritime linked Aegean communities, the other links inland sites to central Balkan populations. The mechanism and relations that brought obsidian to these peoples surely cannot be explained in the same manner. Only in the case of Dispilio, where technologically similar assemblages made from Melian and C1 obsidian were found, the motives for the procurement could be the same. In case of C1 obsidian, we might consider exchange within sub-networks created south of the Danube in the later part of LN period, in which people communicated to maintain social relationships. The overlap zone between Aegean and Carpathian interaction zones could be questioned due to the fact that we are only talking of one site where it occurs (albeit in an area only poorly investigated to date), but it serves as a valuable example of illustrating the diversity of interaction and exchange mechanisms.

9.4. Discussion: comparative modelling of obsidian distributions

It has been recognised that when items are exchanged they should be considered in relation to both production and consumption, as different raw materials and object types can indicate separate patterns of procurement, processing and (re-) distribution (Perlès 1992, 115; Souvatzi 2008, 186). Perlès (1992, 117) has emphasised that there is unlikely to be a single exchange network in operation. Rather, she has proposed the co-existence of three exchange systems (*ibid*. 1992, 148-149): exchange of utilitarian goods that may be widely distributed (e.g. knapped and polished stone tools); exchange of non-utilitarian objects with social function amongst the groups in a smaller geographic region (e.g. fine wares); and the exchange of 'prestige goods' with symbolic connotations, limited to certain groups or individuals (e.g. ornaments, stone vases and metals). Even if we focus on obsidian alone, then it is clear that more than one production and exchange mechanism can be relevant in many cases, and to this can be added two different directions for these networks of interaction. Simply put, obsidian as a raw material, as a marker of technical knowhow, as functional object and as a symbol of relationships and/or distance can be variably appreciated in a single object dependent on context, and different ‘obsidians’ could receive different receptions on the basis of biographies and materials alike.

On the basis of fall-off distribution analysis (percentage of obsidian in the lithics assemblage vs. distance from an obsidian source), all Carpathian, Anatolian and Aegean sources show very similar declining patterns as one moves farther from their source (Figure 9.3). Nevertheless, besides quatities, other fundamental factors in interpreting exchange mechanisms discussed in Chapter 2 are the organisation of production, the type of artefacts produced, chronological patterns and contexts of consumption and deposition practices, and even the excavation / recovery strategies of different projects. The Marmara region is located c. 500 km from the sources in Cappadocia. The assemblages here comprise c. 5% of obsidian which when plotted on the fall-off graph seem to fit well with existing regression models (Renfrew *et al.* 1968b). Similarly, the pressure-flake technology that is used both in central Anatolia and the Marmara region could align with down-the-line contact. While central Anatolian cores are large in size (up to 10 cm), the bullet-cores found in Marmara are midway through the knapping sequence, not longer than 4 cm, thus yielding only small pressure flaked blades. When distinguished, Nenezi Dağ and Göllü Dağ material may indicate the co-existence of two distinct networks. Nenezi Dağ obsidian was brought to the north-west as prepared cores and worked skilfully into fine bullet-cores and prismatic blades. In contrast to this, objects made from Göllü Dağ obsidian are less represented. Cores and evidence for production are not common, and there is a noticeably more gradual drop-off in consumption with distance from the source. Currently, we do not know about consumption patterns at intermediary sites between the inner zone and the Marmara region. Farther west, in the north-eastern Aegean, the quantities of central Anatolian obsidian artefacts also correspondingly decrease both in terms of relative frequency (less than 1%) and technology, as they are only found as finished blades. In the eastern Aegean, c. 600 km the from central Anatolian sources, this obsidian is very rare, representing c. 0.1% of assemblages. In this case, intermediary sites may have been in the Lake District which had considerable amounts of obsidian among their lithics assemblages (c. 20%). Nonetheless, it could be suggested that obsidian in the east Aegean might be coming also from the north-eastern Aegean and the Marmara sites, following maritime routes, as was previously suggested for the movement of impressed pottery.

During the EN period, the procurement of obsidian from Göllü Dağ, Nenezi Dağ, and Melos appears to have followed independent trajectories reaching different sites. The exchange of obsidian from Melos to the eastern Aegean could be seen as directional or island-hopping to sites such as Çukuriçi Höyük, but typically, if not exclusively, down-the-line from here to other settlements in the region and farther towards the northern Aegean.

In the LN Aegean there are a number of sites with obsidian artefacts that indicate that Melian obsidian is more extensively used by the western and north-western communities than by those in the north-eastern region. The linear distance of the north-eastern regions (Troad and Thrace) from Melos is 350-450 km, and Thessaly and Macedonia are 300-500 km away, however it is noticeable that obsidian in the latter regions is much more abundant. Northern Aegean communities do not appear to have engaged significantly with the southern Aegean maritime activities and associated networks. Initially, in the EN, they were linked to Anatolian communities but they also developed contacts with Karanovo settlements to the north. Indeed, intensive investigations in Thessaly and Macedonia have provided useful information that demonstrates that some areas apparently had a greater desire for obsidian than others, particularly when other available raw materials were not of suitable quality or easily accessible. Typically, on the basis of quantities and technological characteristics, it would appear that Melian obsidian was brought to coastal mainland sites (e.g. Dimini) in the form of prepared blade cores and from there in successive exchanges it was brought to inland communities. We cannot preclude the maintenance of social relationships including inland groups joining expeditions to Melos, but there is nothing in the character of assemblages to suggest this was common practice. There are examples where two sites in the same region, that are located at the same distance from the sources, had assemblages that were recognisably different from each other, including the richness of tools, and the preparation and knapping of cores on site. This can be seen in the cases of Franchthi Cave and Lerna. The former has the characteristics of a recipient site, whereas the latter was more geared towards being a local producer and/or a consumer.

The situation is not very dissimilar in the marginal Balkan regions where C1 obsidian appears to be more frequently found at certain settlements than at others, as has been shown through the assemblages at early Vinča period sites of Vinča-Belo Brdo in the central, and sites around Vršac, in the northern parts of the Balkans.

In cases like Mandalo and Dispilio, the great importance of long-distance procurement has been emphasised by those charting the extent and character of interaction between Aegean communities and those to the north. The territory associated with the Vinča culture extends south to today's FYROM (Chapman 1981) which is some 150 km away from the Aegean LN settlements[30]. It would be oversimplifying things to explain the expansion of Carpathian obsidian use as constituting a linear extension from source to sites, i.e. over 800 km. It seems to be more realistic to talk about contacts between southern Vinča culture groups and northern Aegean communities, along the Morava and Vardar (Axios) valleys. The dating of these finds to the late LN phase (Vinča C-D), moreover, reminds us that this could be a part of novel social circumstance in which other materials such as metals became more widespread, while occasional exotic obsidian could represent part of that newly established exchange network.

9.4.1. Degrees of interaction - regular vs. one-off

As has been noted above, in the Aegean and neighbouring regions, on the basis of obsidian distribution alone, it has been possible to suggest that people in these places participated in different networks for a variety of reasons. Borrowing from the study of Palaeolithic societies by Gamble (1998), we might distinguish several different degrees of interaction involving different numbers of participants within intimate, effective, extended and global networks. Human networks are functional and material but also emotional and symbolic (Gamble 1998). In the Aegean in particular, obsidian exchange could be seen as a product of at least two separate mechanisms - one Melian, long-standing, perhaps on an inter-settlement level, and maintained through generations. The other is perhaps exotic and shorter-term, and related

---

[30] With little published on Neolithic sites in FYROM and nothing about obsidian assemblages, the relevant behaviour in the intervening area remain unknown.

to new events (e.g. central Anatolian obsidian and the exchange of impressed ware in the Aegean, or C1 and the exchange of copper in the central and southern Balkans).

In the case of the eastern Aegean, for example, it could be argued that communities that lived there would have had a functional need / desire for Melian obsidian due to its sharpness. Its acquisition could become familiar and thus come to form an accepted method. This obsidian is present in large quantities in the region from the 7th until the 3rd millennia BC. Just as at Thessalian settlements in the EN and MN, it is an exogenous raw material at sites where it was used and therefore was not wasted, but it appears to have served practical requirements. It was produced using uniform methods with the same results and possibly exchanged amongst locals from each village (all contain cores and débitage). On the other hand, occasional Anatolian pieces in the eastern Aegean can be seen as outcomes of social relationships which were not based purely on economic networks. Rarely, therefore, we may be able to talk about competitive exchange, as in many cases it seems that there were two distinct interactions, with different communities and individuals and possibly at separate times. In the north-eastern Aegean and sites in the Marmara region, obsidian came from opposite directions (the Cyclades and Anatolia), but is used in similar ways, for regular pressure-flaked blades, and therefore, it is hard to define what distinguished their procurement.

Similar to the appearance of central Anatolian obsidian in the eastern Aegean, C1 obsidian in the central and southern Balkans does not appear to have held much technological value. The character of C1 artefacts, in forms that can be characterised as waste and debris, was far from exotic in appearance, as one might have expected given the distance it had travelled and the hands it had passed through. There is a clear contrast to the C1 blade industries in the northern Balkan regions, as well as to the regular products of Melian obsidian in the south, where objects are part of a distinctive tradition associated with blade manufacture. If there is any significance in the C1 artefacts in the central-southern Balkans, it is probably related to the aesthetics of the raw material itself, serving as a marker of contacts, not trade. Obsidian could have been a symbol of individual / community partnerships, at the time of copper expansion, rather than represent an exchange of technological know-how. The interaction with other communities alone is of great importance and it might be less relevant precisely what goods were exchanged. There is an endless list of reasons for movement and contacts: marriage to ensure reproduction, to start alliances and partnerships, to confirm social status and to hire specialist are some of them. Halstead (1995) has proposed possible motivations to maintain long-distance relationships over and above local ones, especially in times of need. They could be related to conflicts with local groups, when alliances and refuge are sought from more distant but known groups. Also, in case of crop failure and diseases, this support from people in a different environmental zone could be essential for stability. Given that most of these objects occur in finished forms it could be suggested that their procurement symbolises the kinship of a community, family or an individual with another distant group of people.

Finally, there is the question of eccentric exchange (Tykot 2011). While this concept is appropriate in cases of the discovery of unusually shaped pieces at a particular site, it is questionable when such patterns appear across a number of sites and assemblages. Undeniably, Carpathian pieces in settlements such as Mandalo are rarities when looked at in isolation, however when they are put in chronological and regional context, they seem part of a network in which settlements and individuals shared some sort of very rare experience or exceptionally unusual material culture. A piece of Göllü Dağ obsidian in Ulucak is eccentric, but when each site in the region contains one piece from the same source, then this is a pattern, and perhaps not an accidental occurrence. We, unfortunately, cannot be sure whether these exchanges were part of one-off encounters or, for example, did each piece of obsidian represent a single gathering or meeting which we cannot otherwise recognise archaeologically. Until we get more data from excavations, the Nenezi Dağ bullet-core from Uğurlu is one such example (Figure 7.25). We could well ask whether this core is part of the same event(s) in which the Göllü Dağ blades are brought to the settlement. Another example are two prismatic blades found at Knossos X, which stand out in what is otherwise primarily a flake assemblage. The technological, rather than physical (sourcing) appearances indicated that these are objects brought from somewhere else (Conolly 2008, 84).

Even though many of the pieces described above are not aesthetically attractive or ‘characterful’ objects (e.g. projectiles or daggers) or functional razor sharp blades, their transparency might be the feature that makes these pieces different to the mundane or in any way common objects. The social context in which obsidian was used might have more significance than the objects themselves. To be able to recognise this in archaeological contexts is crucial, yet difficult to achieve for at least two reasons. One is in terms of excavation tradition and recovery in which material is collected from arbitrary layers and not discrete depositional contexts; the other reason is related to the Neolithic scenario in which obsidian is often found discarded and not carefully kept in hoards and burials (Robb 2007). In section 2.3.4 I discussed some peculiar archaeological contexts that can stimulate our imagination when it comes to the interpretation of unusual obsidian artefacts. These are obsidian blade and flake fragments used as eye inserts in a life-sized stone statue from Urfa and in anthropomorphic vessels from Hacılar. These obsidian fragments have a particular meaning as a part of a statue, while when found isolated in a layer, they appear ambiguous in character.

Those models used to explain the distribution and consumption of obsidian have previously prioritised the movement of objects as commodities, as objects of desire and/or necessity. Being prepared to consider more idiosyncratic examples of human agency, we can at least speculate that the discovery of few pieces of obsidian at one site may reflect the presence of an individual who came from an obsidian-using area and perhaps brought this material for his/her own needs. At a later stage at the same site, obsidian may have arrived through other mechanisms, but these very different processes cannot be distinguished clearly archaeologically. The particular value of the approach employed here to obsidian characterisation is that at the very least, it can tell us if there was more than one social process or network responsible for bringing obsidian to a specific place.

Chapter 10. Conclusion

In exploring the exchange of obsidian across western Anatolia, the Aegean and the Balkans, this project has developed the first large-scale, pXRF-led obsidian characterisation program. It has thereby enabled the differentiation of assemblages by percentage of sources represented, augmented by establishing the proportion of obsidian relative to other lithic materials in these assemblages. Through this methodology and a wider technological study of the same material, my aim has been to challenge existing theoretical positions, and offer new perspectives on the modes and purposes behind distant resource acquisition in the Neolithic.

While the Neolithic as a phenomenon famously represents the emergence of sedentary settlement systems, mobility can also be seen as a core element of the Neolithic way of life. Obsidian as a tracer of this mobility echoes as much the desire to visit places and make journeys, as it does economic actions that commoditised this material. My focus has been to better understand the motivations, processes, and where possible practices, that lay behind the dissemination and consumption of this very distinctive material. In so doing, the discussion in previous chapters has sought to improve our knowledge of long-distance interactions and complex exchange networks.

In particular, by prioritising case studies located at considerable distances from obsidian sources it was possible to compare these more marginal experiences of obsidian with better published uses of it by communities in closer proximity to the sources where obsidian was usually the raw material of choice for a range of tools and occasionally other artefacts. The key sites for this study were chosen from the outer zones of known obsidian distributions where this stone was not an obvious raw material, and its circulation almost certainly represented a mix of social and technological choices. The character of obsidian assemblages suggested that these communities were participating in two or more distinct exchange and communication networks. Obsidian from different sources may have arrived at such communities through a variety of processes that would have been historically contingent and therefore potentially variable at a temporal scale beneath our ability to differentiate archaeologically. In seeking to explain the material patterns that I have identified, it becomes clear that, in obsidian studies, without provenancing, we have in the past conflated two or more obsidian sources and networks as one. This may in fact be plotting two or more independent social practices which we have hitherto failed to differentiate meaningfully. A key question is whether we may best take a default position whereby obsidian was filtered down-the-line through local exchange relations, or whether we can think of groups actively maintaining longer distance relationships, of which obsidian is a material echo. Indeed, we should not adopt an either / or contrast to these potentially variable possibilities.

The methods employed in this study provide an opportunity to use elemental characterisation and technology as complementary means to improve our understanding beyond site-specific consumption and provenance analyses, and thereby link much larger samples of particular objects to sources. By assessing the different properties of artefacts (techno-typological characteristics), we can make further inferences about chronology, frequency and inter-settlement relations, and contribute to thinking about the variable scales at which interactions may occur. These interactions can vary in terms of distance (short-, medium-, long-range); scheduling (one-off, occasional, regular) and people (individual, group, mass population).

Below I propose some motives behind how, and rhythms by which, certain types of obsidian were procured and consumed:

- Obsidian from particular source areas was certainly exchanged and preferred to other sources with a view to its functional properties, including its general sharpness and the more specific ease with which it could be knapped into regular shapes, compared with locally available alternatives (Göllü Dağ or Nenezi Dağ blades in the north-eastern Aegean and Marmara region; Carpathian 1 blades in the Balkans; Melian blades in all regions). It may be that such blades were used for particular acts such as circumcision, surgery or body-modification, and hence had a value and were sought after at distance beyond the normal attraction of the material in general. The greater sharpness of obsidian in contrast to other lithic raw material, may suggest its acquisition (if not exclusively) for performing tasks for which it was considered uniquely appropriate, whether this was ritually or pragmatically informed.
- Obsidian in general, or from a particular source area, may also have been preferred for its aesthetics - transparency and suitability for non-utilitarian forms (Carpathian 1 in the central and southern Balkans; Göllü Dağ and Nenezi Dağ in the eastern Aegean). We might further speculate that this priority thereby involved heirlooms, dowry, talismans or travel tokens (Göllü Dağ and Nenezi Dağ obsidian in the eastern and north-eastern Aegean; Melian at Dispilio and Gülpınar, Carpathian 1 in the central and southern

Balkans). This type of obsidian procurement belongs to long distance, one-off or occasional exchange which might be a product of individual or village partnerships.

- Obsidian might also be preferred for its aesthetics when embedded in other objects, e.g. the eyes of figurines or jewellery (could not be confirmed in the study sites). Similar to the previous mode, this involves a smaller group or individuals who were engaged in medium or long distance interaction, which happened only rarely and may be related to symbolic (religious?) or ritual (e.g. ancestral journeys) activities.
- Obsidian could also be a secondary material - travelling with pottery, metals, or other raw materials and artefacts, but not the key reason for these exchanges. Indeed, this could be the case in all study sites, especially for obsidian exchanges in the outer zone of obsidian circulation. In any event, it is important to stress that obsidian may not have been transported alone, particularly over very long distances, but carried as a secondary item. Carrying this extra baggage was not a challenging task, even in a Neolithic setting, due to the light weight of the decorticated nodules. Certain primary activities related to fishing and herding, may have led to the secondary movement of obsidian in this way.
- Obsidian may have moved in the form of personal possessions and have been transported by persons travelling for other reasons resulting in the deposition at the places they visited (e.g. the shaving kit of a fisherman), which includes potentially sharing their resources with their hosts. In this sense, obsidian would thereby be a rare material echo of connections maintained for other reasons.

With a view to the above motives, it might be argued that Melian obsidian, primarily being sharper than other lithics raw materials seems, to be in most cases acquired for its functional properties. It was circulating predominantly in the Aegean, and rarely if ever travelled into the ‘unknown’ or across very large distances, i.e. into the inland Balkans or inland Anatolia. It was consumed in the Aegean and my new data reveals its common use in the Marmara region. This can be seen to extend the range of proposed maritime travel associated with Melian obsidian, which unlike Anatolian obsidian, follows coastal routes on current evidence. From EN to FN and in later periods, Melian obsidian was produced and exchanged as blades, even when it reached its most distant points of use (e.g. the Marmara sites). This is particularly clear through the identification of unusual technologies, as is the case of Aceramic Knossos X. The absolute quantities of Melian obsidian in the eastern Aegean, from the first phases of settlements, might be related to contacts between small groups of migrants and the hunter-gatherers that were active around the Aegean since the 9th millennium BC.

Following from these contacts, Melian obsidian continued to be consumed by the Neolithic settlers for centuries afterwards.

In contrast to Melian obsidian, central Anatolian and Carpathian obsidian travelled even longer distances and is often found in the form of fragile bladelets and as objects not suited for practical needs. In most cases these fragments are too small and too fragile to be used for their cutting properties. Central Anatolian rare pieces in the eastern Aegean would be so anomalous to be almost irrelevant, if their occurrence was not documented at every site. The reasons behind this obsidian being brought to the Aegean coast are challenging to understand if we take a purely economic and functional position - they can hardly be trade goods. It could be suggested that they were products of one-off exchange occurring due to sporadic and potentially unplanned encounters. Alternatively, these could be the outcome of contact between descendants of migrant farmers with their ancestral groups deeper inland in Anatolia. Some could literally be 'heirlooms' while others were obtained more as a marker of contact with the homeland. It remains possible that they were simply obtained during reciprocal exchanges with the northern Aegean or Marmara regions, involving other types of artefacts, for example impressed ware. Nonetheless, only with larger and better contextualised datasets we will be able to interpret these unusual artefacts more affectively.

The small quantities of Carpathian 1 obsidian in the southern and central Balkans are, similarly, obtained through sporadic interactions. Crucially, these appear to have taken the form of non-systematic and non-continuous procurement and exchange, especially in the latter part of LN period. Obsidian is probably a secondary materialisation of other social processes requiring travel and interaction (e.g. the exchange of copper artefacts). These obsidian objects may have no other function but to show contact and alliances with distant areas, given the rarity of its occurrence geologically. For such alliances to have a pragmatic value, it is unlikely we are talking about settlements deep in the Balkan interior, but rather those who could have a real impact on the social conditions of the time. This need not preclude far longer-range journeys for other reasons. In any case, the journey could be more important than the material. We may well ask if it was not the obsidian that these travellers wanted to show, but rather the tokens of experience and tales from other places (Helms 1988). Traveling though densely settled areas involves an obligation to stop at villages on the way and maintain friendships with the villagers that would guarantee peaceful crossing and possibly a safe resting place. And this act involves skill, knowledge and risk, conceivably bringing status and reputation to participants.

Interestingly, Carpathian 1 and Göllü Dağ pieces in particular, are of similar visual appearance - often completely transparent and very 'shiny'. Melian obsidian, on the other hand, is grey and matt and, in an aesthetic sense, would not be much more distinctive than some types of chert (Figure 4.3). In the Balkans, for example, Melian obsidian perhaps may not be very visually attractive, where varieties of chert could satisfy all needs, both aesthetic and functional. In contrast, transparent and glossy Anatolian and Carpathian material could be exchanged purely for appearance and not functional purposes. Identifying Anatolian and C1 obsidian artefacts as eccentric and odd is equally problematic because they occur as a minority element in so many assemblages. Since these people were sharing many aspects of material culture with those farther inland (e.g. Ulucak and Mandalo), then the indirect and occasional acquisition of obsidian demonstrates that this material was not in all cases the primary reason for people to travel and to communicate with each other over distances. Thus the occasional pieces have a significant story to tell by virtue of their relative rarity and their not being trade goods. Otherwise, the Melian dominance is seen in purely economic terms - the most effective use of time and resources being to acquire material from a single source.

In conclusion, building on the questions and goals established at the beginning of this study, I hope to have demonstrated that:

1) Obsidian is a very effective proxy for measuring both maritime and overland (and riverine) mobility. By combining technological and provenancing studies, it has been possible to assess the manner in which obsidian was moving and being consumed, and in some cases to explain the motivations behind its acquisition.
2) Obsidian serves as a strong marker for defining the scale and extent of maritime mobility, which potentially serves to differentiate the emerging character of the Neolithic in the eastern and north-eastern Aegean, for example. The macro-regional approach employed in this thesis has enabled the comparison of different manifestations of shared practices surrounding the acquisition, production and consumption of a common material that provides a basis for understanding distinct cultural processes and interactions.
3) This evidence can be used to contribute effectively to our understanding of processes of Neolithisation and to modify our existing knowledge from other datasets (ceramic styles, subsistence practices, symbolic representations). For example, in the north-eastern

Aegean, people located on the fringes of the Aegean Sea had close relations with mainland Anatolian and Marmara communities. This would support the long-standing belief about the movement of peoples across the Hellespont whereby maritime transport was not of the highest importance. Their mainland character is maintained in later phases when they establish links with Thracian communities.

4) The eastern Aegean is a hotspot of movement across the Cyclades to Melos whereby eastern and western Aegean, most likely Thessalian, people were connected. The obsidian evidence (e.g. pressure-flaking of Melian obsidian) generated by this research sheds new light on materials and routes and thereby on existing discussions about connectivity between both sides of the Aegean. Thus we can consider a relatively busy central Aegean maritime network through which both eastern and western Aegean mariners were moving and no doubt meeting, even prior to permanent settlement in the Cyclades in the later Neolithic. Another route following the southern Anatolian coast, via Crete to the Peloponnese (linking the Levant and Greece) has been previously acknowledged (e.g. Çilingiroğlu 2010; Perlès 2001, 2013). This said, on the basis of obsidian exchange, it can be suggested that Cretan communities rarely interacted with other Aegean networks, or that they did so under particular and irregular conditions.

5) The overland links between the Balkans and Aegean are documented by evidence for people moving for different exchange purposes. In the developed societies such as the LN in the central and southern Balkans, the exchange could also reflect the kinds of longer range relationships in which objects moved with people, whereby the 'exchange' was the material residues of these interactions which were not principally object focussed. It implies particular strategies and partnerships of groups and villages that are necessary for their subsistence.

The new regional datasets created as part of this thesis provide an opportunity to assess existing hypotheses and to propose new models for the social relationships and the intensity and direction of connections between communities. These can, and should, be further explored through the large-scale sampling and analysis of further obsidian assemblages using portable-XRF within and beyond these major overlap zones. In particular, large-scale assessments of assemblages from the inner to marginal zones would allow modelling of the whole chain of relationships which must underlie the long-distance relationships here documented from each extreme.

10.1. Considerations for the future

The research in this thesis has included a large region spanning central and western Anatolia, the Aegean basin and the southern-central Balkans. This wide geographical scope necessarily limited the level of site- and assemblage-specific detail that could be realistically achieved by a single researcher in the timeframe of this thesis. There was thus a necessary trade-off to effectively analyse a well-defined set of material that could nonetheless provide high-resolution data for addressing specific questions about regional interaction.

While certain obsidian overlap zones were selected to ascertain the character of obsidian used at the extremities of circulation, the methodology can be effectively used to consider sites in intermediary areas also. In the future, this may enable the identification of occasional Aegean obsidian penetrating into modern FYROM or deeper into Anatolia, for example. It could also define alternative routes, with potentially different patterns of interaction. It would also enable us to define temporal and spatial patterns in the choice of different sources form the same region (e.g. the two Melian sources). This would also be salient for the study of communities closer to the sources. Significant work has already been conducted on technological aspects of obsidian assemblages in the Peloponnese and Thessaly (e.g. Perlès 1990), although the provenancing to specific source of obsidian from these, and Cycladic (Saliagos) sites is lacking. Analysing assemblages in the Anatolian intermediate Lake District in particular has potential for understanding the dispersal of central Anatolian obsidian and how that relates to contacts between these central communities and eastern Aegean ones. Further analyses of possible obsidian sources in Galatia that some have proposed were used in prehistory needs to be more thoroughly explored through compositional analysis. In the Carpathians, it may be possible to explore the balance between choices of obsidian source used and proximity to sources, the role of river transport in facilitating distribution, the chronology of the exhaustion of different sources, and the decline of obsidian use with the development of alternative metal resources.

The study of Neolithic exchange and interaction has a long tradition, but new fieldwork strategies and new analytical technologies are beginning to change many of these long-standing positions and interpretations, not least in the case of eastern Aegean sites. One of the crucial points made in this thesis is that even in obsidian studies, it has been possible to identify two or more distinct interaction mechanisms (e.g Melian vs Anatolian). With that in mind, to be able to more effectively incorporate this into a synthetic regional model of exchange systems, further categories of artefact need be examined. The key issue will be to utilise the expanding means for differentiating similar looking objects using analytic methods (e.g. ceramic petrography) and in conjunction with metric and visual methods. Through such differentiation, generalising models are challenged (and modified) as we come to better equip ourselves for understanding how global phenomena both shape and are shaped by local traditions. For example, the pattern seen in the distribution of C1 obsidian in the later part of the LN in Balkans can be compared and contrasted to the distribution of other prominent exchangeable materials such as *Spondylus* shell, flint, polished stones, copper artefacts, pottery and figurines and many others. When these can be quantified within the more sensitive chronological and contextual frameworks that are increasingly being developed (e.g. LN I or LN II), this will enable more accurate understanding about the directions and nature of regional interactions.

A positive outcome of this work has also been to demonstrate the potential benefits of contextual recovery of obsidian which will enable to determine the value ascribed to materials and help distinguish different acquisition strategies. It is hoped that continued endeavours of this sort can be promoted through this thesis and future publications that demonstrate the value of this data. This can also be better augmented by recording of the volume of soil excavated at sites to compare the relative frequency of obsidian (deposition) in each phase and by context on sites.

Since Gordon Childe there has existed a vision of an interconnected Neolithic encompassing Anatolia, Greece and the Balkans. In recent years, once again we are seeing the development of broader perspectives that are fuelled by both theoretical and pragmatic analytical developments, in which Neolithic worlds ‘fit together’. Obsidian has long been a proxy for measuring interaction at this scale, and through this thesis I have sought to demonstrate how new methods can continue to place it at the heart of our quest to understand Neolithic societies.

Bibliography

Acquafredda, P. & A. Paglionico, 2004. SEM-EDS Microanalysis of Microphenocrysts of Mediterranean Obsidians: A Preliminary Approach to Source Discrimination, *Journal of Mineralogy* 16, 419–29.

Adams, R. McC., 1974. Anthropological perspectives on ancient trade, *Current Anthropology* 15, 239–58.

Agourides, C., 1997. Sea Routes and Navigation in the Third Millenium Aegean, *Oxford Journal of Archaeology* 16(1), 1–24.

Ammerman, A.J., 1979. A Study of Obsidian Exchange Networks in Calabria, *World Archaeology* 11, 95–110.

Ammerman, A.J., 2011. The Paradox of Early Voyaging in the Mediterranean and the Slowness of the Neolithic Transition Between Cyprus and Italy, In *Seascapes in Aegean Prehistory*, (ed.) G. Vavouranakis. Athens: Danish Institute of Athens, 31–50.

Ammerman, A.J. & W. Andrefsky, 1982. Reduction Sequences and the Exchange of Obsidian in Neolithic Calabria, In *Contexts for Prehistoric Exchange*, (eds.) J. Ericson & T. Earle. New York: Academic Press, 149–72.

Ammerman, A.J., A. Cesana, C. Polglase & M. Terrani, 1990. Neutron activation analysis of obsidian from two Neolithic sites in Italy, *Journal of Archaeological Science* 17(2), 209–20.

Andreou, S., Fotiadis M. & K. Kotsakis, 1996. Review of Aegean Prehistory V: The Neolithic and Bronze Age of Northern Greece, *American Journal of Archaeology* 100(3), 537–97.

Anthony, D., 1997. Prehistoric Migration as Social Process. In *Migrations and Invasions in Archaeological Explanation*, (eds.) Chapman, J. & H. Hamerow. Oxford: BAR International Series 664, Archaeopress, 21–32.

Appadurai, A., 1986. Introduction: Commodities and the Politics of Value, In *The Social Life of Things*, (ed.) A. Appadurai. Cambridge: Cambridge University Press, 3–63.

Arias, A., M. Oddone, G. Bigazzi, A. Di Muro, C. Principe & Norelli. P., 2006. New Data for the Characterization of Milos Obsidians, *of Radioanalytical and Nuclear Chemistry* 268(2), 371–86.

Aspinall, A., S.W. Feather & C. Renfrew, 1972. Neutron Activation Analysis of Aegean Obsidians, *Nature* 237, 333–34.

Astruc, L., R. Vargiolu, M. Ben Tkaya, N. Balkan-Atlı, M. Özbaşaran & H. Zahouani, 2011. Multi-scale tribological analysis of the technique of manufacture of an obsidian bracelet from Aşıklı Höyük (Aceramic Neolithic, Central Anatolia), *Journal of Archaeological Science* 38(12), 3415–24.

Atkinson, T.D., R.C. Bosanquet, C.C. Edgar, A.J. Evans, D.G. Hogarth, D. Mackenzie, C. Smith & F.B. Welsch, 1904. *Excavations at Phylakopi in Melos*. London: McMillan.

Ay, F., 2008. *İzmir Yeşilova Höyügü Kaziyici, Kesıcı Aletlerı ve Çekirdekleri.*, MA Thesis, Ege Üniversitesi.

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

Bains, R., M. Vasić, D.E. Bar-Yosef Mayer, N. Russell, K.I. Wright & C. Doherty, 2013. A Technological Approach to the Study of Personal Ornamentation and Social Expression at Çatalhöyük, In *Substantive Technologies at Çatalhöyük: Reports from the 2000–2008 Seasons*, (ed.) I. Hodder. Los Angeles: Monographs of the Cotsen Institute of Archaeology, University of California at Los Angeles, 331–64.

Balcı, S., 2011. The Chipped Stone Industry of Aktopraklık C (Bursa). Preliminary Results, *Anatolia Antiqua* 19(1), 1–11.

Balkan-Atlı, N., 2005. Yontmataş Endüstrisi, In *Höyücek, 1989-1992 Yılları Arasında Yapılan Kazıların Sonuçları*, (eds.) R. Duru & G. Umurtak. Ankara: Türk Tarih Kurumu, 130–37.

Balkan-Atlı, N., D. Binder & M.-C. Cauvin, 1999. Obsidian: Sources, Workshops and Trade in Central Anatolia, In *Neolithic in Turkey: The Cradle of Civilization. New Discoveries*, (eds.) M. Özdoğan & N. Başgelen. Istanbul: Arkeoloji ve Sanat Yayınları, 133–45.

Barge, O. & C. Chataigner, 2003. The procurement of obsidian: factors influencing the choice of deposits, *Journal of Non-Srystalline Solids* 323(1-3), 172–79.

Barjamovic, G., 2011. *A Historical Geography of Anatolia in the Old Assyrian Colony Period*. Copenhagen: Carsten Niebuhr Institute of Near Eastern Studies, University of Copenhagen: Museum Tusculanum Press.

Baykal-Seeher, A., 1994. Silex und Obsidianinustrien, In *Kuruçay Höyük: Results of the Excavations 1978-1988. The Neolithic and Early Chalcolithic Settlements*, (ed.) R. Duru. Ankara: Türk Tarih Kurumu Basımevi, 106–8.

Bellot-Gurlet, L., O. Pelon & M.L. Sémériadès, 2008. Détermination de provenance d'une sélection d'obsidiennes du palais minoen de Malia (Crète), *Comptes Rendus Palevol.* 7, 419–27.

Bergner, M., B. Horejs & E. Pernicka, 2009. Zur Herkunft der Obsidianartefakte vom Çukuriçi Höyük, *Studia Troica* 18, 249–72.

Betancourt, P.P., 1997. The trade route for Ghyali obsidian, In *Craftsmen, Craftswomen and Craftsmanship in the Aegean Bronze Age*, (eds.) R. Laffineur & P.P. Betancourt. Liège, 171–75.

Bevan, A., 2007. *Stone Vessels and Values in the Bronze Age Mediterranean*. Cambridge: Cambridge University Press.

Bevan, A. & J. Conolly, 2013. *Mediterranean Islands, Fragile Communities and Persistent Landscapes: Antikythera in Long-Term Perspective*. Cambridge: Cambridge University Press.

Biehl, P.F., I. Franz, S. Ostaptchouk, D. Orton, J. Rogasch & E. Rosenstock, 2012. One Community and Two Tells: The Phenomenon of Relocating Tell Settlements at the Turn of the 7th and 6th Millennia in Central Anatolia, In *Tells: Social and Environmental Space,* (eds.) R. Hofmann, F.-K. Moetz & J. Müller (Proceedings of the International Workshop 'Socio-Environmental Dynamics over the Last 12,000 Years: The Creation of Landscapes II'). Bonn: Verlag Dr. Rudolf Habelt GmbH, 53–64.

Bigazzi, G., P. Màrton, P. Norelli & L. Rozložnik, 1990. Fission Track Dating of Carpathian Obsidians and Provenance Identification, *IJRAID International Journal of Radiation Applications & Instrumentation. Part D, Nuclear Tracks & Radiation Measurements* 17(3), 391–96.

Bigazzi, G., G. Poupeau, L. Bellot-Gurlet & Z. Yezingili, 1998. Provenance Studies of Obsidian Artefacts in Anatolia Using the Fission-track Dating Method: An overview, In *L'Obsidienne Au Proche et Moyen Orient: Du Volcan À l'Outil*, (eds.) M.-C. Cauvin, A. Gourgaud, B. Gratuze, N. Arnaud, P. Poupeau, J.L. Poidevin & C. Chataigner. Oxford: Maison de l'Orient Méditerranéen, BAR International Series 738, Archaeopress, 69–89.

Binder, D., 2002. Stones Making Sense: What Obsidian Could Tell Us About the Origins of the Central Anatolian Neolithic, In *The Neolithic of Central Anatolia: Internal Developments and External Relations During the 9th - 6th Millennia Cal BC*, (eds.) F. Gérard & L. Thissen. Proceedings of the International CANeW Table Ronde, Istanbul, 23-24 November 2001: British Institute of Archaeology at Ankara / Malcolm and Carolyn Wiener Laboratory for Aegean and Near Eastern Dendrochronology at Cornell University, 79–90.

Binder, D., B. Gratuze, D. Mouralis & N. Balkan-Atlı, 2011. New Investigations of the Göllüdağ Obsidian Lava Flows System: A Multi-Disciplinary Approach, *Journal of Archaeological Science* 38(12), 3174–84.

Bintliff, J.L., 1977. *Natural Environment and Human Settlement in Prehistoric Greece: Based on Original Fieldwork*. Oxford, England: British Archaeological Reports.

Biró, K.T., 1998. Stones, Numbers - History? The Utilization of Lithic Raw Materials in the Middle and Late Neolithic of Hungary, *Journal of Anthropological Archaeology* 17, 1–18.

Biró, K.T., 2004. Carpathian obsidians: myth and reality, In *Proceedings of the 34th ISA, Institución "Fernando El Católico (CSIC) Excma. Diputación de Zaragoza, Electronic Publication*, 267–77.

Biró, K.T., 2014. Carpathian Obsidians: State of Art of Central European Obsidian Research, In *Lithic Raw Material Exploitation and Circulation in Préhistory. A Comparative Perspective in Diverse Palaeoenvironment*, (eds.) M. Yamada & A. Ono (ERAUL 138). Liège, 45–67.

Biró, K.T., I. Pozsgai & A. Vladar, 1986. Electron Beam Microanalyses of Obsidian Samples From Geological and Archaeological Sites, *Acta Archaeologica Academiae Scientiarun Hungaricae* 38, 257–78.

Blackman, M.J., 1986. The provenience of obsidian artifacts from Late Chalcolithic levels at Aphrodisias, In *Prehistoric Aphrodisias: An Account of the Excavations and Artifact Studies*, (ed.) M. Joukowsky. Providence: Brown University, Center for Old World Archaeology and Art, 279–85.

Bordaz, J. & L.A. Bordaz, 1982. Erbaba: The 1977 and 1978 Seasons in Perspective, *Türk Arkeoloji Dergisi* 26(1), 85–92.

Bordes, F., 1961. *Typologie Du Paléolithique Ancien et Moyen*. Bordeaux: Impr. Delmas.

Borić, D., 2005. Deconstructing Essentialisms: Unsettling Frontiers of the Mesolithic-Neolithic Balkans, In *(Un)settling the Neolithic*, (eds.) A. Whittle, V. Cummings & D.W. Bailey. Oxford: Oxbow Books Ltd., 16–31.

Borić, D., 2008. First Households and 'House Societies' In European Prehistory, in *Prehistoric Europe: Theory and Practice*, (ed.) A. Jones. Oxford: Wiley-Blackwell, 109–42.

Borić, D., 2009. Absolute Dating of Metallurgical Innovations in the Vinča Culture of the Balkans, In *Metals and Societies. Studies in Honour of Barbara S. Ottaway*, (eds.) T.L. Kienlin & B.W. Roberts. Bonn: Verlag Dr. Rudolf Habelt GmbH, 191–245.

Bosanquet, R.C., 1904. The Obsidian Trade, In *Excavations at Phylakopi in Melos*, (eds.) T.D. Atkinson, R.C. Bosanquet, C.C. Edgar, A.J. Evans, D.G. Hogarth, D. Mackenzie, C. Smith & F.B. Welsch. London: McMillan, 216–33.

Boyer, W.W. & P. Robinson, 1956. Obsidian artifacts of Northwestern New Mexico and their correlation with source material, *El Palacio* 63, 333–45.

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

Brami, M. & V. Heyd, 2011. The origins of Europe's first farmers: the role of Hacılar and Western Anatolia, fifty years on., *Praehistorische Zeitschrift* 86(2), 165–206.

Braswell, G.E., J.E.. Clark, K. Aoyama, H.. McKillop & M.D. Glascock, 2000. Determining the Geological Provenance of Obsidian Artifacts from the Maya Region: A Test of the Efficacy of Visual Sourcing, *Latin American Antiquity* 11(3), 269–82.

Broodbank, C., 1993. Ulysses without Sails: Trade, Distance, Knowledge and Power in the Early Cyclades, *World Archaeology* 24(3), 315–31.

Broodbank, C., 1999. Colonization and Configuration in the Insular Neolithic of the Aegean, In *Neolithic Society in Greece,* (ed.) P. Halstead. Sheffield: Sheffield Academic Press, 15–41.

Broodbank, C., 2000. *An Island Archaeology of the Early Cyclades*. Cambridge: Cambridge University Press.

Broodbank, C., 2006. The Origins and Early Development of Mediterranean Maritime Activity, *Journal of Mediterranean Archaeology* 19(2), 199–230.

Broodbank, C., 2013. *The Making of the Middle Sea: A History of the Mediterranean from the Beginning to the Emergence of the Classical World*. London, UK: Thames & Hudson.

Broodbank, C. & T. Strasser, 1991. Migrant Farmers and the Neolithic Colonization of Crete, *Antiquity* 65, 233–45.

Brukner, B., 1980. Насеље винчанске групе на Гомолави (неолитски и раноенеолитски слој) - Извештај са ископавања 1967-1976 (Settlement of the Vinča Group at Gomolava (Neolithic and Early Eneolithic Stratum) – Excavation Report 1967–1977), *Rad Vojvodjanskih muzeja* 26, 5–53.

Brumfiel, E.M. & T.K. Earle, 1987. Specialization, Exchange, and Complex Societies: An Introduction. In *Specialization, Exchange, and Complex Societies,* (eds.) E.M. Brumfiel & T.K. Earle, Cambridge: Cambridge University Press, 1–9.

Buck, B.A., 1982. Ancient Technology in Contemporary Surgery, *Western Journal of Medicine* 136, 265–69.

Caneva, I., 1999. Early Farmers on the Cilician Coast: Yumuktepe in the Seventh Millennium BC, In *Neolithic in Turkey: The Cradle of Civilization. New Discoveries*, (eds.) M. Özdoğan & N. Başgelen. Istanbul: Arkeoloji ve Sanat Yayınları, 105–14.

Cann, J.R., 1983. Petrology of Obsidian Artefacts, In *The Petrology of Archaeological Artefacts*, (eds.) D.R.C. Kempe & A.P. Harvey. Oxford: Clarendon Press, 227–55.

Cann, J.R. & C. Renfrew, 1964. The Characterisation of Obsidian and its Application to the Mediterranean Region, *Proceedings of the Prehistoric Society* 30, 111–33.

Carter, T., 2003. Problematizing the analysis of obsidian in the Aegean and surrounding worlds, In *METRON. Measuring the Aegean Bronze Age. Proceedings of the 9th International Aegean* (Aegaeum 24), (eds.) K.P. Foster & R. Laffineur. Liège: Université de Liège, 75–82.

Carter, T., 2007. The Theatrics of Technology: Consuming Obsidian in the Early Cycladic Burial Arena, *APAA Archeological Papers of the American Anthropological Association* 17(1), 88–107.

Carter, T., 2008. The Consumption of Obsidian in the Early Bronze Age Cyclades, In *Horizon: A Colloquium on the Prehistory of the Cyclades*, (eds.) N. Brodie, J. Doole, G. Gavalas & C. Renfrew. Cambridge: McDonald Institute Monographs, 225–36.

Carter, T., 2009. L'obsidienne Égéenne: Caractérisation, Utilisation et Culture, In *L'Homme et Le Precieux. Matières Minérales Précieuses de La Préhistoire À Aujourd'hui*, (eds.) M.-H. Moncel & F. Frohlich. Oxford: BAR International Series 1934, Archaeopress, 199–212.

Carter, T., 2011. A true gift of mother earth: the use and significance of obsidian at Çatalhöyük, *Anatolian Studies* 61, 1–19.

Carter, T., J. Conolly & A. Spasojević, 2005a. The Chipped Stone, In *Changing Materialities at Çatalhöyük: Reports from the 1995-99 Seasons*, (ed.) I. Hodder. Cambridge: McDonald Institute for Archaeological Research, 221–83.

Carter, T. & D.A. Contreras, 2012. The Character and Use of the Soros Hill Obsidian Source, Antiparos (Greece), *Paléorient* 11, 595–602.

Carter, T., S. Dubernet, R. King, F.-X. Le Bourdonnec, M. Milić, G. Poupeau & M.S. Shackley, 2008a. Eastern Anatolian Obsidians at Çatalhöyük and the Reconfiguration of Regional Interaction in the Early Ceramic Neolithic, *Antiquity* 82, 900–909.

Carter, T. & V. Kilikoglou, 2007. From Reactor to Royalty? Aegean and Anatolian Obsidians from Quartier Mu, Malia (Crete), *Journal of Mediterranean Archaeology* 20(1), 115–43.

Carter, T., F.-X. Le Bourdonnec, M. Kartal, G. Poupeau, T. Calligaro & P. Moretto, 2011. Marginal Perspectives : Sourcing Epi-Palaeolithic to Chalcolithic Obsidian from the Öküzini Cave (SW Turkey), *Paléorient* 37(2), 123–49.

Carter, T., D. Mihailović, Y. Papadatos & C. Sofianou, forthcoming. The Cretan Mesolithic in context: New data from Livari Skiadi (SE Crete), *Antiquity*.

Carter, T. & M. Milić, 2013a. The Chipped Stone, In *Substantive Technologies at Çatalhöyük: Reports from the 2000-2008 Seasons*, (ed.) I. Hodder. Los Angeles: Monographs of the Cotsen Institute of Archaeology, University of California at Los Angeles, 417–507.

Carter, T. & M. Milić, 2013b. The Chipped Stone Industry from Dhaskalio, In *The Settlement at Dhaskalio. The Sanctuary at Keros and the Origins of Aegean Ritual*,(eds.) C. Renfrew, O.

Philaniotou, N. Brodie, G. Gavalas & M. Boyd. Cambridge: McDonald Institute Monographs, 531–56.

Carter, T., M. Milić, N. Kayacan, S. Ostaptchouk & B.L. MacDonald, 2008b. *Chipped Stone Report*. http://www.catalhoyuk.com/downloads/Archive_Report_2008.pdf.

Carter, T., G. Poupeau, C. Bressy & N.J.P. Pearce, 2005b. From Chemistry to Consumption: Towards a History of Obsidian Use at Çatalhöyük through a Programme of Inter-laboratory Trace-elemental Characterization, In *Changing Materialities at Çatalhöyük: Reports from the 1995-99 Seasons*, (ed.) I. Hodder. Cambridge: McDonald Institute for Archaeological Research, 285–305.

Carter, T., G. Poupeau, C. Bressy & N.J.P. Pearce, 2006. A New Programme of Obsidian Characterization at Çatalhöyük, Turkey, *Journal of Archaeological Science* 33(7), 893–909.

Carter, T. & M.S. Shackley, 2007. Sourcing Obsidian from Neolithic Çatalhöyük (Turkey) Using Energy Dispersive X-ray Fluorescence, *Archaeometry* 49(3), 437–54.

Cauvin, J., 2000. *The Birth of the Gods and the Origins of Agriculture*. Cambridge: Cambridge University Press.

Cauvin, M.-C. & C. Chataigner, 1998. Distribution de l'Obsidienne Dans les Sites Archéologiques du Proche et Moyen Orient, In *L'Obsidienne Au Proche et Moyen Orient: Du Volcan À l'Outil*, (eds.) M.-C. Cauvin, A. Gourgaud, B. Gratuze, N. Arnaud, P. Poupeau, J.L. Poidevin & C. Chataigner. Oxford: Maison de l'Orient Méditerranéen, BAR International Series 738, Archaeopress, 325–50.

Cauvin, M.-C., A. Gourgaud, B. Gratuze, N. Arnaud, G. Poupeau, J.L. Poidevin & C. Chataigner, 1998. *L'Obsidienne Au Proche et Moyen Orient: Du Volcan À l'Outil*. Oxford: Maison de l'Orient Méditerranéen, BAR International Series 738, Archaeopress.

Cessford, C. & T. Carter, 2005. Quantifying the consumption of obsidian at Çatalhöyük, *Journal of Field Archaeology* 30(3), 305–15.

Chapman, J., 1981. *The Vinča Culture of South-East Europe: Studies in Chronology, Economy and Society*. Oxford: British Archaeological Reports.

Chapman, J., 1998. Objectification, embodiment and the value of places and things, In *The Archaeology of Value : Essays on Prestige and the Process of Valuation*, (ed.) D.W. Bailey. Oxford: British Archaeological Reports, 106–30.

Chapman, J., 2008. Approaches to trade and exchange in earlier prehistory (Late Mesolithic – Early Bronze Age), In *Prehistoric Europe. Theory and Practice*, (ed.) A. Jones. Oxford: Wiley-Blackwell, 333–55.

Chapman, J. & P. Dolukhanov, 1997. *Landscapes in Flux*. Oxford: Oxbow Books.

Chapman, J. & B. Gaydarska, 2011. Can We Reconcile Individualisation with Relational Personhood?: A Case Study from the Early Neolithic, *Documenta Praehistorica* 38, 21–43.

Chataigner, C., 1998. Sources des Artefacts Néolithiques, In *L'Obsidienne Au Proche et Moyen Orient: Du Volcan À l'Outil*, (eds.) M.-C. Cauvin, A. Gourgaud, B. Gratuze, N. Arnaud, P. Poupeau, J.L. Poidevin & C. Chataigner. Oxford: Maison de l'Orient Méditerranéen, BAR International Series 738, Archaeopress, 273–324.

Chataigner, C., J.L. Poidevin & N.O. Arnaud, 1998. Turkish Occurrences of Obsidian and Use by Prehistoric Peoples in the Near East from 14,000 to 6000 BP, *VOLGEO Journal of Volcanology and Geothermal Research* 85(1), 517–37.

Cherry, J.F. & R. Torrence, 1982. The Earliest Prehistory in Melos, In *An Island Polity: The Archaeology of Exploitation in Melos*, (eds.) C. Renfrew & J.M. Wagstaff. Cambridge; New York: Cambridge University Press, 24–34.

Childe, V.G., 1981. *Man Makes Himself*. Bradford-on-Avon: Moonraker.

Çilingiroğlu, A., Ç. Özlem & C. Çilingiroğlu, 2012. Towards Understanding the Early Farming Communities of Middle West Anatolia: Contribution of Ulucak, In *The Neolithic in Turkey - Western Turkey*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 139–75.

Çilingiroğlu, Ç., 2005. The Concept of 'Neolithic Package': Considering its Meaning and Applicability, *Documenta Praehistorica* 32, 1–13.

Çilingiroğlu, Ç., 2009. *Central-West Anatolia at the End of 7th and Beginning of 6th Millennium BCE in the Light of Pottery from Ulucak (Izmir)*, PhD Dissertation, University of Tübingen.

Çilingiroğlu, Ç., 2010. Appearence of Neolithic Impressed Pottery in Aegean and Its Implications for Maritime Networks in the Eastern Mediterranean, *TÜBA-AR* 13, 9–22.

Çilingiroğlu, Ç. & C. Çakirlar, 2013. Towards Configuring the Neolithisation of Aegean Turkey, *Documenta Praehistorica* 40, 21–29.

Clark, J.E. & W. Parry, 1990. Craft Specialisation and Cultural Complexity, *Research in Economic Anthropology* 12, 289–346.

Cobb, C.R., 1993. Archaeological Approaches to the Political Economy of Nonstratified Societies, *Archaeological Method and Theory* 5, 43–100.

Cobean, R.H., J.R. Vogt, M.D. Glascock & T.L. Stocker, 1991. High-Precision Trace-Element Characterization of Major Mesoamerican Obsidian Sources and Further Analyses of Artefacts from San Lorenzo Tenochtitlan, Mexico, *Latin American Antiquity* 2(1), 69–91.

Conolly, J., 1999. *The Çatalhöyük Flint and Obsidian Industry: Technology and Typology in Context*. Oxford: Archaeopress.

Conolly, J., 2008. The knapped stone technology of the first occupants at Knossos, In *Escaping the Labyrinth: The Cretan Neolithic in Context*, (eds.) V. Isaakidou & P. Tomkins. Sheffield: Oxbow Books, 73–89.

Costin, C.L, 1991. Craft specialisation: issues in defining, documenting, and explaining the organisation of production, *Archaeological Method and Theory* 3, 1–56.

Costin, C.L. & M.B. Hagstrum, 1995. Standardisation, labour investment, skill, and the organisation of ceramic production in late Prehispanic highland Peru, *American Antiquity* 60(4), 619–39.

Craig, N., R.J. Speakman, R.S. Popelka-Filcoff, M.D. Glascock, Robertson J.D., M.S. Shackley & M.S. Aldenderfer, 2007. Comparison of XRF and PXRF for analysis of archaeological obsidian from southern Peru´, *Journal of Archaeological Science* 34(12), 2012–24.

Davis, J., 1992. Review of Aegean Prehistory 1: The Islands of the Aegean, *American Journal of Archaeology* 96, 699–756.

Davis, M.K., T.L. Jackson, M.S. Shackley, T. Teague & J.H. Hampel, 2011. Factors Affecting the Energy-Dispersive X-Ray Fluorescence (EDXRF) Analysis of Archaeological Obsidian, In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology,* (ed.) M.S. Shackley. New York: Springer, 45–63.

Delerue, S., 2007. L' obsidienne dans le Processus de Néolithisation du Proche-Orient (12000-6500 av. j.-C. cal.), PhD Dissertation, Université Bordeaux Montaigne.

Demoule, J.-P. & C. Perlès, 1993. The Greek Neolithic: A New Review, *Journal of World Prehistory* 7, 355–416.

Derin, Z., 2012. Yeşilova Höyük, In *The Neolithic in Turkey - Western Turkey*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 177–95.

Dillian, C.D., C.A. Bello & M.S. Shackley, 2010. Long-Distance Exchange of Obsidian in the mid-Atlantic United States, In *Trade and Exchange : Archaeological Studies from History and Prehistory*, (eds.) C.D. Dillian & C.L. White. New York; London: Springer, 17–36.

Dimitrijević, S., 1979. Sjeverna zona, In *Praistorija Jugoslovenskih Zemalja (Prehistory of Yugoslav Countries),* (ed.) A. Benac. Sarajevo: Centar za balkanološka istraživanja ANU, BiH, 229–362.

Dimitrijević, V. & B. Tripković, 2006. Spondylus and Glycymeris Bracelets: Trade Reflections at Neolithic Vinča-Belo Brdo, *Documenta Praehistorica* 33, 1–16.

Dobosi, V.T., 2011. Obsidian use in the Palaeolithic in Hungary and adjoining areas, Natural Resource Environment and Humans 1, 83–95.

Dobres, M.-A. & J.E. Robb, 2000. *Agency in Archaeology*. London; New York: Routledge.

Düring, B.S., 2013. Breaking the Bond: Investigating the Neolithic Expansion in Asia Minor in the Seventh Millennium BC, *Journal of World Prehistory* 26(2), 75–100.

Düring, B.S. & B. Gratuze, 2013. Obsidian Exchange Networks in Prehistoric Anatolia: New Data from the Black Sea Region, *Paléorient* 39(2), 173–82.

Duru, R., 2012. The Neolithic of the Lakes Region: (Hacılar - Kuruçay Höyük - Höyücek - Bademağacı, In *The Neolithic in Turkey - Western Turkey*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 1–65.

Earle, T.K. & J.E. Ericson, 1977. *Exchange Systems in Prehistory*. New York: Academic Press.

Earle, T.K., 1981. Comment on P. Rice, Evolution of Specialized Pottery Production: A Trial Model, *Current Anthropology* 22, 230–31.

Efe, T., 2007. The Theories of the 'Great Caravan Route' Between Cilicia and Troy: The Early Bronze Age III Period in Inland Western Anatolia, *Anatolian studies* 57 (Transanatolia: Bridging the Gap between East and West inthe Archaeology of Ancient Anatolia), 47–64.

Erdoğu, B., 2008. *Trench 8*. http://www.catalhoyuk.com/downloads/Archive_Report_2008.pdf.

Erdoğu, B., 2011. A Preliminary Report from the 2009 and 2010 Field Seasons at Uğurlu on the Island of Gökçeada, *Anatolica* 37, 45–65.

Erdoğu, B., 2013. Uğurlu: A Neolithic Settlement on the Aegean Island of Gökçeada, In *Neolithic in Turkey - Northwestern Turkey and Istanbul*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 1–33.

Ericson, J., 1982. Production for Obsidian Exchange in California, In *Contexts for Prehistoric Exchange*, (eds.) J. Ericson & T. Earle. New York: Academic Press, 129–48.

Ericson, J. & T. Earle, 1982. *Contexts for Prehistoric Exchange*. New York: Academic Press.

Eerkens J.W. & R.L. Bettinger, 2001. Techniques for assessing standardisation in artefact assemblages: Can we scale material variability?, *American Antiquity* 66, 493–504.

Evans, J.D. & C. Renfrew, 1968. *Excavations at Saliagos near Antiparos*. London: Thames and Hudson.

Fakorellis, G. & Y. Maniatis, 2002. Apotelesmata chronologisis deigmaton me ti methodo tou 14C, In *Dispilio, 7500 Chronia Meta*, (ed.) G.H. Hourmouziadis. Thessaloniki: University Studio Press, 289–94.

Farr, H.R, 2006. Seafaring as Social Action, *Journal of Maritime Archaeology* 1(1), 85–99.

Farr, H.R., 2010. Island Colonization and Trade in the Mediterranean, In *The Global Origins and Development of Seafaring*, (eds.) A. Anderson, J. Barrett & K. Boyle. Cambridge: McDonald Institute for Archaeological Research, 179–89.

Felsch, R.C.S., 1988. *Das Kastro Tigani: Die Spatneolithische und Chalkolithische Siedlung*. Bonn: In Kommission bei R. Habelt.

Filippakis, S.E., A.P. Grimanis & B. Perdikatsis, 1981. X-ray and NAA of Obsidian from Kitsos Cave, *Science and Archaeology* 23, 21–26.

Forenbaher, S. & P.T. Miracle, 2005. The Spread of Farming in the Eastern Adriatic, *Antiquity* 79, 514–28.

Frahm, E., 2013a. Validity of 'Off-the-Shelf' Handheld Portable XRF for Sourcing Near Eastern Obsidian Chip Debris, *Journal of Archaeological Science* 40(2), 1080–92.

Frahm, E., 2013b. Is Obsidian Sourcing About Geochemistry or Archaeology?: A Reply to Speakman and Shackley, *Journal of archaeological science* 40(2), 1444–48.

Frahm, E. & R.C.P. Doonan, 2013. The Technological Versus Methodological Revolution of Portable XRF in Archaeology., *Journal of archaeological science* 40(2), 1425–34.

Frahm, E., R. Doonan & V. Kilikoglou, 2014. Handheld Portable X-Ray Fluorescence of Aegean Obsidians, *Archaeometry* 228–60.

Francaviglia, V., 1988. Ancient Obsidian Sources on Pantelleria (Italy), *Journal of Archaeological Science* 15, 109–22.

French, D.H., 1967. Prehistoric Sites in Northwest Anatolia: I. The İznik Area, *Anatolian Studies* 17, 49–100.

Galanidou, N., 2002. The Chipped Stone Industry from Ftelia: An Introduction, In *The Neolithic Settlement at Ftelia, Myconos*, (ed.) A. Sampson. Rhodes: University of the Aegean, 317–32.

Gamble, C., 1998. Palaeolithic Society and the Release from Proximity: A Network Approach to Intimate Relations, *World Archaeology* 29(3), 426–49.

Garašanin, M., 1979. Centralnobalkanska zona, In *Praistorija Jugoslavenskih Zemalja (Prehistory of Yugoslav Countries)*, (ed.) A. Benac. Sarajevo: Centar za balkanološka istraživanja ANU, BiH, 79–212.

Gatsov, I., 2008. Chipped Stone Assemblages from Ilıpınar Part I: A Techno-typological study, In *The Ilıpınar Excavations. With Contributions on Hacılartepe and Menteşe*, (eds.) J.J. Roodenberg & S. Alpaslan Roodenberg. Istanbul: Nederlands Instituut voor het Nabije Oosten, 227–63.

Gatsov, I., 2009. *Prehistoric Chipped Stones, E Thrace and S Marmara, 7th-5th Mill. B.C.* Oxford: BAR international series 1904.

Gatsov, I., M. Kay & P. Nedelcheva, 2013. Lithic Assemblages From the Prehistoric Settle Ment at Barcin Höyük, Northwestern Anatolia. New Results, *Eurasian Prehistory* 9(1-2), 129–37.

Gatsov, I. & M. Özdoğan, 1994. Some Epi-Paleolithic Sites from NW Turkey: Agaçli, Domali and Gümüsdere, *Anatolica* 20, 97–120.

Georgiadis, M., 2008. The Obsidian in the Aegean Beyond Melos: An Outlook from Yali, *Oxford Journal of Archaeology* 27(2), 101–17.

Gérard, F., 2002. Transformations and Societies in the Neolithic of Central Anatolia, In *The Neolithic of Central Anatolia: Internal Developments and External Relations During the 9th - 6th Millennia Cal BC*, (eds.) F. Gérard & L. Thissen. Proceedings of the International CANeW Table Ronde, Istanbul, 23-24 November 2001: British Institute of Archaeology at Ankara / Malcolm and Carolyn Wiener Laboratory for Aegean and Near Eastern Dendrochronology at Cornell University, 105–17.

Gerritsen, F., R. Özbal & L. Thissen, 2013. Barcin Höyük: The Beginnings of Farming in the Marmara Region, In *The Neolithic in Turkey - Northwestern Turkey and Istanbul*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm, 93–112.

Glascock, M.D., 1998. A Systematic Approach to Obsidian Source Characterisation, In *Archaeological Obsidian Studies: Method and Theory*, (ed.) M.S. Shackley. New York: Advances in Archaeological and Museum Science, Plenum Press, 15–65.

Golitko, M., J. Meierhoff & J.E. Terrell, 2010. Chemical Characterization of Sources of Obsidian from the Sepik Coast (PNG), *Archaeology Oceania* 45, 120–29.

Gosden, C., 1989. Production, power and prehistory, *Journal of Anthropological Archaeology* 8, 355–87.

Grammenos, D. & S. Kotsos, 2002. *Sostikes Anaskafes sto Neolithiko Oikismo Stavroupolis Thessalonikis*. Thessaloniki: Archaiologiko Institouto Voreias Helladas.

Gratuze, B., 1999. Obsidian Characterization by Laser Ablation ICP-MS and its Application to Prehistoric Trade in the Mediterranean and the Near East: Sources and Distribution of Obsidian with the Aegean and Anatolia, *Journal of Archaeological Science* 26(10), 869–81.

Greenfield, H.J., 1991. A Kula Ring in Prehistoric Europe? A Consideration of Local and Interregional Exchange during the Late Neolithic of the Central Balkans, In *Between Bands and States*, (ed.) S.A. Gregg. Carbondale: Southern Ilinois University, Center for Archaeological Investigation, Occasional Paper 9, 287–308.

Greenfield, H.J. & T.L. Jongsma, 2006. The Spatial Organization of Early Neolithic Settlements in Temperate Southeastern Europe: A View from Blagotin, Serbia, In *Space and Spatial Analysis in Archaeology*, (eds.) E.C. Robertson, J.D. Siebert, D.C. Fernandez & M.U. Zender. Calgary: University of Calgary Press, 69–79.

Guilbeau, D. & B. Erdoğu, 2011. Des 'Lames de Karanovo' Dans le Site Néolithique d'Uğurlu (île de Gökçeada, Turquie), *Bulletin de Correspondance Hellenique* 135, 1–19.

Hallam, B.R., S.E. Warren & C. Renfrew, 1976. Obsidian in the Western Mediterranean: Characterization by Neutron Activation Analysis and Optical Emission Spectroscopy, *Proceedings of the Prehistoric Society* 42, 85–110.

Halstead, P., 1995. From Sharing to Hoarding: the Neolithic Foundations of Aegean Bronze Age Society?, In *Politeia: Society and State in the Aegean Bronze Age*, (eds.) R. Laffineu & W.-D. Niemeier. Liège: University of Liège, 11–20.

Halstead, P., 1999. Neighbours from Hell? The Household in Neolithic Greece, In *Neolithic Society in Greece,* (ed.) P. Halstead. Sheffield: Sheffield Academic Press, 77–95.

Halstead, P. & K. Kotsakis, 2002. Paliambela, In *Archaeology in Greece 2002-2003*, (ed.) J. Whitley, *Archaeological Reports 49*, 66.

Hancock, R.G.V. & T. Carter, 2010. How Reliable Are Our Published Archaeometric Analyses? Effects of Analytical Techniques through Time on the Elemental Analysis of Obsidians, *Journal of Archaeological Science* 37(2), 243–50.

Healey, E., 2007. Obsidian as anIindicator of Inter-regional Contacts and Exchange: Three Case-studies from the Halaf Period., *Anatolian studies* 57(Transanatolia: Bridging the Gap between East and West inthe Archaeology of Ancient Anatolia), 171–89.

Healey, E. & S. Campbell, 2009. The Challenge of Characterising Large Assemblages of Exotic Materials: A Case Study of the Obsidian from Domuztepe, SE Turkey, *IA Internet Archaeology* 26.

Helms, M.W., 1988. *Ulysses' Sail: An Ethnographic Odyssey of Power, Knowledge, and Geographical Distance*. Princeton: Princeton University Press.

Herling, L., K. Kasper, C. Lichter & R. Meriç, 2008. Im Westen nichts Neues? Ergebnisse der Grabungen 2003 und 2004 in Dedecik-Heybelitepe, *Istanbuler Mitteilungen 58*, 13–65.

Hodder, I., 1974. Regression Analysis of Some Trade and Marketing Patterns, *World Archaeology* 6(2), 172–89.

Hodder, I., 1982. Toward a Contextual Approach to Prehistoric Exchange, In *Contexts for Prehistoric Exchange*, (eds.) J. Ericson & T. Earle. New York: Academic Press, 199–211.

Hodder, I., 2007. Çatalhöyük in the Context of the Middle Eastern Neolithic, *Annual Review of Anthropology* 36, 105–20.

Hodder, I. & C. Orton, 1976. *Spatial Analysis in Archaeology*. Cambridge: Cambridge University Press.

Holste, F., 1939. Zur chronologischen Stellung der Vinča-Keramik, *Wiener Prähistorische Zeitschrift* 26, 1–21.

Hood, S., 1981. *Prehistoric Emporio and Ayio Gala I*. London: Thames & Hudson.

Horejs, B., 2012. Çukuriçi Höyük: A Neolithic and Bronze Age Settlement in the Region of Ephesos, In *The Neolithic in Turkey - Western Anatolia*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 117–31.

Horejs, B. & B. Milić, 2013. A 7th Millennium House Complex of Çukuriçi Höyük: In the Light of Lithics Assemblage. Poster Presentation. *International Symposium on Chert and Other Knappable Materials*, Iasi, Romania.

Hourmouziadis, G.H., 2002. *Dispilio, 7500 Chronia Meta*. Thessaloniki: University Studio Press.

Hovorka, D., 2010. Prehistoric Transeuropean Transport of Stone Tools: On Examples of Jadeitite and Obsidian Implements, *Acta archaeologica Academiae Scientiarum Hungaricae* 49–56.

Ifantidis, F., 2011. Cosmos in Fragments: Spondylus and Glycymeris Adornment at Neolithic Dispilio, Greece, In *Spondylus in Prehistory: New Data & Approaches – Contributions to the Archaeology of Shell Technologies*, (eds.) F. Ifantidis & M. Nikolaidou. Oxford: BAR International Series 2216, Archaeopress, 123–37.

Inizan, M.-L., H. Roche & J. Tixier, 1992. *Technology of Knapped Stone*. Meudon, France: Cercle de Recherches et d' Etudes Prehistoriques.

Izuho, M. & H. Sato, 2007. Archaeological Obsidian Studies in Hokkaido, Japan: Retrospect and Prospects, *Indo-Pacific Prehistory Association Bulletin* 27, 114–21.

Jacobsen, T.W., 1973. Excavation in the Franchthi Cave, 1969-1971, Part I, *hesperia Hesperia: The Journal of the American School of Classical Studies at Athens* 42(1), 45–88.

Jia, P.W., T. Doelman, C. Chen, H. Zhao, S. Lin, R. Torrence & M.D. Glascock, 2010. Moving sources: A Preliminary Study of Volcanic Glass Artifact Distributions in Northeast China Using PXRF, *Journal of Archaeological Science* 37(7), 1670–77.

Kaczanowska, M. & J.K. Kozlowski, 1990. Chipped Stone Industry of the Vinča Culture, in *Vinča and Its World. International Symposium - The Danubian Region from 6000 to 3000 B.C.*. Belgrade: Serbian Academy of Sciences and Arts, 35–47.

Kaczanowska, M. & J.K. Kozłowski, 2008. The Körös and the Early Eastern Linear Culture in the Northern Part of the Carpathian Basin: A View from the Perspective of Lithic Industries, *Acta Terrae Septemcastrensis Journal, Proceedings of the International Colloquium:The Carpathian Basin and its Role in the Neolithisation of the Balkan Peninsula* VII, 9–37.

Kaczanowska, M. & J.K. Kozlowski, 2011. Lithic Industry from the Aceramic Levels at Knossos (Crete, Greece): An Alternative Approach, *Eurasian Prehistory* 8(1-2), 67–87.

Kaczanowska, M. & J.K. Kozlowski, 2013. Mesolithic Obsidian Networks in The Aegean, In *Unconformist Archaeology: Papers in Honour of Paolo Biagi*, (ed.) E. Starnini. Oxford: BAR International Series 2528, Archaeopress, 17–26.

Kaiser, T., 1990. Ceramic Technology, In *Selevac: A Neolithic Village in Yugoslavia*, (eds.) R. Tringham & D. Krstić. Los Angeles: UCLA, 255–87.

Kaiser, T. & B. Voytek, 1983. Sedentism and Economic Change in the Balkan Neolithic, *YJAAR Journal of Anthropological Archaeology* 2(4), 323–53.

Kalicz, N., A. Kreiter & G. Szakmány, 2011. *Méhtelek: The First Excavated Site of the Méhtelek Group of the Early Neolithic Körös Culture in the Carpathian Basin*. Oxford: Archaeopress.

Kalogiropoulou, E., 2014. Αναζητώντας κοινωνικές ταυτότητες: η συμβολή των θερμικών κατασκευών στην οργάνωση του χώρου στη νεολιθική Μακεδονία, In *1912-2012: A Century of Research in Prehistoric Macedonia. International Conference Proceedings. Archaeological Museum of Thessaloniki 22-24 November 2012.*, (eds.) E. Stefani, N. Merousis, & A. Dimoula. Thessaloniki: Archaeological Museum of Thessaloniki, 359–72.

Karimali, E., 1994. *The Neolithic Mode of Production and Exchange Reconsidered: Lithics Production and Exchange Patterns in Thessaly, Greece, During the Transitional Late Neolithic-Bronze Age Period*, PhD Dissertation, Boston University.

Karkanas, P., K. Pavlopoulos, K. Kouli, M. Ntinou, G. Tsartsidou, Y. Facorellis & T. Tsourou, 2011. Palaeoenvironments and Site Formation Processes at the Neolithic Lakeside Settlement of Dispilio, Kastoria, Northern Greece., *Geoarchaeology* 26(1), 83–117.

Karul, N., 2011. The Emergence of Neolithic Life in South and East Marmara Region, In *Beginnings - New Research in the Appearance of the Neolithic between Northwest Anatolia and the Carpathian Basin.* Papers of the International Workshop 8th – 9th April 2009, Istanbul, (ed.) R. Krauß. Istanbul: Deutsches Archäologisches Institut, 57–65.

Karul, N. & M.B. Avcı, 2013. Aktopraklık, In *Neolithic in Turkey - Northwestern Turkey and Istanbul*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 45–68.

Kasztovszky, Z., K.T. Biró & Z. Kis, 2014. Prompt Gamma Activation Analysis of the Nyírlugos Obsidian Core Depot Find, *Journal of Lithic Studies* 1(1), 151–63.

Keller, J., G. Bigazzi & E. Pernicka, 1994. The Galatia-X Source: A Combined Major-Element, Trace-Element and Fission-Track Characterization of an Unknown Obsidian Source in Northwestern Anatolia, *Archaeometry*, 543–51.

Keller, J. & C. Seifried, 1990. The Present State of Obsidian Source Identification in Anatolia and the Near East, In *Volcanologie et Archéologie PACT 25*, (eds.) C. Albore Livadie & F. Wideman. Strasbourg: Conseil de l'Europe, 58–87.

Kilikoglou, V., Y. Bassiakos, A.P. Grimanis, K. Souvatzis, A. Pilali-Papasteriou & A. Papanthimou-Papaefthimiou, 1996. Carpathian Obsidian in Macedonia, Greece, *Journal of Archaeological Science* 23(3), 343–49.

Klejn, L.S., G.A. Wright & C. Renfrew, 1970. On Trade and Culture Process in Prehistory, *Current Anthropology* 11(2), 169–75.

Knappett, C., 2011. *An Archaeology of Interaction: Network Perspectives on Material Culture and Society*. Oxford: Oxford University Press.

Knitter, D., H. Blum, B. Horejs, O. Nakoinz, B. Schutt & M. Meyer, 2013. Integrated Centrality Analysis: A Diachronic Comparison of Selected Western Anatolian Locations, *Quaternary international: The journal of the International Union for Quaternary Research* 312, 45–56.

Kolankaya-Bostancı, N., 2014. What Happened to Projectile Points in the İzmir Region during the Neolithic Period?, *Arkeoloji Dergisi* 19, 127–36.

Kotsakis, K., 1999. What Tells Can Tell: Social Space and Settlement in the Greek Neolithic, In *Neolithic Society in Greece*, (ed.) P. Halstead. Sheffield: Sheffield Academic Press, 66–76.

Kotsakis, K., 2006. Settlement of Discord: Sesklo and the Emerging Household, In *Homage to Milutin Garasanin*, (eds.) N. Tasić & C. Grozdanov. Belgrade: Serbian Academy of Sciences & Macedonian Academy of Sciences & Arts, 207–19.

Kotsakis, K. & P. Halstead, 2004. Anaskafi sta Neolithika Paliambela Kolindrou, *To Archaeologiko Ergo sti Makedonia kai Thraki* 16, 407–15.

Kotsakis, K., A. Papanthimou-Papaefthimiou, A. Pilali-Papasteriou, T. Savopoulou, Y. Maniatis & B. Kromer, 1989. Carbon-14 dates from Mandalo, W Macedonia, In *Archaeometry, International Symposium on Archaeometry*, (ed.) Y. Maniatis. Amsterdam: Elsevier, 679–85.

Kozlowski, J.K., M. Kaczanowska & M. Pawlikowski, 1996. Chipped-Stone Industries from Neolithic Levels at Lerna, *Hesperia* 65(3), 295–372.

Kuzmin, Y.V., 2006. Recent Studies of Obsidian Exchange Networks in Prehistoric Northeast Asia, In *Archaeology in Northeast Asia: On the Pathway to Bering Strait*, (eds.) D.E. Dumond & R.L. Bland. Oregon: Museum of Natural and Cultural History and Deptment of Anthropology, University of Oregon anthropological papers, 61–71.

Kuzmin, Y.V. & M.D. Glascock, 2007. Two Islands in the Ocean: Prehistoric Obsidian Exchange between Sakhalin and Hokkaido, Northeast Asia, *Journal of Island and Coastal Archaeology* 2, 99–120.

Kuzmin, Y.V., M.D. Glascock & H. Sato, 2002. Sources of Archaeological Obsidian on Sakhalin Island (Russian Far East), *Journal of Archaeological Science* 29(7), 741–49.

Last, J., 1996. Surface Pottery at Çatalhöyük, In *On the Surface: Çatalhöyük 1993-95*, (ed.) I. Hodder. Cambridge: McDonald Institute for Archaeological Research, 115–72.

Leakey, M.D., 1971. *Olduvai Gorge. Excavations in Beds I and II, 1960-1963*. Cambridge: Cambridge University Press.

Le Bourdonnec F.-X., Delerue S., Dubernet S., Moretto P., Calligaro T., Dran J.-C. & P. G., 2005. PIXE Characterization of Western Mediterranean and Anatolian Obsidians and Neolithic Provenance Studies, *Nuclear Instruments and Methods in Physics Research* 240, 595–99.

Le Bourdonnec F.-X., Delerue S., Dubernet S., Moretto P., Calligaro T., Dran J.-C. & P. G., 2010. SEM-EDS Characterisation of Western Mediterranean Obsidians and the Neolithic Site of A Fuata (Corsica), *Journal of Archaeological Science* 37, 92–106.

Leroi-Gourhan, A., 1964. *Le Geste et la Parole - Technique et Langage*. Paris: Albin Michel.

Lichter, C., 2005. Western Anatolia in the Late Neolithic and Early Chalcolithic: The Actual State of Research, In *How Did Farming Reach Europe? Anatolian-European Relations from the Second Half of the 7th through to the First Half of the 6th Millennium Cal BC*, (ed.) C. Lichter (Proceedings of the International Workshop Istanbul, 20 – 22 May 2004. Byzas 2). Istanbul: Ege Yayinlari, 59–74.

Lichter, C. & R. Meriç, 2012. Dedecik-Heybelipete: Excavations at a Neolithic Settlement in the Torbalı Plain, In *The Neolithic in Turkey - Western Turkey*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 133–38.

Liritzis, I., 2008. Assessment of Aegean Obsidian Sources by a Portable ED-XRF Analyser: Grouping, Provenance and Accuracy, In *Proceedings of the 4th Symposium of the Hellenic Society for Archaeometry*, (eds.) Y. Facorellis, N. Zacharias & K. Polikreti. Oxford: BAR International Series 1746, Tempus Reparatum, 399–406.

Liritzis, I. & N. Zacharias, 2011. Portable XRF of Archaeological Artifacts: Current Research, Potentials and Limitations, In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, (ed.) M.S. Shackley. New York: Springer, 109–42.

Lugliè, C., F.-X. Le Bourdonnec, G. Poupeau, E. Atzeni, S. Dubernet, P. Moretto & L. Serani, 2007. Early Neolithic Obsidians in Sardinia (Western Mediterranean): The Su Carroppu Case, *Journal of Archaeological Science* 34, 428–39.

Mackenzie, D., 1904. The Successive Settlements at Phylakopi in their Aegeo-Cretan Relations, In *Excavations at Phylakopi in Melos*, (eds.) T.D. Atkinson, R.C. Bosanquet, C.C. Edgar, A.J. Evans, D.G. Hogarth, D. Mackenzie, C. Smith & F.B. Welsch. London: McMillan, 238–72.

Malinowski, B., 1922. *Argonauts of the Western Pacific: An Account of Native Enterprise and Adventure in the Archipelagoes of Melanesian New Guinea*. London; New York: G. Routledge & Sons; E.P. Dutton & Co.

Manson, J.L., 1995. Starčevo Pottery and Neolithic Development in the Central Balkans, In *The Emergence of Pottery*, (eds.) W. Barnett & J. Hoopes. Washington: Smithsonian Institution, 65–77.

Marciniak, A. & L. Czerniak, 2007. Social transformations in the Late Neolithic and the Early Chalcolithic periods in central Anatolia, *Anatolian studies* 57(Transanatolia: Bridging the Gap between East and West inthe Archaeology of Ancient Anatolia), 115–30.

Marić, M., 2015. Modelling Obsidian Trade Routes During Late Neolithic During in The South-East Banat Region of Vršac Using GIS, *Starinar* 65, 37–52.

Mauss, M., 1990. *The Gift: The Form and Reason for Exchange in Archaic Societies*. London: Routledge.

Mellaart, J., 1960. Excavations at Hacılar: Third Preliminary Report, 1959, *Anatolian Studies* 10, 83–104.

Mellaart, J., 1965. Çatal Hüyük West, *Anatolian Studies* 15, 135–56.

Mellaart, J., 1967. *Çatal Hüyük: A Neolithic Town in Anatolia*. London: Thames and Hudson.

Mellaart, J., 1970. *Excavations at Hacılar*. Edinburgh: Edinburgh University Press.

Milić, M., 2014. PXRF Characterisation of Obsidian from Central Anatolia, the Aegean and Central Europe, *Journal of Archaeological Science* 41, 285–96.

Milić, M., K. Brown & T. Carter, 2013. A Visual Characterisation of the Çatalhöyük Obsidian (Appendix 21), In *Substantive Technologies at Çatalhöyük Reports from the 2000–2008 Seasons*, (ed.) I. Hodder. Los Angeles: Monographs of the Cotsen Institute of Archaeology, University of California at Los Angeles.

Milleker, F., 1938. Vorgeschichte des Banats, *Starinar* 13, 102–66.

Millhauser, J.K., E. Rodríguez-Alegría & M.D. Glascock, 2011. Testing the Accuracy of Portable X-ray Fluorescence to Study Aztec and Colonial Obsidian Supply at Xaltocan, Mexico, *Journal of Archaeological Science* 38(11), 3141–52.

Milojčić, V., 1949. *Chronologie der Jüngeren Steinzeit Mittel- und Südosteuropas.* Berlin: Gebr. Mann.

Moholy-Nagy, H., 1999. Mexican Obsidian at Tikal, Guatemala, *Latin American Antiquity* 10(3), 300–313.

Moholy-Nagy, H., 2003. Source Attribution and the Utilization of Obsidian in the Maya Area, *Latin American Antiquity* 4(3), 301–10.

Molloy, B.P.C., M. Milić & R. Doonan, 2014. Temporal Rhythms in the Consumption of Obsidian at Prepalatial Priniatikos Pyrgos: A pXRF Study, In *A Cretan Landscape through Time: Survey, Geoarchaeological Prospection, and Excavation in the Environs of Priniatikos Pyrgos*, (eds.) B.P.C. Molloy & C. Duckworth. Oxford: British Archaeological Reports, 118–24.

Mortensen, P., 1970. Chipped Stone Industry, In *Excavation at Hacılar*, (ed.) J. Mellaart. Edinburgh: Edinburgh University Press, 153–57.

Mulazzani, S., F.-X. Le Bourdonnec, L. Belhouchet, G. Poupeau, J. Zoughlami, S. Dubernet, E. Tufano, Y. Lefrais & R. Khedhaier, 2010. Obsidian from the Epipalaeolithic and Neolithic eastern Maghreb. A view from the Hergla context (Tunisia), *Journal of Archaeological Science* 37(10), 2529–37.

Nandris, J., 1970. Ground Water as a Factor in the First Temperate Neolithic Settlement of the Körös Region, *Zbornik Narodnog Muzeja* VI, 59–69.

Nandris, J., 1975. A Reconsideration of the South-east European Sources of Archaeological Obsidian, *Bulletin London University Institute of Archaeology* 12, 71–94.

Nazaroff, A.J., K.M. Prufer & B.L. Drake, 2009. Assessing the Applicability of Portable X-ray Fluorescence Spectrometry for Obsidian Provenance Research in the Maya Lowlands, *Journal of Archaeological Science* 30, 1–11.

Nikolić, D., 2008. *Vinča – praistorijska metropola. Istraživanja 1908-2008. Katalog izložbe*. Belgrade: Filozofski fakultet univerziteta u Beogradu.

Oddone, M., P. Marton, B. Bigazzi & B.K. T., 1999. Chemical Characterizations of Carpathian Obsidian Sources by Instrumental and Epithermal Neutron Activation Analysis, *Journal of Radioanalytical and Nuclear Chemistry* 240(1), 147–53.

O'Shea, J., 2011. A River Runs Through It: Landscape and the Evolution of Bronze Age Networks in the Carpathian Basin, *Journal of World Prehistory* 24(2-3), 161–74.

Ostaptchouk, S., 2009. *Chipped Stone from the West Mound: Towards a Characterization of the Chalcolithic Lithic Production*. http://www.catalhoyuk.com/downloads/Archive_Report_2009.pdf.

Özdoğan, M., 1983. Pendik: A Neolithic Site of Fikirtepe Culture in the Marmara Region, In *Beiträge Zur Altertumskunde Kleinasiens. Festschrift Fur Kurt Bittel*, (eds.) R. Boemher & H. Hauptmann. Mainz am Rhein: Philipp von Zabern, 401–11.

Özdoğan, M., 1994. Obsidian in Anatolia: an Archaeological Perspective on the Status of Research, *Archaeometry* 423–31.

Özdoğan, M., 1997. The Beginning of Neolithic Economies in Southeastern Europe: An Anatolian Perspective, *Journal of European Archaeology* 5(2), 1–33.

Özdoğan, M., 1998. Hoca Çeşme: An Early Neolithic Anatolian Colony in the Balkans?, In *Man and the Animal World: Studies in Archaeozoology, Archaeology, Anthropology and Palaeolinguistics in Memoriam Sándor Bökönyi*, (eds.) P. Anreiter & L. Bartosiewicz. Budapest: Archaeolingua Alapítvány, 435–51.

Özdoğan, M., 1999. Northwestern Turkey: Neolithic Cultures in Between the Balkans and Anatolia, In *Neolithic in Turkey: The Cradle of Civilization: New Discoveries*, (eds.) M. Özdoğan & N. Başgelen. Istanbul: Arkeoloji ve Sanat Yayinlari, 203–24.

Özdoğan, M., 2008. Obsidian in the Context of Near Eastern Prehistory: A Conspectus on the Status of Research, Problems and Prospects, In *Anatolian Metal IV: Frühe Rohstoffgewinnung in Anatolien Und Seinen Nachbarländern. Die Anschnitt, Beiheft 21. Veröffentlichungen Aus Dem Deutschen Bergbau-Museum 157*, (ed.) Ü. Yalçin. Bochum: Deutsches Bergbau-Museum, 191–201.

Özdoğan, M., 2011. Archaeological Evidence on the Westward Expansion of Farming Communities from Eastern Anatolia to the Aegean and the Balkans, *Current Anthropology* 52(4), 415–30.

Özdoğan, M., 2013. Neolithic Sites in the Marmara Region: Fikirtepe, Pendik, Yarımburgaz, Toptepe, Çeşme, and Aşağı Pınar, In *Neolithic in Turkey - Northwestern Turkey and Istanbul*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 167–269.

Özdoğan, M., N. Başgelen & P. Kuniholm, 2012. *The Neolithic in Turkey - Western Turkey*. Istanbul: Archaeology and Art Publications.

Özdoğan, M. & I. Gatsov, 1998. The Aceramic Neolithic Period in Western Turkey and in the Aegean, *Anatolica* 24, 209–32.

Öztan, A., 2012. Köşk Höyük: A Neolithic Settlement in Nigde-Bor Plateau, In *The Neolithic in Turkey - Cemtral Anatolia*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 31–70.

Panagiotaki, M., 1999. *The Central Palace Sanctuary at Knossos*. London: British School at Athens.

Papanthimou, A. & A. Papasteriou, 1993. O proistorikos oikismos sto Mandalo: Nea stoiheia stin proistoria tis Makedonias, *Archaia Makedonia* 5, 1206–16.

Pappa, M., 2007. Neolithic Societies: Recent Evidence from Northern Greece, In *The Struma/Strymon River Valley in Prehistory : Proceedings of the International Symposium Strymon Praehistoricus, Kjustendil, Blagoevgrad (Bulgaria), Serres, Amphipolis (Greece)*, (eds.) H. Todorova, M. Stefanovich & G. Ivanov. Sofia: Gerda Henkel Stiftung, 257–72.

Pappa, M., T. Antonaras & E. Vliora, 2009. Νεολιθικός οικισμός Θέρμης 2008-2009, *To Archaeologiko Ergo sti Makedonia kai Thraki* 22, 343–50.

Pappa, M. & M. Besios, 1999a. The Neolithic Settlement at Makriyalos, Northern Greece: Preliminary Report on the 1993-1995 Excavations, *Journal of Field Archaeology* 26(2), 177–95.

Pappa, M. & M. Besios, 1999b. The Makriyalos Project: Rescue Excavations at the Neolithic Site of Makriyalos, Pieria, Northern Greece, In *Neolithic Society in Greece,* (ed.) P. Halstead. Sheffield: Sheffield Academic Press, 108–20.

Peltenburg, E., S. Colledge, P. Croft, A. Jackson, C. McCartney & M.A. Murray, 2001. Neolithic Dispersals from the Levantine Corridor: a Mediterranean Perspective, *Levant Levant* 33(1), 35–64.

Perić, S., 2008. The Oldest Cultural horizon of Trench XV at Drenovac, *Starinar* 58, 29–50.

Perlès, C., 1981. Les Industries Lithiques de la Grotte de Kitsos, In *La Grotte Préhistorique de Kitsos (Attique) : Missions, 1968-1978 : L'occupation Néolithique : Les Vestiges Des Temps Paléolithiques, de L'antiquité et de L'histoire Récente*, (ed.) N. Lambert. Paris: A.D.P.F. : Ecole française d'Athènes, 129–209.

Perlès, C., 1987. *Les Industries Lithiques Taillées de Franchthi (Argolide, Grèce). I. Presetation Gènérale et Industries Paléolithiques (Excavations at Franchthi Cave, Greece, Fascicle 3)*. Bloomington: Indiana University Press.

Perlès, C., 1990. L'outillage en Pierre Taillée Néolithique en Grèce: Approvisionnement et Exploitation des Matières Premières, *Bulletin de Correspondance Hellénique* 114, 1–42.

Perlès, C., 1992. Systems of Exchange and Organisation of Production in Neolithic Greece, *Journal of Mediterranean Archaeology* 5(2), 115–62.

Perlès, C., 2001. *The Early Neolithic in Greece*. Cambridge: Cambridge University Press.

Perlès, C., 2005. Réflexion sur les Échanges Dans le Néolithique de Grèce, In *Autour de Polanyi, Vocabulaires, Théories et Modalités Des Échanges*, (eds.) P. Clancier, F. Johannès, P. Rouillard & A. Tenu. Paris: De Boccard, 201–15.

Perlès, C., 2007. Echanges et Technologie : L'exemple du Néolithique, In *Un Siècle de Construction Du Discours Scientifique En Préhistoire,* (ed.) J. Evin (Aux conceptions d'aujourd'hui. Congrès du centenaire de la Socété préhistorique française / XXVIe Congrès préhistorique de France, Avignon, 21 – 25 septembre 2004). Paris: Socété Préhistorique Française, 53–62.

Perlès, C., A. Quiles & H. Valladas, 2013. Early Seventh-millennium AMS dates from Domestic Seeds in the Initial Neolithic at Franchthi Cave (Argolid,Greece), *Antiquity* 87, 1001–15.

Perlès, C., T. Takaoğlu & B. Gratuze, 2011. Melian Obsidian in NW Turkey: Evidence for Early Neolithic Trade, *Journal of Field Archaeology* 36(1), 42–49.

Perlès, C. & K.D. Vitelli, 1999. Craft Specialization in the Neolithic Greece, In *Neolithic Society in Greece,* (ed.) P. Halstead. Sheffield: Sheffield Academic Press, 96–108.

Pernicka, E., J. Keller, G.J. Rapp & T. Ercan, 1994. Provenance of Late Neolithic and Early Bronze Age Obsidian Artifacts from Troad, *Archaeometry* 94, 515–19.

Peschlow-Bindokat, A. & C. Gerber, 2012. The Latmos-Beşparmak Mountains: Sites with Early Rock Paintings in Western Anatolia, In *The Neolithic in Turkey - WesternTurkey,* (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 67–115.

Phillips, S.C. & R.J. Speakman, 2009. Initial Source Evaluation of Archaeological Obsidian from the Kuril Islands of the Russian Far East Using Portable XRF, *Journal of Archaeological Science* 36, 1256–63.

Piperno, M., C. Collina, R. Galloti, J.-P. Raynal, G. Kieffer, F.-X. Le Bourdonnec, G. Poupeau & D. Geraads, 2009. Obsidian Exploitation and Utilization During the Oldowan at Melka Kunture (Ethiopia), In *Interdisciplinary Approaches to the Oldowan*, (eds.) E. Hovers & D.R. Braun. Dordrecht: Springer, 111–28.

Pliny the Elder, n.d. *Naturalis Historiae Xxxvi*.

Poidevin, J.L., 1998. Les Gisements d'Obsidienne de Turquie et de Transcaucasie: Géologie, Géochemie et Chronométrie, In *L'Obsidienne Au Proche et Moyen Orient: Du Volcan À l'Outil*, (eds.) M.-C. Cauvin, A. Gourgaud, B. Gratuze, N. Arnaud, G. Poupeau, J.L. Poidevin & C. Chataigner. Oxford: Maison de l'Orient Méditerranéen, BAR International Series 738, Archaeopress, 105–203.

Polanyi, K., 1957. *The Great Transformation*. Boston: Beacon Press.

Pollard, A.M. & C. Heron, 2008. *Archaeological Chemistry*. Cambridge: The Royal Society of Chemistry.

Porčić, M., 2012. Social Complexity and Inequality in the Late Neolithic of the Central Balkans: Reviewing the Evidence, *Documenta Praehistorica* 39, 167–83.

Poupeau, G., F.-X. Le Bourdonnec, T. Carter, S. Delerue, M.S. Shackley, J.-A. Barrat, S. Dubernet, P. Moretto, T. Calligaro, M. Milić & K. Kobayashi, 2010. The use of SEM-EDS, PIXE and EDXRF for Obsidian Provenance Studies in the Near East: A Case Study from Neolithic Çatalhöyük (Central Anatolia), *Journal of Archaeological Science* 37(11), 2705–20.

Radivojević, M., T. Rehren, E. Pernicka, D. Šljivar, M. Brauns & D. Borić, 2010. On the Origins of Extractive Metallurgy: New Evidence from Europe, *Journal of Archaeological Science* 37, 2775–87.

Radovanović, I., M. Kaczanowska, J.K. Kozlowski, M. Pawlikowski & B. Voytek, 1984. *The Chipped Stone Industry from Vinča*. Belgrade: Centar za arheološka istraživanja, Filozofski Fakultet.

Reingruber, A., 2011. Early Neolithic Settlement Patterns and Exchange Networks in the Aegean, *Documenta Praehistorica* 38, 291–305.

Renfrew, C., 1969. Trade and Culture Process in European Prehistory, *Current Anthropology* 10(2/3), 151–69.

Renfrew, C., 1972. *The Emergence of Civilization: Cyclades and the Aegean in the Third Millennium B.C.* London: Methuen.

Renfrew, C., 1975. Trade as Action at a Distance: Questions of Integration and Communication, In *Ancient Civilisation and Trade*, (eds.) J.A. Sabloff & C.C. Lamberg-Karlovsky. Albuquerque: University of New Mexico Press, 3–60.

Renfrew, C., 1993. Trade Beyond the Material, in *Trade and Exchange in Prehistoric Europe*, eds. C. Scarre & F. Healy. Oxford: Oxbow Monographs, 5–16.

Renfrew, C. & A. Aspinall, 1990. Aegean Obsidian and Franchthi Cave, In *Les Industries Lithiques Tatllees de Franchthi (Argolide, Grece). Tome II: Les Industries Du Mesolithique et Du Neolithique Initial*, (ed.) C. Perlès. Bloomington and Indianapolis: Indiana University Press, 257–70.

Renfrew, C. & P. Bahn, 2008. *Archaeology: Theories, Methods and Practice*. London: Thames & Hudson.

Renfrew, C., J.R. Cann & J.E. Dixon, 1968a. Appendix IV: The Sources of the Saliagos Obsidian, In *Excavation at Saliagos near Antiparos*, (eds.) J.D. Evans & C. Renfrew. London: Thames and Hudson, 105–7.

Renfrew, C., J.E. Dixon & J.R. Cann, 1965. Obsidian in the Aegean, *Annual of the British School of Archaeology at Athens* 60, 225–47.

Renfrew, C., J.E. Dixon & J.R. Cann, 1966. Obsidian and Early Culture Contact in the Near East, *Proceedings of the Prehistoric Society* 32, 30–72.

Renfrew, C., J.E. Dixon & J.R. Cann, 1968b. Further Analysis of Near Eastern Obsidians, *Proceedings of the Prehistoric Society* 34, 319–31.

Rice, P.M., 1981. Evolution of Specialisation Pottery Production: a trial model, *Current Anthropology* 22(3), 219–40.

Robb, J.E., 2007. *The Early Mediterranean Village: Agency, Material Culture, and Social Change in Neolithic Italy*. Cambridge: Cambridge University Press.

Roodenberg, J. & S. Alpaslan-Roodenberg, n.d. *The Neolithic in the Eastern Marmara: Two Examples of Settlement*. http://www.nino-leiden.nl/doc/Neolithic_eastern_Marmara.pdf.

Roodenberg, J.J., 1999. Ilıpınar, an Early Farming Village in the İznik Lake Basin, In *Neolithic in Turkey: The Cradle of Civilization: New Discoveries*, (eds.) M. Özdoğan & N. Başgelen. Istanbul: Arkeoloji ve Sanat Yayinlari, 194–202.

Roodenberg, J., A. Van As, L. Jacobs & M.H. Wijnen, 2003. Early Settlement in the Plain of Yenişehir (NW Anatolia), *Anatolica* 29, 17–59.

Rosania, C.N., M.T. Boulanger, M.D. Glascock, K.T. Biró, S. Ryzhov & G. Trnka, 2008. Revisiting Carpathian obsidian, *Antiquity* 82, 318.

Rosenstock, E., 2006. Early Neolithic Tell Settlements of South-east Europe in Their Natural Setting: A study in Distribution and Architecture, In *Aegean - Marmara - Black Sea: Of The Present State Research on The Early Neolithic*, (eds.) I. Gatsov & I. Schwarzberg (Proceedings of the Session held at the EAA 8th Annual Meeting at Thessaloniki, 28th September 2002). Langenweissbach: Beier&Beran, 115–25.

Rózsa, P., G. Szöõr, B. Gratuze, Z. Elekes, I. Uzonyi & Á.Z. Kiss, 2006. Comparative Geochemical Studies of Obsidian Samples from Various Localities, *Acta Geologica Hungarica* 49(1), 73–87.

Sağlamtimur, H., 2012. The Neolithic Settlement of Ege Gübre, In *The Neolithic in Turkey - Western Turkey*, (eds.) M. Özdoğan, N. Başgelen & P. Kuniholm. Istanbul: Archaeology and Art Publications, 197–225.

Sahlins, M., 1972. *Stone Age Economics*. Chicago: Aldine-Atherton.

Şahoğlu, V., 2005. The Anatolian Trade Network and the Izmir Region During the Early Bronze Age, *Oxford Journal of Archaeology* 24(4), 339–61.

Sampson, A., 1987. *The Neolithic Period in Dodecanese*. Athens: Tameio Archaiologikon Poron kai Apollotrioseon.

Sampson, A. (ed.), 2002. *The Neolithic Settlement at Ftelia, Mykonos*. Rhodes: University of the Aegean.

Sampson, A., 2008a. The Architectural Phases of the Neolithic Settlement of Ftelia on Mykonos, In *Horizon: A Colloquium on the Prehistory of the Cyclades*, (eds.) N. Brodie, J. Doole, G. Gavalas & C. Renfrew. Cambridge: McDonald Institute Monographs, 29–35.

Sampson, A., 2008b. *The Cave of the Cyclops: Mesolithic and Neolithic Networks in the Northern Aegean, Greece*. Philadelphia: INSTAP Academic Press.

Sampson, A., J.K. Kozlowski, M. Kaczanowska & B. Giannouli, 2002. The Mesolithic Settlement at Maroulas, Kythnos, *Mediterranean Archaeology & Archaeometry* 2(1), 45–67.

Šarić, J., 2002. Stone as Material for Production of Chipped Artifacts in Early and Middle Neolithic of Serbia, *Starinar* 52, 11–26.

Schier, W., 1996. The Relative and Absolute Chronology of Vinča: New Evidence From the Type Site, In *The Vinča Culture, Its Role and Cultural Connections*, (ed.) F. Draşovean. Timişoara: The Museum of Banat, 141–62.

Schmidt, K., 2007. Katalog, In *Vor 12.000 Jahren in Anatolien: Die Ältesten Monumente Der Menschheit*. Stuttgart: Theiss, 287–88.

Schoop, U.D., 2005. The Late Escape of the Neolithic from the Central Anatolian Plain, In *How Did Farming Reach Europe? Anatolian-European Relations from the Second Half of the 7th through to the First Half of the 6th Millennium Cal BC*, (ed.) C. Lichter (Proceedings of the International Workshop Istanbul, 20-22 May 2004. Byzas 2). Istanbul: Ege Yayinlari, 41–58.

Scott, M.J. & M.J. Scott, 1982. Obsidian Surgical Blades: Modern Use of a Stone Age Implement, *DSU The Journal of Dermatologic Surgery and Oncology* 8(12), 1050–52.

Shackley, M.S., 2005. *Obsidian: Geology and Archaeology in the North American Southwest*. Tucson: University of Arizona Press.

Shackley, M.S., 2011. Is There Reliability in Portable X-Ray Fluorescence (pXRF) Spectrometry, *SAA Archaeological Record* 10, 17–20.

Shackley, M.S., 2012. Portable X-ray Fluorescence Spectrometry (pXRF): The Good, the Bad, and the Ugly, *Archaeology Southwest Magazine* 26(2).

Sheets, P.D. & G.R. Muto, 1972. Pressure Blades and Total Cutting Edge: An Experiment in Lithic Technology, *Science Science* 175(4022), 632–34.

Shelford, P., F. Hodson, M.E. Cosgrove, S.E. Warren & C. Renfrew, 1982. The Sources and Characterisation of Melian Obsidian, In *An Island Polity: The Archaeology of Exploitation on Melos*, (eds.) C. Renfrew & M. Wagstaff. Cambridge: Cambridge University Press, 182–91.

Shennan, S., 1999. Cost, benefit and value in the organisation of Early European copper production, *Antiquity* 73, 352–62.

Sheppard, P.J., J.G. Irwin, S.C. Lin & C.P. McCaffrey, 2011. Characterization of New Zealand Obsidian Using PXRF, *Journal of Archaeological Science* 38(1), 45–56.

Sherratt, A., 2005. *ArchAtlas: The Obsidian Trade in the Near East, 14,000 to 6500 BC*. 2005. http://www.archatlas.org/ObsidianRoutes/ObsidianRoutes.php [Accessed 22 Oct 2013].

Skourtopoulou, K., 1993. *I Lithitechnia Tis Thermis B. Neolithiki Paragogi Kai Technologiki Drastiriotita.*, MA Thesis, University of Thessaloniki.

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, *Papers from the EAA third annual meeting at Ravenna 1997,* 9–16.

Skourtopoulou, K., 1999. The Chipped Stone from Makriyalos: A Preliminary Report, in *Neolithic Society in Greece*, (ed.) P. Halstead. Sheffield: Sheffield Academic Press, 121–27.

Skourtopoulou, K., 2004. I lithotechnia tou apokrousmenou lithou ston oikismo tis Stavroupolis, In *Sostikes Anaskafes Sto Neolithiko Oikismo Stavroupolis Thessalonikis, Part II*, (eds.) D.V. Grammenos & S. Kotsos. Thessaloniki: Dimosievmata tou Arhaeologikou Institoutou Voreias Elladas, 361–476.

Skourtopoulou, K., 2006. Questioning Spatial Contexts: The Contribution of Lithics Studies as Analytical and Interpretative Bodies of Data, In *Deconstructing Context: A Critical Approach to Archaeological Practice*, (ed.) D. Papakonstantinou. Oxford: Oxbow Books, 50–78.

Slimak, L., S.L. Kuhn, H. Roche, D. Mouralis, H. Buitenhuis, N. Balkan-Atlı, D. Binder, C. Kuzucuoğlu & H. Guillou, 2008. Kaletepe Deresi 3 (Turkey): Archaeological Evidence for Early Human Settlement in Central Anatolia, *Journal of Human Evolution* 54(1), 99–111.

Souvatzi, S., 2008. *A Social Archaeology of Households in Neolithic Greece: An Anthropological Approach*. Cambridge: Cambridge University Press.

Spataro, M., 2013. Continuity and Change in Pottery Manufacture Between the Early and Middle Neolithic of Romania, *Archaeological and Anthropological Sciences* 6(2), 175–97.

Speakman, R.J. & M. Steven Shackley, 2013. Silo Science and Portable XRF in Archaeology: A Response to Frahm, *Journal of Archaeological Science* 40(2), 1435–43.

Srejović, D., 1969. *Lepenski Vir. Nova praistorijska kultura u Podunavlju*. Beograd: Srpska književna zadruga.

Srejović, D., 1988. *The Neolithic of Serbia. Archaeological Research 1948-1988*. Belgrade: Faculty of Philosophy, Centre for Archaeological Research.

Srejović, D. & N. Tasić, 1990. *Vinča and Its World*. Belgrade: Serbian Academy of Sciences and Arts.

Stevanović, M., 1997. The Age of Clay: The Social Dynamics of House Destruction, *Anthropological Archaeology* 16, 334–95.

Summerhayes, G.R., J.R. Bird, R. Fullagar, C. Gosden, J. Specht & R. Torrence, 1998. Application of PIXE-PIGME to Archaeological Analysis of Changing Patterns of Obsidian Use in West New Britain, Papua New Guinea, In *Archaeological Obsidian Studies: Method and Theory*, (ed.) M.S. Shackley (Advances in Archaeological and Museum Science). New York: Plenum Press, 129–58.

Sydris, R., 1977. Mass-distance Measures for the Maya Obsidian Trade, in *Exchange Systems in Prehistory*, (eds.) T. Earle & J. Ericson. New York: Academic Press, 91–107.

Takaoğlu, T., 2004. Moralı: A Neolithic Mound in Central-West Anatolia, In *Anadolu'da Doğdu, 60. Yaşında Fahri Işık'a Armağan*, (ed.) T. Korkut. Istanbul: Ege Yayınları.

Takaoğlu, T., 2006. The Late Neolithic in the Eastern Aegean: Excavations at Gülpınar in the Troad, *Hisperia* 75, 289–315.

Težak-Gregl, T. & M. Burić, 2009. Archaeometrical Research of Lithic Raw Materials for Early Neolithic Prehistoric Communities with the Help of Prompt Gamma Activation Analysis: The Aims of Project, Current Achievements and Future Perspectives, *Archeometriai Műhely* 3, 1–3.

Theocharis, D.R., 1973. *Neolithic Greece*. Athens: Ethniki Trapeza tis Ellados.

Thissen, L., 2005. Coming to Grips with the Aegean in Prehistory: An Outline of the Temporal Framework, 10.000-5500 cal BC, In *How Did Farming Reach Europe? Anatolian-European Relations from the Second Half of the 7th through to the First Half of the 6th Millennium Cal BC*, (ed.) C. Lichter (Proceedings of the International Workshop Istanbul, 20 – 22 May 2004. Byzas 2). Istanbul: Ege Yayinlari, 29–40.

Thorpe, O.W., 1978. *A Study of Obsidian in Prehistoric Central and Eastern Europe, and Its Trace Element Characterization*, PhD Dissertation, University of Bradford.

Todorović, J. & A. Cermanović-Kuzmanović, 1961. *Banjica – naselje vinčanske kulture*. Beograd: Muzej grada Beograda.

Tomkins, P., 2004. Filling in the 'Neolithic background': Social Life and Social Transformation in the Aegean Before the Bronze Age, In *The Emergence of Civilisation Revisited*, (eds.) J.C. Barrett & P. Halstead. Oxford: Oxbow Books, 38–63.

Torrence, R., 1986. *Production and Exchange of Stone Tools*. Cambridge: Cambridge University Press.

Torrence, R., 2004. Now You See It, Now You Don't: Changing Obsidian Source Use in the Willaumez Peninsula, Papua New Guinea, In *Explaining Social Change: Studies in Honour of Colin Renfrew*, (eds.) Cherry J., C. Scarre & S. Shennan. Cambridge: McDonald Institute for Archaeological Research, 115–25.

Triantaphyllou, S., 1999. Prehistoric Makiyalos: A Story from the Fragments, In *Neolithic Society in Greece,* (ed.) P. Halstead. Sheffield: Sheffield Academic Press, 128–35.

Tringham, R.E., 2000. The Continuous House: A View from the Deep Past, In *Beyond Kinship: Social and Material Reproduction in House Societies*, (eds.) S. Gillespie & R. Joyce. Philadelphia: University of Pennsylvania Press, 115–34.

Tringham, R.E., B. Brukner & B. Voytek, 1985. The Opovo Project: A Study of Socio-Economic Change in the Balkan Neolithic, *Journal of Field Archaeology* 12, 425–44.

Tringham, R.E. & D. Krstić, 1990. *Selevac: A Neolithic Village in Yugoslavia*. Los Angeles: UCLA.

Tripković, B., 2003. Obsidian Deposits in the Central Balkans? Tested Against Archaeological Evidence, *Starinar* 53-54, 163–79.

Tripković, B., 2007. *Домаћинство и простор у касном неолиту: Винчанско насеље на Бањици (Household and Space in the Late Neolithic Vinča Settlement at Banjica)*. Belgrade: Српско археолошко друштво (Serbian Archaeological Society).

Tripković, B., 2011. Containers and Grains: Food Storage and Symbolism in the Central Balkans (Vinča period), *Documenta Praehistorica* 38, 159.

Tripković, B., 2013. *Domaćinstvo i zajednica: kućne i naseobinske istorije u kasnom neolitu centralnog Balkana*. Belgrade: Filozofski Fakultet, Univerziteta u Beogradu.

Tripković, B. & M. Milić, 2008. The Origin and Exchange of Obsidian from Vinča-Belo Brdo, *Starinar* 58, 71–86.

Tykot, R.H., 1996. Obsidian Procurement and Distribution in the Central and Western Mediterranean, *Journal of Mediterranean Archaeology* 9(1), 39–82.

Tykot, R.H., 2002. Chemical Fingerprinting and Source Tracing of Obsidian: The Central Mediterranean Trade in Black Gold, *Accounts of Chemical Research* 35, 618–27.

Tykot, R.H., 2004. Neolithic Exploitation and Trade of Obsidian in the Central Mediterranean: New Results and Implications for Cultural Interaction, In *The Neolithic in the Near East and Europe (Acts of the XIVth UISPP Congress, University of Liège, Belgium, 2 – 8 September 2001)*. Oxford: BAR International Series 1303, 25–35.

Tykot, R.H., 2010. Sourcing of Sardinian Obsidian Collections in the Museo Preistorico-Etnografico 'Luigi Pigorini' Using Non-Destructive Portable XRF, In *L'ossidiana Del Monte Arci Nel Mediterraneo. Nuovi Apporti Sulla Diffusione, Sui Sistemi Di Produzione E Sulla Loro Cronologia. Atti Del 5° Convegno Internazionale (Pau, Italia, 27 – 29 Giugno 2008)*, ed. C. Lugliè. Ares: NUR, 85–97.

Tykot, R.H., 2011. Obsidian Finds on the Fringes of the Central Mediterranean: Exotic or Eccentric Exchange?, In *Exotica in the Prehistoric Mediterranean*, (ed.) A. Vianello. Oxford: Oxbow Books, 33–44.

Tykot, R.H. & A.. Ammerman, 1997. New Directions in Central Mediterranean Obsidian Studies, *Antiquity* 71, 1000–1006.

Tykot, R.H., M.D. Glascock, R.J. Speakman & E. Atzeni, 2008. Obsidian Subsources Utilized at Sites in Southern Sardinia (Italy), *Materials Research Society Symposium Proceedings* 1047, 175–83.

Vedder, J.F., 2005. The Obsidian Mirrors of Çatalhöyük, In *Changing Materialities at Çatalhöyük: Reports from the 1995-1999 Seasons*, (ed.) I. Hodder. Cambridge: McDonald Institute Monographs and BIAA, 597–619.

Vogt, J.R., C.C. Graham, M.D. Glascock & R.H. Cobean, 1981. A Study of Mesoamerican Obsidian Sources Using Activation Analysis, *Journal of Radioanalytical Chemistry* 69(1-2), 271–89.

Voytek, B., 1985. *The Exploitation of Lithic Resources in Neolithic Southeast Europe*, PhD Dissertation, University of Berkeley.

Warren, P., 1969. *Minoan Stone Vases*. Cambridge: Cambridge University Press.

Was, M., 2006. *The TP Area*.
http://www.catalhoyuk.com/downloads/Archive_Report_2006.pdf.

Whittle, A.W.R., L. Bartosiewicz, D. Borić, P. Pettitt & M.P. Richards, 2002. In the Beginning: New Radiocarbon Dates for Early Neolithic in Northern Serbia and South-East Hungary, *Antaeus* 25, 63–117.

Whittle, A.W.R., L. Bartosiewicz, D. Borić, P. Pettitt & M.P. Richards, 2005. New Radiocarbon Dates for the Early Neolithic In Northern Serbia and South-East Hungary: Some Omissions and Corrections, *Antaeus* 28, 347–55.

Williams, O. & J. Nandris, 1977. The Hungarian and Slovak Sources of Archaeological Obsidian: An Interim Report on Further Fieldwork, with a note on Tektites, *Journal of Archaeological Science* 4, 207–19.

Williams-Thorpe, O., 1995. Obsidian in the Mediterranean and the Near East: A Provenancing Success Story, *Archaeolometry* 37, 217–48.

Williams-Thorpe, O., S.E. Warren & J.G. Nandris, 1984. The Distribution and Provenance of Archaeological Obsidian in Central and Eastern Europe, *Journal of Archaeological Science* 11, 183–212.

Ziota, C., A. Hondroyanni-Metoki & E. Magouretsiou, 2009. Η αρχαιολογική έρευνα στον Κλείτο Κοζάνης το 2009, *To Archaeologiko Ergo sti Makedonia kai Thraki* 23, 37–52.

Zvelebil, M., 2001. The Agricultural Transition and the Origins of Neolithic Society in Europe, *Documenta Praehistorica* 28, 1–26.

Zvelebil, M. & M. Lillie, 2000. Transition to Agriculture in Eastern Europe, In *Europe's First Farmers*, (ed.) D.T. Price. Cambridge: Cambridge University Press, 57–92.

Appendix - Sites description

This Appendix provides a brief description of the sites that are examined in the study as well as some other sites that are included in the discussion on the basis of published material. The data from research at these settlements was available for this work and / or already published, and so the list is not exhaustive of all sites known from this period and these regions through survey or other means. The sites are listed according to their location within the three obsidian distribution zones, central Anatolia, the Aegean and the Carpathians, and correspondingly to Chapters 6, 7 and 8 respectively.

Central Anatolia

1. Çatalhöyük

Çatalhöyük is located in southern Anatolia, in the Konya Plain, 52 km southeast of modern Konya on the eastern bank of Çarşamba River, an important fresh water sources for the Konya Plain. It was firstly discovered by J. Mellaart in the 1958, while the excavations were carried out between 1961 and 1965. After a break of almost 30 years, a new survey and excavations directed by I. Hodder (Stanford University) were initiated in 1993 and are continuing to date.

This large tell covers over 13 hectares, and consists of two mounds (çatal means *fork* in Turkish) - Çatalhöyük East (7500-6000 BC) and Çatalhöyük West (6000-5500 BC). Mellaart identified twelve levels (XII-0) while Hodder's team uncovered four pre-XII levels (pre-XII.D-A) that belong to Aceramic Neolithic. Recently Hodder re-named levels at Çatalhöyük, running alphabetically G-T. The occupation of the mound includes Aceramic Neolithic, pottery Neolithic, Chalcolithic and also Hellenistic and Byzantine remains.

The main characteristics of the Neolithic settlement at Çatalhöyük East are closely clustered rectilinear mudbrick houses with flat roofs that were used as activity areas. The entrances to the houses were located on the roofs while the interior spaces were often separated into two or three rooms, forming living spaces and storage areas. Burials were intramural, frequently located under domestic floors. Some more 'elaborate' houses (Hodder 2007) are occasionally decorated with wall paintings, bull horns (bucrania) and molded figures.

The earliest pottery (levels XII-IX) is light coloured and low-fired and porous. Only from

Level VIII and, typically in Level VII, a dark burnished ware is used for hole-mouth jars. This ware has parallels at Can Hasan 7-4 and also the basal level of the sites in north-western Anatolia (Menteşe, Demircihöyük and archaic Fikirtepe). Contemporary sites in the Lake District (early Bademağacı and Höyücek) are lacking the typical dark coloured burnished pottery. From Level III onward the dark burnished ware is less frequently produced while lighter monochrome wares are more common. New shapes include vessels with S-shaped profiles, tubular lugs and ring bases (Çilingiroğlu 2009; Last 1996).

The following levels of the settlement belong to Early Chalcolithic tell Çatalhöyük West. Unfortunately, the transition between LN Çatalhöyük East and EC Çatalhöyük West could not yet be demonstrated (Marciniak & Czerniak 2007, 123).

Çatalhöyük West belongs to Early Chalcolithic period, separated by Mellaart into two phases EC I and EC II on the basis of large quantities of painted pottery (Mellaart 1965). EC I is characterised with red-on-cream painted wares, while EC II with dark-on-light wares. Mud-brick rectangular houses were comprised of a series of small, cell-like spaces, with plastered walls and surfaces (Biehl *et al.* 2012; Erdoğu 2008). In contrast to the earlier East mound, the Chalcolithic buildings lack the decorative architectural elements - bucrania, mouldings and wall paintings.

Even though it is geographically quite isolated, Çatalhöyük at this time shows similarities with Can Hasan I layer 2B particularly in terms of building layout, use of mud-brick and construction of internal buttresses (Biehl *et al.* 2012). Similar buttresses have also been discovered in the Lake District sites (Hacılar, Kuruçay) and in the Marmara region (Aktopraklık, Ilıpınar).

The Neolithic settlement at Çatalhöyük East was continuously occupied from c. 7400 until 5900 BC, while EC Çatalhöyük West belongs to the first half of the 6th millennium BC.

2. Köşk Höyük

This site is located in the vicinity of Cappadocian obsidian sources. The stratigraphy is consisted of Levels V-I of which II-I belong to Late Neolithic / Early Chalcolithic period. Building Levels V-II are dated to 6300-5600 BC, while Level I belongs to the early 5th millennium BC.

Rectilinear houses are divided into two or more rooms with plastered floors and walls, sometimes with painted walls (Öztan 2011). Parallels with earlier Çatalhöyük East were documented through the existence of burials under the house floors, pottery with relief decoration, and animal and female figurines (*ibid.*). Another distinctive characteristic of this settlement is the presence of a number of plastered skulls that have clear parallels with some from Çatalhöyük and some Levantine PPN sites (*ibid.*, 36). The earliest pottery from Level V is monochrome although typical LN shapes are missing in the assemblage and forms have greater parallels in EC assemblages (e.g. Çatalhöyük West and Can Hasan 3-2). White-on-red painted pottery that was found at this site is rarely found in inland Anatolian settlements - that is occasionally at EC levels at Hacılar, Bademağacı and Höyücek. This decoration is more characteristic of the EN cultures of south-eastern Europe, as documented at Hoca Çeşme II and sites of Karanovo I culture (Çilingiroğlu 2009, 339).

The Lake District

1. Hacılar

This mound is located near Lake Burdur on the northern slopes of the Taurus Mountains. It was initially excavated between 1957-1960 by J. Mellaart who identified three Neolithic occupation horizons: Aceramic Neolithic, Late Neolithic and Early Chalcolithic. In two seasons in 1980s, the excavation was led by R. Duru (Istanbul University) who claimed that there was no Aceramic Neolithic based on pottery finds he discovered. Architecture consisted of rectilinear mudbrick houses with courtyards and open spaces between them. The houses had plastered walls and contained platforms, benches, storage bins and ovens. The early pottery was light monochrome ware mainly in the form of S-shaped bowls. From the Early Chalcolithic period, the red-on-cream painted wares became more frequent (Duru 2012).

2. Kuruçay

A small mound, located close to Lake Burdur, this was excavated in the 1970s and 1980s by R. Duru. The stratigraphy consists of 13 levels that include the Early and Late Neolithic, the Early and Late Chalcolithic and Early Bronze Age levels. The architecture of the earliest phases (12-8) consists of rectilinear buildings on stone foundations. From level 7, mudbrick houses with inner buttresses were documented and represent a parallel with Can Hasan 2B and Çatalhöyük West. The Neolithic finds include light monochrome wares, (bowls with S-shaped profiles and hole-mouth jars) anthropomorphic and zoomorphic figurines, bone and stone tools. Painted pottery is also present, and its frequency increases in later levels. The exploitation of domesticated animals is evidenced only from the Early Chalcolithic period.

3. Höyücek

This is a tell site in the Burdur region which as excavated between 1989 and 1992 by R. Duru and G. Umurtak (Istanbul University). Duru (2012, 8) believes that the settlement does not contain domestic structures but buildings related to cult ("shrines" and "temples"). The occupation of the settlement is separated into EN I, EN II (The Shrine Phase) and LN phase (The Sanctuaries Phase). The architecture from the first phase is not preserved. In the following phase, the houses were built of mudbrick, were often one-roomed with plastered walls, storage bins and ovens. One house (the Shrine) contained a separate room, a small staircase, a large storage bin and a variety of finds including deer antlers, cattle mandibles and ankle bones as well as marble bowls and various pottery vessels and thousands of flint blades. This phase is followed by the "Sanctuaries Phase" which contained mudbrick structures and a large number of figurines, polished axes, flint and obsidian pressure-flaked blades. The earliest pottery is monochrome usually in shape of S-bowls and hole-mouth jars. For the "Sanctuary Phase", white-on-red painted decoration is characteristic for ceramics. The "Shrine Phase" is dated to c. 6400-6200 BC, while the following phase is not absolutely dated, although it is likely to belong to the last half of the 7th millennium BC.

North-western Anatolia

1. Fikirtepe and Pendik

The sites are located in the suburbs of modern-day Istanbul on the east coast of the Sea of Marmara. The type-site Fikirtepe is a flat settlement and represents the core of 'Fikirtepe culture' (Özdoğan 1997; 1999). Initial excavations at Fikirtepe were carried out between 1952 and 1954. The settlement contained a single half metre thick cultural layer and no stratified material has been revealed which made the dating of the site problematic.

Pendik consists of a shallow mound (c. 2 m high) that has been surveyed on several occasions, with excavation taking place in 1982 (Özdoğan 1999). Even though the site is not well-preserved, the area that the settlement covers almost three times larger than that of

Fikirtepe (Özdoğan 1983). The stratigraphy of the site remains unclear. According to the ceramic assemblage, Özdoğan assigned Pendik to the Archaic Fikirtepe phase, stating that the ceramics are "almost identical with that of Fikirtepe" (Özdoğan 1983, 405). This typically includes bowls and jars with convex sides or with a slight S-profile, hole-mouth jars, rectangular vessels, horizontally placed lug handles. Pottery decoration is not very common, usually including incised decoration with geometric designs (*ibid.*).

The typical architecture of the sites is better preserved at Fikirtepe, indicating sub-circular or oval huts, with superstructures made of wattle-and-daub.

Fikirtepe and Pendik have not been scientifically dated and the chronology of these sites is estimated on the basis of comparison with material from Ilıpınar with its more complete stratigraphic sequence. As a result, obsidian that was studied from these sites is not well datable beyond this general earlier phase of the Neolithic.

2. Barcın Höyük

Excavation at Barcın Höyük (Yenişehir II) is part of the "Early farming communities in the eastern Marmara region" project of Netherlands Institute in Turkey whose other sub-projects include excavations at Ilıpınar and Menteşe (Roodenberg 1999).

Barcın Höyük is situated south of Iznik Lake in the plain of Yenişehir. The 4m high tell consists of two conjoined mounds, with the earliest occupation dated to mid-7th millennium BC, after which there is a gap in occupation. The habitation is resumed in the beginning of the 4th millennium BC. The deposits include the Neolithic, Chalcolithic, Early and Middle Bronze Age, Roman and Byzantine periods (Phases VI-I). A sondage excavation reached the Neolithic which was dated to 6500-5900 BC (Gerritsen *et al.* 2013).

Late Neolithic house plans have not been fully exposed at Barcın Höyük but rectangular houses were built using a combination of mud-brick and wooden posts. A deep sounding revealed evidence for red painted lime floors in level VI (*ibid.*). Between the houses were open areas, similar to the settlement layouts seen in Greece and the Balkans. Pottery provides a recognisable link with other Fikirtepe sites.

3. Aktopraklık

The Neolithic site of Aktopraklık is located at the village of the same name, 25 km west of modern Bursa on the Bursa-Izmir road on the eastern terraces of Lake Ulubat (Karul & Avcı 2013). The survey at the small mound at Aktopraklık started in 2004 while excavations began in 2006 when three settlement units A, B and C were discovered. . Site A probably belongs to the Chalcolithic period, site B to the Early Chalcolithic and site C to the Late Neolithic and Chalcolithic. Dark monochrome pottery in area C dates it to the end of the 7th / beginning of the 6th millennium BC. Finds are quite similar to those at Ilıpınar and Menteşe, however simple wattle-and-daub round dwellings are closely related to a similar building tradition at Fikirtepe and Pendik. Similar to Fikirtepe and Pendik, Aktopraklık has not been radiocarbon dated and it is chronologically assigned to early Neolithic phases according to parallels in material culture. In the Early Chalcolithic period (mid 6th millennium BC) houses are square in plan with mud-brick walls covered with thick plaster and inner buttresses (Karul and Avcı 2013).

The excavations of the mound revealed the settlement was surrounded by two ditch systems, one measuring 100 metres diameter and the other around 70 metres in diameter. The ditches were filled with refuse pits and burials as well as broken ground stones and dark burnished pottery with white incised decoration. This latter can be roughly dated to the second half of 6th millennium BC (*ibid*.).

4. Ilıpınar

Ilıpınar is a tell site located on an alluvial plain west of Lake Iznik. The significance of this site is owed to the seven metres of archaeological deposits that consist of at least ten occupational levels from the Late Neolithic to the Early Byzantine periods. The earliest settlement is in Level X which is dated to 6000-5900 BC, while the Early Chalcolithic Levels IX-VA span from 5900 until 5600 BC (Roodenberg 1999). Roodenberg (1999, 197) separated the Neolithic / Early Chalcolithic period into two sub-periods which is related to the architectural development. In the earlier phase (c. 6000-5700 BC or Levels X-VI) the houses were free-standing, rectangular, with single rooms, timber-framed or mud-slab structures. In the second phase (5700-5500 BC), from Levels VI and VA, the houses were not freestanding units or single-room anymore and they were built of mud-brick, which is a more Near-eastern or central Anatolian characteristic (Roodenberg 1999, 196). Apart from architecture, the changes are also seen in pottery, figurine and bone assemblages (Roodenberg 1999). Following phase VB, the next occupation belongs to the Late Chalcolithic period.

The Cyclades

1. Saliagos

Saliagos is located on an islet between the islands of Paros and Antiparos, although in the Neolithic period, it was a part of an isthmus between the two islands. J.D. Evans and C. Renfrew excavated the in 1964 and 1965, establishing three main stratigraphic phases (Stratums 1-3).

The site was surrounded by an enclosure wall and houses were rectilinear and built on stone foundations. The pottery repertoire is relatively restricted with the main types including dark burnished and un-burnished coarse wares. The vessels are open bowls, often on high pedestal bases and with rolled rims. There are also hole-mouth jars, while lug handles predominate among the handle types. The most distinctive features of the pottery assemblage is the use of painted white-on-dark geometric motifs which represent one of the characteristics of Saliagos culture. Pattern-burnished pottery is notpresent at the site. Another important characteristic of the site is the large obsidian assemblage, with diagnostic barbed and tanged-and-barbed points and ovates. On the other hand, bone tools are rare and there are only two fragments of marble bowls and two marble figurines, while animal figurines and stamp seals are absent (Evans & Renfrew 1968).

Five radiocarbon dates demonstrate occupation at Saliagos was throughout the 5th millennia BC which in relative Aegean chronology belongs to the Late Neolithic I period (Evans & Renfrew 1968, 144). Apart from other LN Cycladic sites, parallels for material from Saliagos were found in Emporio X-VIII, Tigani I-II, and in the Troad at Kumtepe 1a, Beşik-Sivritepe and Gülpınar (Takaoğlu 2006).

2. Ftelia

Ftelia is situated on the northern part of Mykonos. It was excavated between 1995 and 1996 and again in 2000 by A. Sampson (University of the Aegean). The C14 analyses yielded dates between 5000-4500 BC, which in relative terms belong to Late Neolithic I in the

Aegean and Saliagos culture. The settlement is separated into four architectural phases with rectangular stone-built houses in all phases. In the first architectural phase, a well-built megaron-type building was recovered. Additionally, smaller structures were excavated, which probably served as storage places (Sampson 2002).

Dark-burnished wares dominated the assemblage. The most common pottery types are bowls in various shapes, but also vessels on high pedestals, and a variant the excavator calls *réchaud* vessel (Sampson 2002). 'Cheese-pots' are also present. The decoration is mainly crusted ware and rarely white-on-dark painted and pattern-burnished. The rich obsidian industry shows similarities to Saliagos, particularly the projectile points, which are commonly tanged points (Galanidou 2002). The other material includes figurines, copper ornaments and other objects are of symbolic significance (bone musical instrument, anchor-shaped objects, incised sherds).

The North-eastern Aegean

1. Coşkuntepe

Coşkuntepe is located on the south-western tip of the Troad peninsula overlooking the Aegean Sea. It is a flat settlement and represents the only site in the Troad that can be dated to around 6000 BC or Anatolian Late Neolithic / Early Chalcolithic. Surface survey of the site revealed finds that belong to the Neolithic, Chalcolithic, EBA and MBA periods. The Neolithic pottery types include fine, slipped and well-burnished fabrics, often in red colour. Painted pottery is absent, which is also common in central-western and north-western LN/EC sites. They also share the same ceramic shapes - jars, bowls with convex and S-shaped profiles, vertically placed tubular lugs, etc. Furthermore, one fragment of an incised Fikirtepe box was also found at Coşkuntepe (Çilingiroğlu 2009, 258)

2. Gülpınar

Gülpınar is situated in the south-west corner of the Troad, some 200 m north of the Apollo Smintheus temple that contained deposits that belong to the Chalcolithic, Early Bronze Age and Roman periods. It is interesting in the report by Takaoğlu (2006) that Gülpınar material culture is comparable to the LN I settlements on the Aegean islands in the Cyclades (Saliagos, Ftelia, Zas and Grotta), the eastern Aegean (Tigani I-II and Emporio X-VIII) and the Thracian and Macedonian sites (Dikili Tash I, Sitagroi I-II, Dimitra I-II, Paradimi I-II and Karanovo III-IV). It has been emphasised that the contemporary Middle and Late Chalcolithic sites in Anatolia are underrepresented and, in fact, the only local settlements of the same period are Kumtepe and Beşik-Sivritepe.

In the published excavation seasons 2004 and 2005, the only architectural features found were floors and pits dug into the floors but no stone walls (Takaoğlu 2006, 293). These pits were filled with pottery, bones, ground and chipped stones and probably served as 'rubbish pits'. Similar pits were found in Kumtepe, Tigani, Aşağı Pınar, Hoca Çeşme and Makri Evrou.

The pottery is black burnished, and usually the shapes are bowls with flat or pedestal bases. The most distinctive bowl type is that with uprising high handles and other types of handles. The bowls occasionally have pattern-burnished decoration as zig-zag, parallel lines and dots. This type of decoration is known from the site of Beşik-Sivritepe in the Troad, dated to 4780-4500 BC, but also from Aegean sites (e.g. Zas, Tigani I-II, Emporio, Kephala, Tsangli, Arapi Magula, Franchthi) (Takaoglu 2006, 299). The relationship between Gülpınar and the other Aegean sites is also seen through the common appearance of cheese pots found at sites such are Ftelia, Emporio X-VIII and Ayio Gala Upper Cave.

3. Uğurlu

Uğurlu is a low mound located on the western side of the northern Aegean island of Gökçeada (Imbros). The site was occupied during the Neolithic, Chalcolithic and Early Bronze periods, which is marked with phases V-I. Excavated by a team led by B. Erdoğu (University of Thrace), the main focus of work has been on the spread of early farmers and colonisation of islands, plus the site of Gökçeada close (17 km) from the Troad mainland. Work has been fruitful in the recovery of the settlement at Uğurlu which belongs to the Anatolian Early Neolithic or Late Neolithic / Early Chalcolithic period (Erdoğu 2013). The only island-based parallels to Uğurlu's earliest LN/EC phases are not very well-stratified. This includes the site of Ayio Gala on Chios and the settlements located in western Anatolia. Typical for this period, the ceramic assemblage includes red slipped wares, deep bowls with S-shaped profiles, hole-mouth jars, and the use of vertically placed tubular lugs. Radiocarbon dates for the phase IV are c. 5900 BC which places this together with Ulucak IV, Aktopraklik and Ilıpınar VIII. Phase V is dated to c. 6400 BC which would be contemporary with Ulucak

V, Hoca Cesme IV and the basal levels at Mentese and Barcin Hoyuk (Erdoğu 2011, 50). The Chalcolithic dark burnished pottery from phase II is comparable to finds from Kumtepe and Beşik-Sivritepe, Emporio X-VIII and Tigani I-III (Erdoğu 2011, 48), which in turn should be related to nearby Gülpınar. The only preserved building is from Chalcolithic phase II, and is a stone built rectangular structure.

4. Hoca Çeşme

There are only a small number of sites explored in Thrace, including Hoca Çeşme and Aşaği Pınar. Hoca Çeşme is located near the Aegean coast in the delta of the Meriç (Maritsa or Evros) river at a "strategic location between the Aegean and the littoral Thrace" (Özdoğan 1998, 437). Three seasons of excavation at the beginning of the 1990s revealed four Neolithic occupational phases (IV-I). Phases IV and III are the earliest while the later parts of Phase II are disturbed with numerous Phase I pits (Özdoğan 1999). The architecture of phases IV-III consisted of round huts that are cut into the bedrock and which are of different type to Fikirtepe sites. In Phase II, the building practices changed and round houses were replaced with rectangular wattle-and-daub built structures. Phase I is heavily damaged, with no identifiable architectural remains. The settlement is surrounded by a substantial stone enclosure wall interpreted as defensive (Özdoğan 1998, 440).

Monochrome pottery dominates in the earlier phases (IV-III) as well as some types with painted decoration from Phase II. The later phases (II-I) have the characteristic black burnished pottery and pattern-burnished decoration typical for Balkan communities. The main ceramic shapes are bowls with S-profiles, carinated bowls, hole-mouth jars, vertically or diagonally placed tubular lugs on bowls, beaded rims (Özdoğan 2013).

Stratigraphy and absolute dates indicate continuous occupation from c. mid-7th - mid 6th millennium BC (Phase IV 6400-6200 BC; Phase III 5950-5700 BC; Phase II - c. 5700 BC; Phase I 5610-5360 BC). On the other hand pottery styles suggest that Hoca Çeşme IV cannot be earlier than 6200-6000 BC, while Hoca Çeşme III belongs to the beginning of the 6th millennium BC (Özdoğan 2013).

Özdoğan suggested that Hoca Çeşme II has characteristics of Karanovo I material culture and, therefore, Phases IV and III should belong to an earlier period that precedes Karanovo I (Özdoğan 2013). The end of Phase II is, in fact, parallel to transitional Karanovo I-II, while

Phase I includes features typical of Karanovo III, Karanovo III/IV.

It has also been noted that the architecture of the site is different to the sites in north-western and western Anatolia (apart from Ege Gübre). The circular huts and enclosure wall in Hoca Çeşme IV and III are perhaps of east Mediterranean or Cypriot origin, while from Phase II, the settlement has typical Aegean and Balkan characteristics (Özdoğan 2011).

The Eastern Aegean

1. Ayio Gala

Ayio Gala is a cave site located on the north-western part of island of Chios which is only c. 15 km away from Izmir's Karaburun peninsula. Two parts - the Upper and Lower Caves have been excavated by E. Eccles in 1938, although no stratified deposits were obtained from this site. The finds do not show similarities with Emporio or Tigani on Samos and they are often compared to the material from central-western Anatolian LN/EC sites on the basis of common pottery styles. This is related to the red burnished ware, jars and bowls with S-profiles, hole-mouth jars, vertical tubular lugs, pierced knobs and beaded rims. The other finds include terracotta human heads from figurines, bone tools, stone and shell pendants and stone bracelets (Davis 1992; Hood 1981).

2. Emporio

Emporio is situated in the south-eastern part of the island of Chios. The site was excavated between 1952 and 1955 by S. Hood of the British School at Athens. The stratigraphy includes ten phases: Periods V-I belong to the Early Bronze Age - contemporary with various phases of Troy II and I; Periods VII-VI are parallel to Kum Tepe IB (Traod) and Late Chalcolithic in Anatolia (Beycesultan), while on the other hand, pottery from Period VII have close parallels to Final Neolithic material from Kephala on Keos; Periods X-VIII are related to the Anatolian Chalcolithic and the Greek Late Neolithic. S. Hood suggested that the earliest phases of Emporio belong to the Early Neolithic of the Greek mainland, although many scholars did not support this chronology, setting Emporio X-VIII in the Late Neolithic I and II or even to the Anatolian Late Chalcolithic (Davis 1992, 725; Evans & Renfrew 1965).

The architecture is not well preserved although some remnants of stone built houses were uncovered. In period VIII there is a possibility for the presence of an apsidal house. Pottery of the Neolithic periods is mainly dark burnished, while light brown burnished ware is more distinctive for Periods VII-VI. The decoration commonly consists of pattern burnished and incised forms, particularly in period VIII. The variety of bowls, jars and jugs includes deep open bowls, flat-mouthed jugs, globular jars, which possess large handles and horn handles, as well as some with vertical lugs. Other objects are clay spoons, a few clay figurines, spindle whorls and small amount of copper objects from Periods IX and VIII (Hood 1981). The chipped stone industry largely consists of flint tools, while obsidian is relatively rare in all layers apart from Period VIII (where it is almost 50%).

3. Tigani

The tell at Tigani is located on the southern coast of the island of Samos, less than 10km from the Dilek Peninsula and the Delta of Büyük Menderes (Meander) river in Anatolia. The first excavations of the site were carried out by the German Institute in Athens under the direction of W. Wrede in 1928 and 1930. The material excavated, however, remained stratigraphically undetermined. Renewed excavation between 1966 and 1968 was later published by R. Felsch (1988). On the hill of Kastro Tigani, deposits in Neolithic pits was used to separate four chronological phases (I-IV), some of which are further divided into sub-phases. The architectural remains are not well preserved enabling the reconstruction of the habitation. Much of the study on Tigani material is dedicated to pottery styles that can be linked to the Late Neolithic and Chalcolithic periods in the Aegean and Anatolia. According to Felsch, the material from Tigani I-IV is broadly parallel to Emporio X-VI. The earliest phases (I and II) contain material that is not securely dated and its association with EN and MN of the eastern Aegean islands is uncertain. According to Takaoglu (2006), pattern-burnishing, particularly zigzag and crosshatched patterns are very similar at Gülpınar and Tigani I-II.

4. Moralı

Moralı is located in Akhisar plain, a land-route from Anatolia to the Aegean, and represents one of the few sites where the development of the Late Neolithic can be followed (Takaoglu 2004). The site was identified and surveyed in 1959 by D. French who collected pottery and lithics assigning them to the Late Neolithic, contemporary to Hacılar (French 1965). The site was re-surveyed in the 1990s by Turkish archaeologists, though the mound has never been excavated.

Monochrome burnished pottery, bowls and jars with curved sides and tubular lugs are commonly found in the ceramic repertoire. One fragment of a rectangular vessel with incised decoration was also collected. There were also a few painted fragments (red-on-cream) that resemble those from the Lake District. Renfrew, Cann and Dixon (1965) analysed two pieces of obsidian and assigned them to Melian sources.

5. Dedecik-Heybelitepe

The mound at Dedecik-Heybelitepe is situated about 40 km south of Izmir. The trial excavation of the site took place in 2003 and 2004 by C. Lichter and R. Meriç. According to ceramic assemblages that contain red burnished ware, S-profile bowls and ones with vertically placed tubular lugs, demonstrating that this is a Late Neolithic / Early Chalcolithic settlement. It was also occupied in the Late Chalcolithic, Roman and Byzantine periods. Other characteristic artefacts are a conical stamp seal, bone spoons and sling stones. The architecture of the site is not well preserved (Lichter & Meriç 2012).

6. Çukuriçi Höyük

Çukuriçi Höyük is located close to ancient city of Ephesos and close to the Küçük Menderes river that flows into the Aegean Sea. Systematic excavation of the tell started in 2007, directed by B. Horejs from Austrian Archaeological Institute. The stratigraphy reveals at least six occupational phases - Early Chalcolithic (ÇuHö VIII), Late Chalcolithic (ÇuHö VII), Early Bronze Age (ÇuHö VI, IV, III) dated to the early 6th millennium BC to the first half of the 3^{rd} millennium BC. An earlier phase (ÇuHö IX) belongs to the Late Neolithic and is documented through core drilling of the mound (Horejs 2012).

The Neolithic / Chalcolithic architecture is characterised by rectangular houses made of mud-brick on stone foundations and with stamped clay floors. Ceramics of phase VIII are homogenous, consisting mainly of fine and medium monochrome wares. Shapes are typical for this region and period - bowls with S-profile, hole-mouth jars, tubular lugs, and disc-shaped bases (Horejs 2012). The large amount of obsidian (c. 87% of total lithic assemblages is possibly the proportionately highest from any site in the region.

The relative chronology of early Çukuriçi Höyük can be characterised as: Çukuriçi Höyük VIII - Ulucak IV (V) - Yeşilova III - Ege Gübre - Dedecik-Heybelitepe A - EN II in the Lake District.

7. Yeşilova Höyük

Yeşilova islocated within urban area of Izmir and was discovered during rescue excavations initiated in 2005 and directed by Z. Derin of Ege University, Izmir. The stratigraphy of the mound includes three major Levels and ten sub-phases:

Level I - Bronze Age, Iron Age and Roman periods
Level II (with 2 sub-phases) - Chalcolithic period
Level III (with 8 sub-phases) - Neolithic period

The Chalcolithic occupation possibly consisted of pit-dwelling or hut structures, but no coherent architecture was found. The ceramics of this period are mainly coarse, grey and blackish in colour. Common shapes are bowls with carinated inverted rims, hemispherical vessels and cheese-pots. The parallels were drawn with Emporio X-VII, Kumtepe Ia and Ilıpınar VIII-VI, which can be dated to Middle Chalcolithic period.

Neolithic Level III is the longest occupation of the tell, containing three stages III.1-2, 3-5 and 6-8 which is being the earliest. Architecture is best preserved in the last Neolithic sequence III.1-2 with hut-like structures in III.1 which were replaced with rectangular houses built of mud-brick on stone foundations. They were single room houses organised around a common courtyard. Pottery is light brown and red with slipped surfaces. The majority of shapes belong to bowls with straight and S-profiles, hole-mouth jars, and features that include flat bases, vertical lugs. Other notable artefacts are bone spatulas, clay stamps, stone bowls and anthropomorphic figurines.

Derin (2012) believes that Yeşilova III.6-8 belongs to the earliest settlement in the Aegean area of Anatolia. One radiocarbon sample from Yeşilova III.7 provided a date of 6490 cal.BC. Considering pottery types, Yeşilova III.6-8 shows similarities with the Lake District sites, Yeşilova III.3-5 with Ulucak V, while Yeşilova III.1-2 is parallel to Ulucak IV as well as Ege Gübre, Çukariçi and Dedecik-Heybelitepe (*ibid.*).

8. Ulucak

Ulucak is located outside of the modern town of Izmir, c. 20 km east of the Aegean coast, close to a natural pass between the mountains linking littoral and inner areas of central-western Anatolia (Çilingiroğlu *et al.* 2012). The mound was discovered in 1960 by D.

French, but excavations started in 1995 led by A. Çilingiroğlu (Ege University). Since 2009, the excavation has been directed by Ö. Çevik (University of Thrace) together with the team from Ege University.

Ulucak's 5 meters of stratigraphy includes six occupational levels:
Level I - Early Byzantine/Late Roman
Level II - Bronze Age levels
Level III - Middle/Late Chalcolithic period
Level IV - Neolithic period with ten sub-phases (IVa-k), phase IVb is further divided into IVb1 and IVb2
Level V - Neolithic period including six superimposed sub-phases (Va-f)
Level VI - Neolithic period - 'aceramic' phase

Middle and Late Bronze age pottery is present at the site but no associated architecture has been found. Middle/Late Chalcolithic period (Level III) structures are preserved only in a small area, hence the periodization of this level relies entirely on pottery. In terms of absolute dates, Level VI is dated to approximately 7000-6400 BC, Level V ranges 6400-6000 BC and Level IV 6000-5700 BC (Çilingiroğlu *et al.* 2012).

Level VI, the earliest occupation of Ulucak mound, is characterised with the lack of pottery or any clay objects. The excavated buildings have red painted plaster floors with hearth areas in the corners. Open areas contained ovens and hearths. In Level V, the buildings are made of wattle-and-daub with hearths, ovens and storage bins placed inside. The buildings also contained large number of finds. Level IV structures are rectangular mud-brick houses on stone foundations. Here also, hearths, ovens, storage bins and working areas are preserved inside the houses (*ibid.*).

In the Levels V and IV, the main pottery type (90%) is red slipped and burnished ware followed by grey ware with impressed decoration and very rarely painted red-on-cream and cream-on-red pottery. The most common ceramics are bowls with S-profiles and convex profiles, jars with short necks and jars with hole-mouth, vertical tubular lugs and horizontally placed double-knobs. Other finds include female and animal figurines, stamps (pintaderas), sling missiles, bone and clay spoons and bone awls (*ibid*.).

9. Ege Gübre

Ege Gübre is a multi-period settlement, situated north of Izmir, 1 km from today's coastline of the Aegean Sea. The first excavations were undertaken in the late 1990s by Izmir Archaeological Museum (T. Özkan and S. Lagona), while new excavations between 2004 and 2008 represent rescue projects of Izmir Archaeological Museum and Ege University, directed by H. Sağlamtimur.

The stratigraphy includes four main phases (Sağlamtimur 2012, 197):
Ege Gübre I - Hellenistic period
Ege Gübre II - Chalcolithic period
Ege Gübre IIIa - Neolithic period (rectangular houses with one or two rooms and circular structures)
Ege Gübre IIIb - Neolithic period (rectangular houses with one room and round structures)
Ege Gübre IIIc - Neolithic period (round buildings).

The absolute dates for the Neolithic period range between 6200 and 5700 BC.

Architecture of the settlement is unique in the region as it contains 8 round and 12 rectangular buildings arranged around a central courtyard. All were possibly used simultaneously. The round houses were probably made of wattle-and-daub, while rectangular ones have mud-brick walls on stone foundations. The courtyard that covered 900m2 was probably a workshop and midden area. The settlement was surrounded by a stone wall that might have served as protection against the floods, but was unlikely to have been for defensive purposes (Sağlamtimur 2012). The co-existence of circular architecture and enclosure wall is unusual and, apart from Ege Gübre, it is only evidenced at Hoca Çeşme III and IV.

The pottery repertoire includes red slipped, thin wall ware appears as bowls with S- or straight profiles, hole-mouth jars, flat and disc-shaped bases and tubular lugs. Rarely, Neolithic pottery includes some painted and incised sherds, while *impresso* is relatively common. Other finds are anthropomorphic figurines (Central Anatolian style), seals and pintaderas, bone awls. The chipped stone industry is based on flint and a small percentage of obsidian.

The Southern Aegean

1. Knossos

This large tell settlement is located in the north-central part of the island of Crete in the southern Aegean. It was discovered and excavated by A. Evans at the very beginning of the 20th century. The main focus of this and subsequent research became the Minoan Bronze Age occupation of the site as one of the largest and most important sites in Crete. In the 1950s, excavations by J. Evans in the Central Court, uncovered the basal level of the mound, Stratum X, dated to Aceramic Neolithic EN (beginning of the 7th millennium BC). The layer did not contain architectural remains, only the settlement debris, while mudbrick walls were found in above Stratum IX. The importance of the EN evidence is that the economy and subsistence are based on fully domesticated pig and cattle and cultivated wheat, emmer and barley, implying the arrival of Neolithic farmers from the Levant, Cyprus and / or southern Anatolia (Perlès 2001).

The North-western Aegean

1. Paliambela

This Neolithic tell is located in central Macedonia (Greece) between the foot of the mountains of Pieria and plain of Yiannitsa. It is also located relatively close to the Thermaic Gulf and the Aliakmonas River. Excavations under the directions of K. Kotsakis (Aristotle University of Thessaloniki) and P. Halstead (University of Sheffield) began in 1999 and continue still, and have revealed long-term settlement including the main Neolithic phases (Early, Middle and Late Neolithic) and some traces of the Bronze Age, Byzantine and post-Byzantine periods. The occupation started at a flat settlement in the Early Neolithic (end of the 7th millennium), but a tell developed during the occupations in Middle Neolithic (5800-5200 BC) and Late Neolithic (5200-4500 BC). Early Neolithic architecture was pit-dwellings while Middle Neolithic and Late Neolithic houses were built on stone foundations with wattle-and-daub walls. Open spaces between houses had pebble surfaces. In the Middle Neolithic deep ditches surrounded the settlement, also evident at the flat site at Makriyalos, while in the Late Neolithic a stone enclosure wall was documented (Halstead & Kotsakis 2002; Kotsakis & Halstead 2004).

The pottery represents a combination of local traditions with Thessalian styles. In the EN period the pottery in not decorated and vessels were not used for storing, possibly only for serving and occasionally cooking. In the MN the variety of shapes is still small with the majority of vessels used for serving and consuming, plus a few cooking pots, but the change to LN is marked by the appearance of storage vessels. Most of the material in this period (lithics, weights, ground tools, bones from big animals) comes from open areas of the site. Ceramics are represented as a variety of table wares, similar to MN ones, large bowls and cups and a variety of cooking pots and baking dishes, wiht a few storage vessels. Pottery is decorated classical Dimini style - highly burnished and covered with various geometric patterns (*ibid.*).

2. Makriyalos

Makriyalos is a large flat settlement of c. 50 ha, discovered in 1992, and excavated as a rescue project in 1993-1995 by M. Besios and M. Pappa of the Ephorate of Prehistoric and Classical Antiquities of Thessaloniki. The site is located near to the modern village of Makriyalos on the Aegean coast, overlooking the Thermaic Gulf. The settlement had two phases of occupation - Makriyalos I on the southern slope of the hill dated to the beginning of the Late Neolithic (5200-4900 BC) and Makriyalos II, a smaller part on the northern slope dated to the end of Late Neolithic (4900-4500 BC) (Pappa & Besios 1999a, 1999b). Both parts of the settlement were surrounded with substantial enclosure ditches. The difference in settlement organisation and architecture between the two sites is noticeable. The first phase is bigger and has more open space between the structures. The houses in Makriyalos I are subterranean and semi-subterranean dwellings made of wattle-and-daub. However, in the more densely organised phase II settlement, similar round structures were found but this phase was also characterised by the appearance of structures with apses on their southern ends. One of the houses was divided into two ‘rooms’ similar to the arrangement of the *megaron* type houses known in Thessaly. The architectural change with apsidal structures has been related to the emergence of social complexity (Pappa & Besios 1999a).

Pottery found in LN I phase is mainly black burnished and there are also some coarse wares. The decoration is often plastic and appears as rippled, incised and there is also pattern burnished decoration, while painted decoration is rare, only as white-on-black and white-on-red. The common shapes are open bowls and large storage vessels. In LN II, painted pottery is dominant and closely related to the "classical" Dimini style. The bowls appear in various sizes, together with jars and fruitstands. The other finds are also numerous and they include clay anthropomorphic and zoomorphic figurines, flint and some obsidian chipped stone artefacts, large amounts of *Spondylus gaederopous* manufacturing waste, seal stones and some possible weights. From phase II stone schematic figurines have been recovered and a number of copper artefacts, mainly beads, which are some of the earliest copper in Greece (Pappa & Besios 1999a, 1999b).

3. Kleitos

Kleitos is a large flat site in the northern part of Kitrini Lake which was excavated as a part of rescue project between 2006 and 2010 by Ch. Ziota (Ephoreia of Antiquities in Florina). The settlement occupation belongs to two main phases - Kleitos 1 which falls into the Late Neolithic I and Kleitos 2 which belongs to the Late Neolithic 2. The survey has shown that the area was inhabited in later periods, in Hellenistic and Roman times.

The settlement was surrounded by ditches and fences that enclosed an area of about 8 ha. The excavation revealed ten rectangular buildings, built in wattle-and-daub technique which is in the tradition of Neolithic houses in the Balkans. In almost all occupational phases, the houses were destroyed by fire. The layout of the buildings is irregular and the distances between them vary. Houses had clay floors and walls, occasionally walls were decorated with painted concentric circles, triangles and zigzag lines. The houses contained hearths and storage bins, but most of the activities took place in the courtyards and workshops. Black and brown burnished pottery is characteristic of the settlement for the period Kleitos 1.

Based on pottery styles, Kleitos 2 was occupied during the Late Neolithic II (Dimini phase) and the Final Neolithic (parallel with the Rachmani phase). In the Final Neolithic there is the occurrence of stylized marble figurines, as was documented in Makriyalos II. The settlement "Kleitos 2 is much smaller than Kleitos 1, and it is more compact with small buildings and limited open spaces (Ziota *et al.* 2009).

4. Vasilara Rahi

The site is situated on a prominent hill overlooking the Aliakmon River. It was excavated in 1994 by A. Hondroyanni-Metoki from the IZ' Ephoreia of Antiquities in Kozani. The main settlement was first inhabited during the Late Neolithic and continued to be occupied until the Bronze Age. It is possible that the site was settled after the abandonment of settlement at

Servia located c. 5 km upstream from Vasilara (Andreou *et al.* 1996).

5. Thermi B

Thermi is located a few kilometers south-east of Thessaloniki in the Vassilika valley. The Neolithic site of Thermi was discovered in 1987, but salvage excavations were conducted in 2000 and 2001 by the ΙΣΤ' Ephoreia led by D. Grammenos. It is a flat extended settlement with stratigraphy that can be divided into three main building phases (I-III), the oldest dated to the end of MN, followed by LN I and LN II periods. The characteristic of this and other sites in the region is the use of cobbled yards with refuse and storage pits, hearths and ovens, where most of the activities (food processing and preparation, flint knapping) were taking place. The distinctive feature of Thermi, as in the case of Makriyalos, is the presence of a number of pits, of various sizes and for different purposes, sometimes as large communal structures (the largest could be 4 m in diameter). The architecture includes the co-existence of three building types, post-framed houses, mud-brick houses on stone foundations and possibly pit-dwellings.

The chronology of the Neolithic phases is established through the ceramic finds. The late MN includes brown and red-brown slipped wares, often decorated with white linear motifs. The typical LN I pottery repertoire includes black burnished, white topped and brown burnished wares. Apart from these types, there are moderate amounts of coarse undecorated pottery. The shapes were usually carinated, large open bowls and jars. The presence of black-on-red ware, dominance of black burnished pottery and the disappearance of red-brown ware mark the LN II phase of the site. The decoration on the black burnished pottery was pattern burnished and incised. The other finds include large amounts of polished tools, *Spondylus* shell, clay figurines and chipped stone (Pappa 2007; Pappa *et al.* 2009).

6. Stavroupoli

Stavroupoli is, like Thermi, Vassiliki and Makriyalos, a flat extended settlement located in the vicinity of Thessaloniki and dated to the end of MN and the beginning of LN I. It had been excavated by ΙΣΤ' Ephoreia, under the supervision of D. Grammenos and S. Kotsos. The habitation includes two main phases. There were elliptical pit-dwellings in phase Ia, followed by mud-brick structures in phase Ib.In phase II, houses were rectangular and built of mud-brick on stone foundations. This settlement also included paved open spaces between numbers of pits (Grammenos & Kotsos 2002).

7. Mandalo

Mandalo is a small mound situated 20 km north-west of the Hellenistic town of Pella in western Macedonia. It was excavated in the period between 1981 and 1986 by A Pilali-Pasteriou, A Papanthimou-Papaefthimiou and K Kotsakis of the Aristotle University of Thessaloniki. The site stratigraphy can be divided into two main occupational phases, Late Neolithic (Mandalo Ia-Ib, II) and Early Bronze Age (Mandalo III). The radiocarbon dates of the Neolithic phases range between 4600 and 4000 BC which should be assigned to the Final Neolithic period (Andreou *et al.* 1996, 571; Kotsakis *et al*. 1989).

Two stone walls (perivoloi) enclosed the settlements, one belongs to the end of Neolithic occupation, and the other is dated to EBA phase. According to the wall surrounded area, the settlement was densely organised with timber-built houses and mud-brick walls. The pottery of phase I is characterised mainly by black burnished ware and some grey and brown wares. Incised pottery is also present. A small number of sherds are pattern burnished and painted (white-on-black). The main shapes are medium sized open bowls with S-profile. In phase II, black burnished ware is still dominant, but there is an increase in the use of painted pottery.

Various types of headless figurines appear in phase II, but of interest are a few fragments of copper artefacts. Other objects include loom-weights, spindle-whorls, stone and bone tools and clay cylinders. Clay cylinders are problematic to interpret although similar objects were found in Sitagroi and Dikili Tash and the northern Balkan region. The chronological and cultural links of Mandalo with other sites are not clear, although this might be related to the first phase of Rachmani culture, Dimini I-IV, Sitagroi III and Late Neolithic of Dikili Tash (Kotsakis *et al.* 1989; Papanthimou & Papasteriou 1993).

8. Dispilio

Dispilio is situated by the southern shore of Lake Orestias near Kastoria in western Macedonia. The excavations of the low mound at Dispilio started in 1992, directed by G. Hourmouziades (Aristotle University of Thessaloniki). The site was inhabited during the Middle Neolithic (5459-5082 BC, from Fakorellis & Maniatis 2002) and Late Neolithic I (5300-5000 BC, from Karkanas *et al.* 2011) and Late Neolithic II / Final Neolithic (5000-4300 BC, from Karkanas *et al*. 2011), while the later occupations date to Early Bronze Age and Classical period. This was a lake-side settlement that was spread on the littoral as well as dry environment. The coastal houses were built on raised wooden platforms along the edge of the lake, while those on dry land were built directly on the ground. Large vessels were used for storage in the coastal part of the settlement while storage pits were possible to construct in the dry area.

Apart from traditional ceramic and stone assemblages, Dispilio contained some interesting finds including the remains of a dugout canoe which is related to the numerous boat-shaped ceramic vessels that were also found at the settlement. Other finds include a variety of clay anthropomorphic figurines, *Spondylus gaederopus* ornaments, three bone flutes and a 'mysterious' wooden tablet dated to 5260 BC (Hourmouziadis 2002; Ifantidis 2011).

The Carpathian zone / Southern Pannonia

1. Opovo

The Neolithic settlement of Opovo-Ugar Bajbuk is located in the valley of the Tamis River, in the Vojvodina region of Serbia. It was excavated in 1983 and 1984 by R. Tringham (University of California, Berkeley), and B. Brukner (University of Novi Sad). This 5 ha Neolithic occupation lasted from 4700 until 4500 BC, including the Vinča D (Vinča Pločnik) period. The excavators suggested that the settlement was not permanently inhabited but was only used for a short period of time by the populations of larger settlements. The wattle-and-daub structures were used for certain specialised activities such as seasonal hunting of red deer and wild pig and the acquisition of raw materials, including obsidian from the Carpathian sources (Tringham *et al.* 1985).

The settlement contained characteristic late Vinča pottery and figurine types, although in much smaller numbers than at the permanent settlements such as Vinča-Belo Brdo and Gomolava. Small fragments of copper oxide were found at the site, which has links to the sites located south of the Danube and in the Morava valley (*ibid*.).

2. Potporanj-Kremenjak and Potporanjska granica

The settlements near the town of Vršac in north-eastern Serbia were discovered in the late 19th century by F. Milleker. He collected a large number of finds related to the Vinča culture, including dark-burnished ceramics, anthropomorphic and zoomorphic figurines, bone and stone tools and ornaments. Potporanj-Kremenjak was excavated in 1957, due to the construction of the Danube-Tisza-Danube canal, and dated to the early and late Vinča periods. In the early Vinča period (A-B), it was one of the largest settlements in the region, consisting of rectangular wattle-and-daub buildings.

3. Vršac At

The site near the town of Vršac in north-eastern Serbia was excavated in the 1970s. The excavations revealed occupation that includes the Upper Palaeolithic, Late Neolithic Vinča culture, and Bronze and Iron Age periods. The LN settlement has typical Vinča culture characteristics. No further details are available.

4. Gomolava

Gomolava is a tell situated at the southern edge of the Pannonian Plain on the left bank of the Sava River, near the modern village of Hrtkovci. The site was excavated in the period between 1953 and 1985 by B. Brukner, B. Jovanovic and N. Tasic (Museum of Vojvodina, Novi Sad). The stratigraphy of the mound includes the entire Vinča culture sequence, followed by Bronze Age, Iron Age, Roman and Medieval periods. The Neolithic Vinča period at Gomolava is divided into three phases Ia (Vinča B2 or the beginning of C), Ia-b (Vinča C) and Ib (Vinča D1); Gomolava Ia is characterised by large pits and semi-subterranean objects (one above-ground structure was ascribed to this phase). Gomolava Ia-b contains large above-ground post-built buildings and Gomolava Ib includes above-ground buildings of smaller sizes than those in Ia-b phase. Late phase Ib (Vinča D2) also contain a cemetery which represent the only Late Vinča cemetery found to the date (Borić 2009; Brukner 1980). The houses vary is size and some of them were separated into more than one room. The households contained ovens, ceramic vessels and stone tools while one of the buildings from phase Ib was also decorated with bucrania attached to a wall. Some of the structures at Gomolava were used for keeping animals or storing foodstuffs.

Central Balkans / South of the Danube

1. Vinča-Belo Brdo

Vinča Belo-Brdo is a large tell settlement located on the south bank of the Danube, between the Pannonian plain and the hilly region of the central Balkans. The tell was discovered in

1908 by M. Vasić and excavated sporadically until 1934. After a long break, several campaigns were carried on in the 1970s and 1980s. The current ongoing excavations began in 1998, directed by N. Tasić (University of Belgrade). The site has a long history with the main Neolithic occupation spanning c. 5500-4500 BC. The stratigraphy of this tell represented the basis for defining the Balkan and south-east European Neolithic, named the Vinča culture. There are four main phases of the 10m high tell[31], Vinča A (9.3m-8m), B (sub-phases B1-2; 8m-6.5 m), C (6.5m-4.5 m) and D (sub-phases D1-2; 4.5m to the top). These phases are used as comparable chronological markers for the wider region. In relative terms, the phases correspond to Middle Neolithic (phase A), Late Neolithic (phases B and C) and Early Eneolithic (phase D). The more recent phases of the tell include late Eneolithic and Bronze Age periods and a medieval cemetery (Srejović & Tasić 1990).

The absolute dates (Borić 2009) of the main Neolithic Vinča settlements are:

- Vinča A 5400/5300-5200 BC;
- Vinča B 5200-5000 BC;
- Vinča C 5000/4950-4850 BC;
- Vinča D 4850-4650/4600 BC

The first settlement of the mound belongs to Starčevo culture, including typical sub-circular or oval huts. From the later Neolithic phase the structures are ground-level rectilinear buildings constructed using wattle-and-daub. In the subsequent phases, the houses become larger in size with several rooms that contained hearths and ovens. Vinča settlements are regularly destroyed by intentional burning (Stevanović 1997).

Vinča-Belo Brdo was rich in material culture with typical dark-burnished fine pottery, anthropomorphic and zoomorphic figurines, but also a number of more unusual finds such as obsidian, *Spondylus* shell, alabaster and copper.

2. Banjica

The site is located within the urban area of Belgrade and was discovered in 1921, although the first excavations began in 1955 by J. Todorović and A. Cermanović (City Museum of

[31] The chronology used is based on Holste (1939) and Milojčić (1949), later adapted by many authors (e.g. Schier 1996). The alternative chronology by Garašanin (1979) includes phases Vinča-Turdaş I-II, Gradac phase, Vinča-Pločnik I-II.

Belgrade). The excavations revealed five horizons of habitation dated to the Vinča culture (A-D). The houses were rectangular and made of wattle-and-daub. In phase III (late Vinča period), larger ‘megaron’ type structures were found alongside more simple houses with one or two rooms (Tripković 2013).

3. Masinske njive

Rescue excavation was conducted during 2006 and 2007, directed by M. Blagojević. Horizontal stratigraphy of the site contains Starčevo, Vinča, Eneolithic and Bronze Age occupations. This large flat settlement is situated in the region of the Kolubara river, one of the Sava River tributaries.

4. Supska

The settlement was situated near the Morava River, excavated in the 1965 and 1980. This site contains occupational phases that belong to Starčevo and Vinča cultures, including early and late Vinča period. The architecture and finds are typical for the Vinča settlements - wattle-and-daub houses and black-burnished pottery (Srejović 1988).

5. Drenovac

This tell site is situated on the terrace near the Morava River in central Serbia. It was excavated during rescue excavations in the period between 1968 and 1972. Since 2004, the excavations have been directed by S. Perić. The 5.5.m high tell contains occupation levels dated to Starčevo, Vinča and Bronze Age periods, with the Vinča settlement covering c. 30 ha. The finds are typical for the Vinča period with dark-burnished pottery, anthropomorphic and zoomorphic figurines (Perić 2008).

6. Slatina

Located in the Morava Valley, this settlement is similar to the other Vinča culture sites with reference to the material culture, architecture and development of a tell. Rescue excavations were carried out in the period between 1962 and 1964 by S. Vetnić. The tell contains Starčevo and Vinča phases (Srejović 1988).

7. Selevac

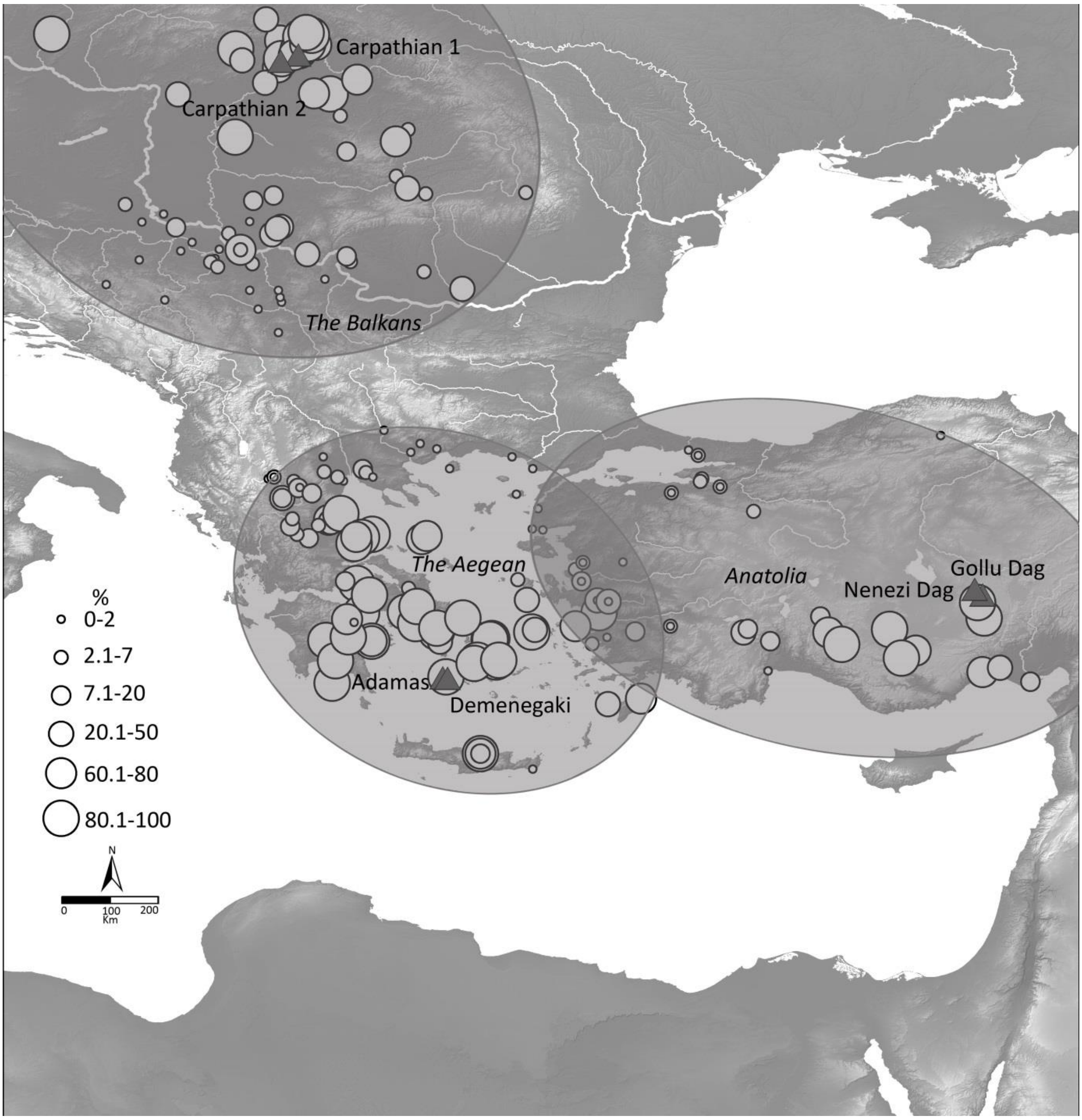
This is a large flat type settlement, covering 30 ha, which is situated in the Morava River valley in central Serbia. It was excavated between 1968 and 1978, by R. Tringham and D. Krstic. The horizontal stratigraphy of the site included settlements that belong to Vinča B, C and D phases. Rectangular houses, built of wattle-and-daub contained silo and numerous Vinča culture finds. From phase D, furnaces for copper smelting were found (Tringham & Krstić 1990). The site is dated to the period between 5500 and 4500 BC.

8. Belovode

The site of Belovode is located near the Mlava River, a tributary of the Danube in central Serbia. The site has, with interruptions been excavated since 1994 to the present and it is estimated to cover c. 100 ha (Borić 2009). The occupation of the settlement is dated to early and late Vinča periods (c. 5400-4600 BC). The settlement is significant due to its closeness to the Rudna Glava copper mines and for the recently discovered early metallurgical activities at this site. Finds are of a typical Vinča culture assemblage (Radivojević et al. 2010).

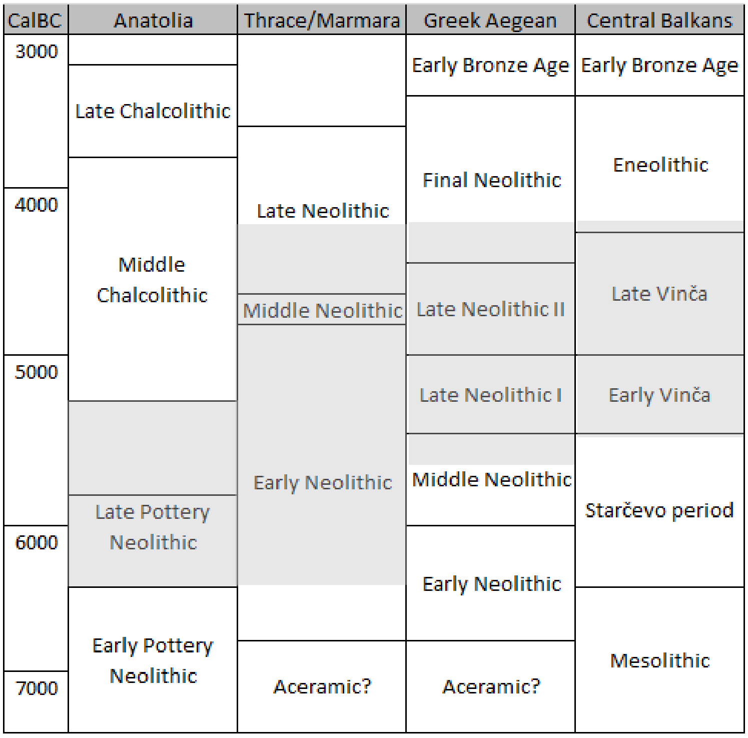
Figures

Chapter 1 Figures:[32]



1.1. Neolithic sites within known distribution zones of obsidian from central Anatolian, Melian and Carpathian sources. The size of the circles indicates the percentage of obsidian to other lithics

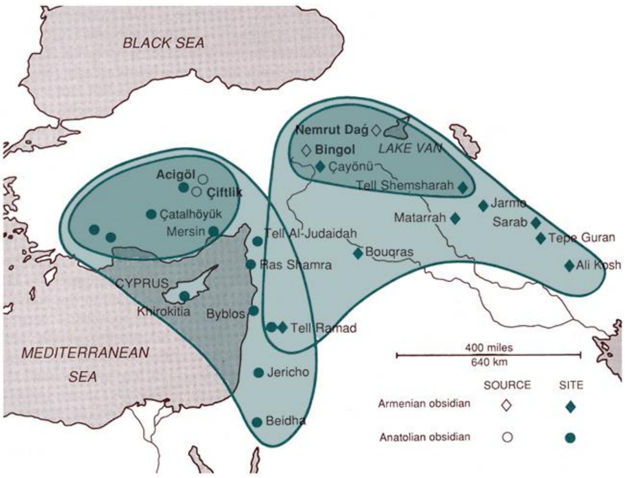
[32] All graphs, tables, illustrations and photographs are by author unless otherwise stated.



1.2. Relative chronology of the study regions (areas shaded in grey are periods included in the study)

Chapter 2 Figures:

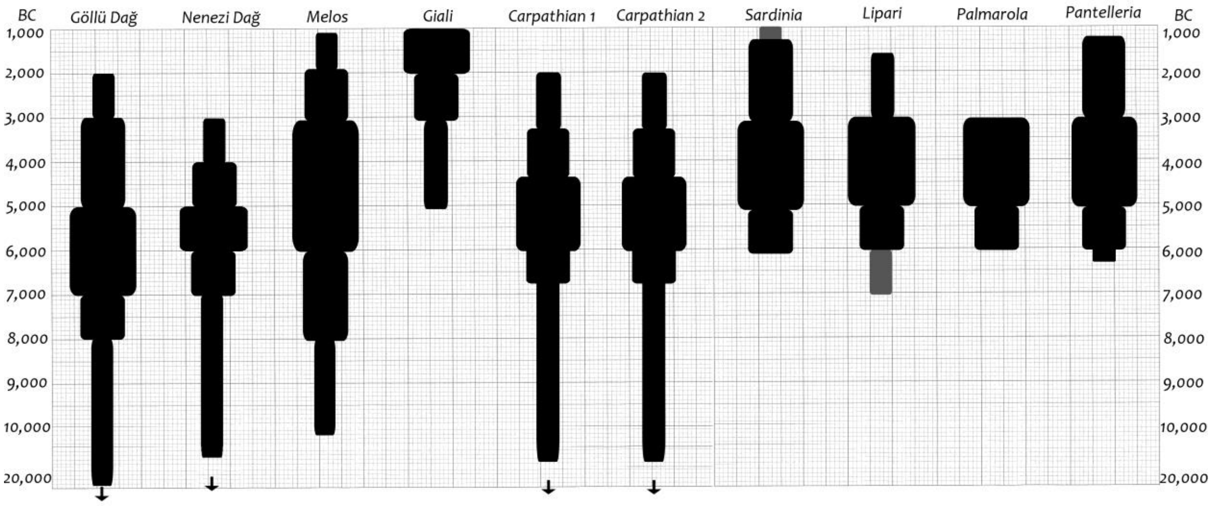
2.1. Obsidian flakes used as eyes on an anthropomorphic vase from Hacılar, left (after Mellaart 1970, Fig. CLXXVI) and on a life-sized statue from Urfa, right



2.2. Supply and contact zones for the distribution of obsidian from central and eastern Anatolian sources (after Renfrew & Bahn 2008, 372). The data from central Anatolian sources includes only the distribution of obsidian to the east and south

Chapter 3 Figures:

3.1. Map with obsidian sources and distribution circles from the three source region



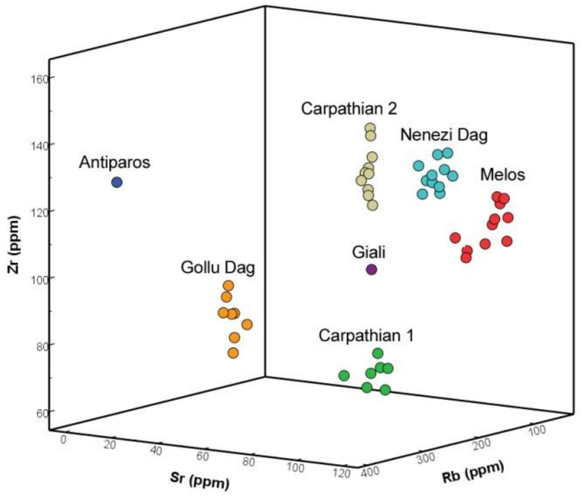
3.2. Battleship curves showing the chronological and quantitative range of European obsidian sources. The grey colour marks possible early exploitation of Liparian sources and the late use of Sardinian sources


3.3. Göllü Dağ at the Kömürçu outcrop

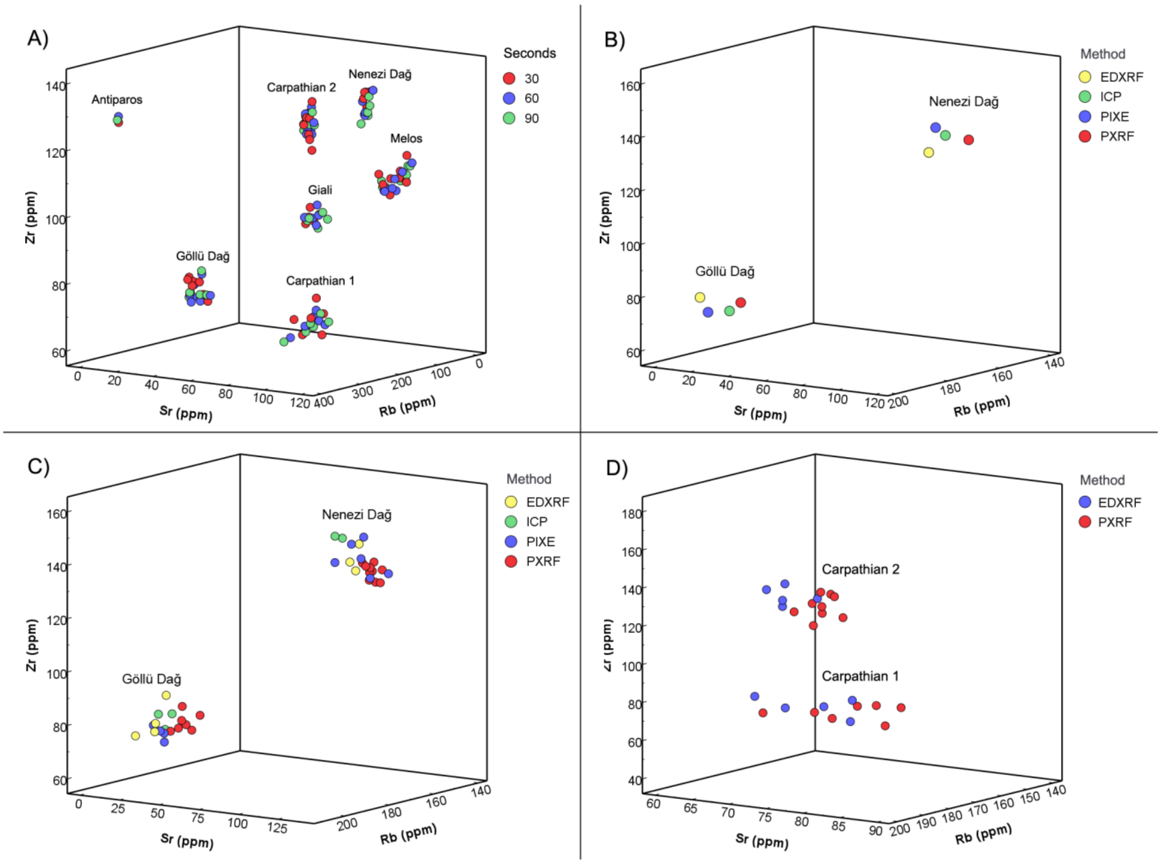

3.4. The Demenegaki source on Melos


3.5. Scatters of obsidian at the Carpathian 1 source

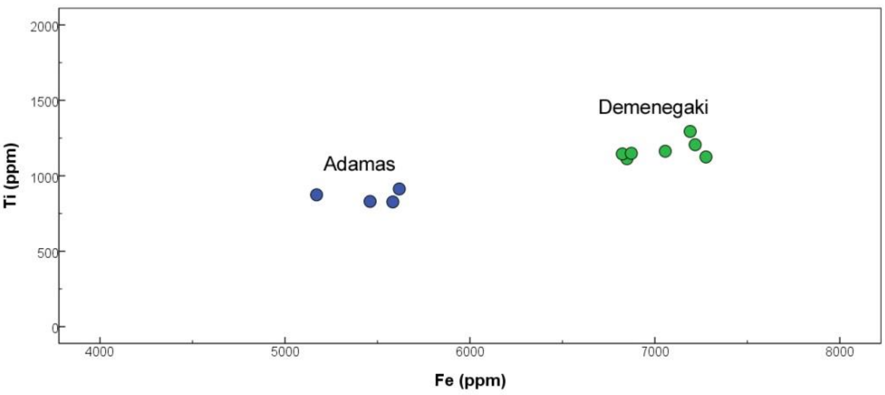
Chapter 4 Figures:



4.1. 3D scatter plot of Zr, Sr and Rb discriminating different obsidian source groups

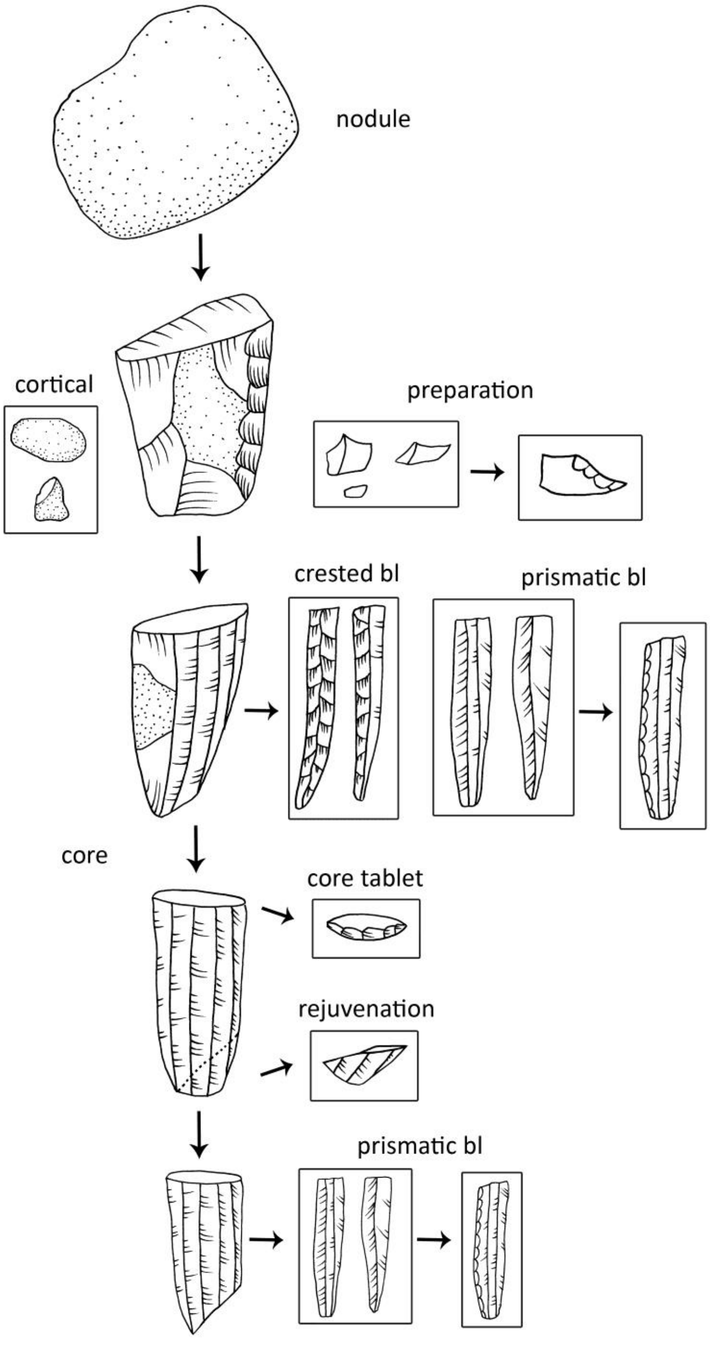


4.2 A) 2D scatter plot of Rb, Sr and Zr showing the discrimination of the sources using 30, 60 and 90 second exposures; B) 3D scatter plot showing the mean values of concentrations of Rb, Sr and Zr in Göllü Dağ and Nenezi Dağ sources as recorded using EDXRF, ICP, PIXE and pXRF; C) 3D scatter plot of Rb, Sr and Zr showing the discrimination of archaeological artefacts from Çatalhöyük examined using EDXRF, ICP, PIXE and pXRF; D) 3D scatter plot of Rb, Sr and Zr showing the discrimination of Carpathian 1 and Carpathian 2, data obtained using EDXRF and pXRF



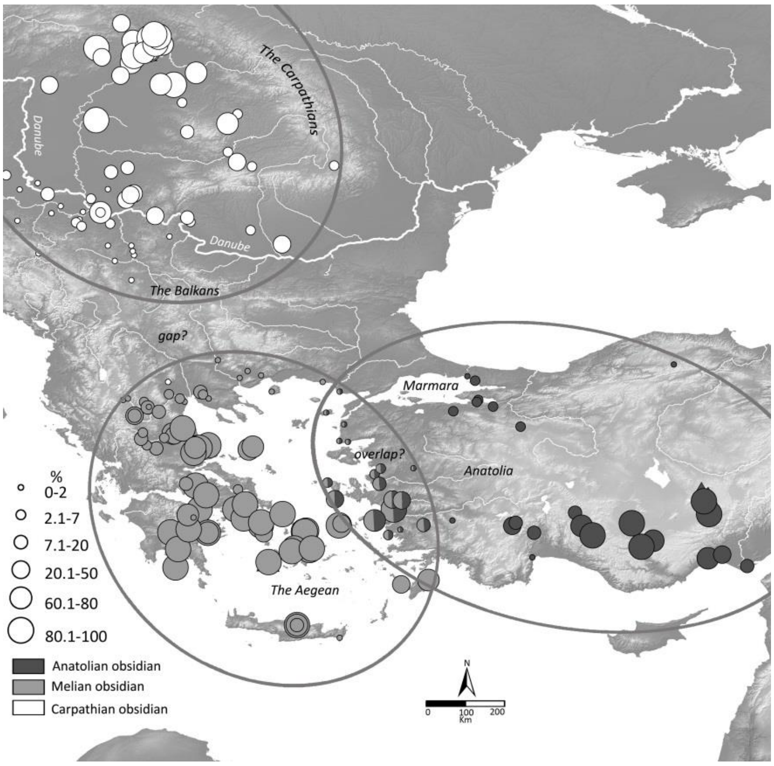
4.3. Scatter plot of Ti and Fe separating the Adamas and Demenegaki sources on Melos

4.4. Colour variation of obsidian from different sources (paralkaline is from east Anatolia, for comparative purposes only)

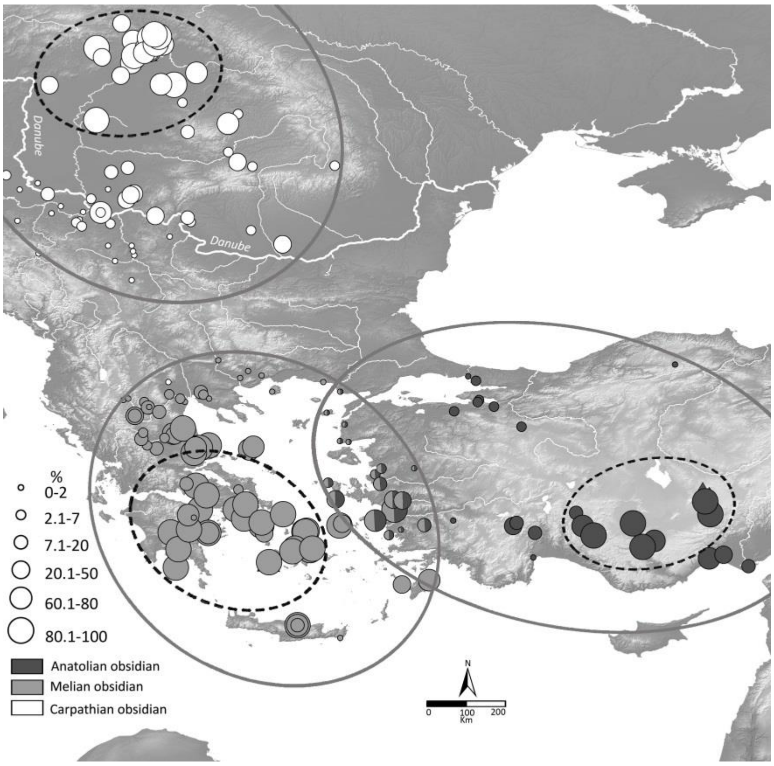


4.5. Reconstruction of the *chaîne opératoire* of blade production (re-drawn after Inizan *et al.* 1992)

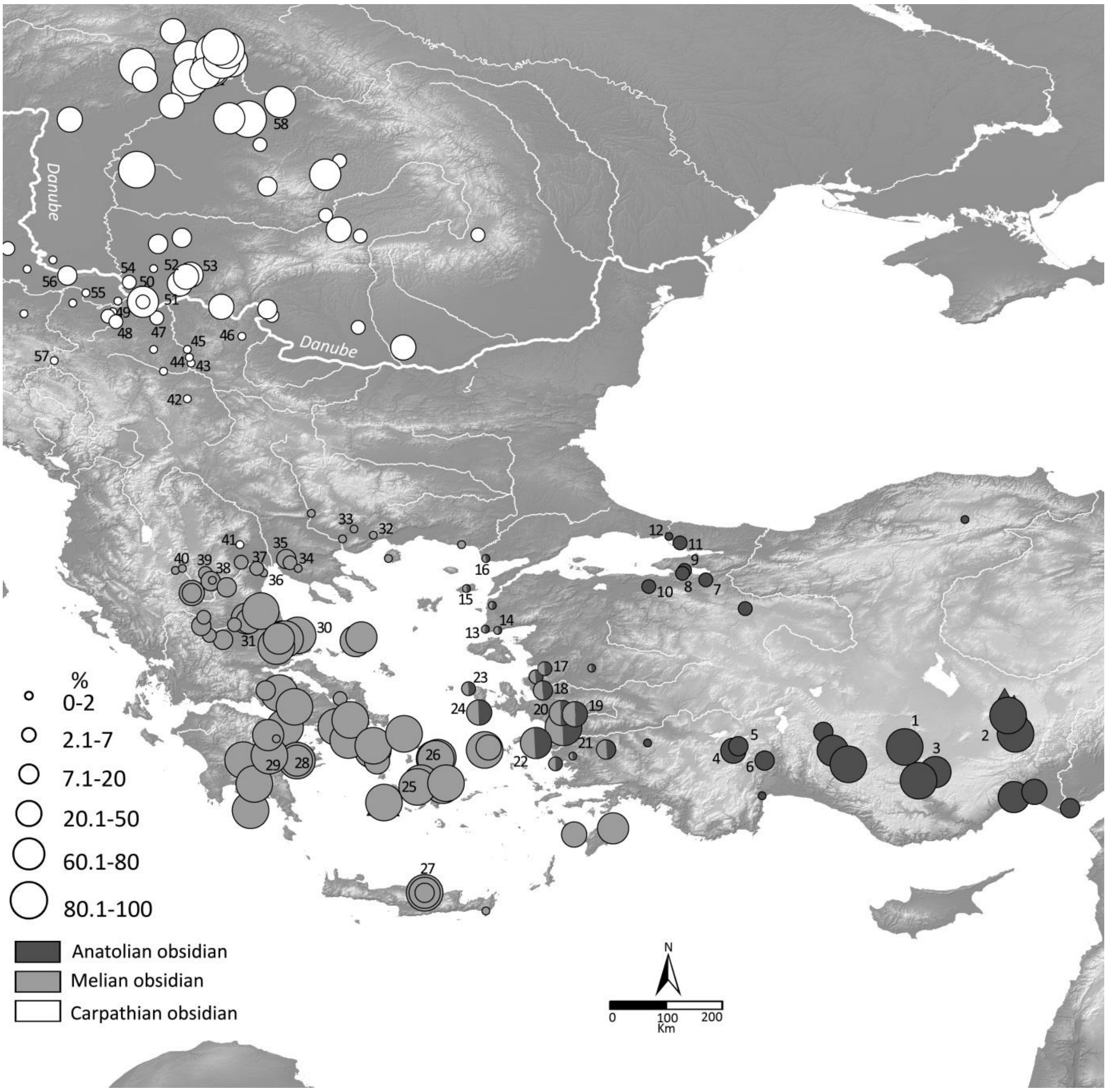
Chapter 5 Figures:



5.1. Relative proportion of obsidian at the sites dated to 7th - 5th millennia BC



5.2. The inner zone (dashed line) and the outer zone (full-line) for each source area

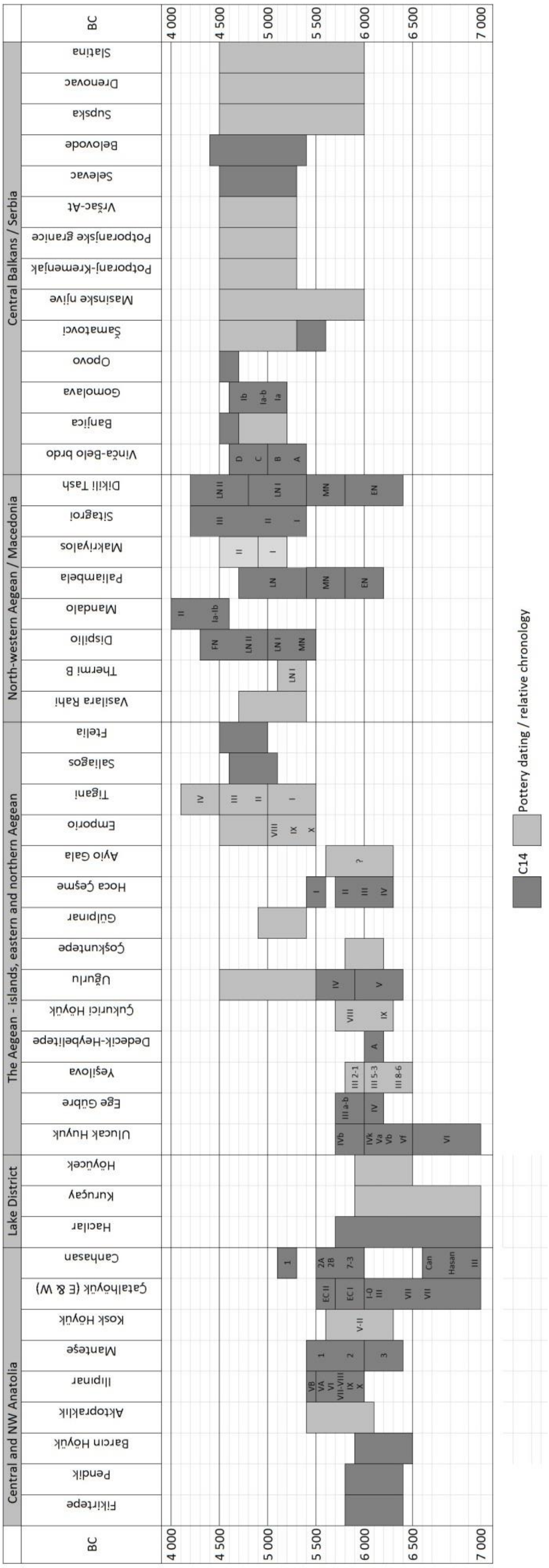


5.3. Proportion of obsidian to other lithics at sites discussed in the text:

1. Çatalhöyük; 2. Koşk Höyük; 3. Can Hasan; 4. Hacılar; 5. Kuruçay; 6. Höyücek 7. Barcın Höyük; 8. Menteşe; 9. Ilıpınar; 10. Aktopraklık; 11. Pendik; 12. Fikirtepe; 13. Gülpınar; 14. Çoşkuntepe 15. Uğurlu; 16. Hoca Çeşme; 17. Ege Gübre; 18. Ulucak; 19. Yeşilova; 20. Dedecik-Heybelitepe; 21. Çukuriçi Höyük; 22. Tigani; 23. Ayio Gala; 24. Emporio; 25. Saliagos; 26. Ftelia 27. Knossos; 28. Franchthi Cave; 29. Lerna; 30. Dimini; 31. Argissa; 32. Dikili Tash; 33. Sitagroi; 34. Thermi B; 35. Stavroupoli; 36. Makriyalos; 37. Paliambela; 38. Vasilara Rahi; 39. Kleitos; 40. Dispilio; 41. Mandalo; 42. Pločnik; 43. Drenovac; 44. Slatina; 45. Supska; 46. Belovode; 47. Selevac; 48. Masinske njive; 49. Banjica; 50. Vinča-Belo Brdo; 51. Potporanj-Kremenjak; 52. Vršac-At; 53. Potporanjska granica; 54. Opovo; 55. Gomolava; 56. Šamatovci; 57. Obre; 58. Mehtelek

BC	North-western Anatolia	Eastern Aegean & Western Anatolia	Western Aegean mainland (Macedonia & Thessaly)	South-central Bulgaria	Northern Bulgaria & Southern Romania	Central Balkans (Serbia)	Eastern Hungary	Western Balkans (Croatia & Bosnia)
2000–3000	Ilipinar III		Sitagroi V	Mikhalich Karanovo VII	Cotofeni Pit Grave	Vučedol	Vučedol	
3000–4000	Ilipinar IV		Early Bronze Age Sitagroi IV / Dikili Tash IIII	Ezero A	Cernavoda III Cernavoda I Transitional Krivodol-Salkuta	Baden Bodrogkeresztur	Baden Bodrogkeresztur	
4000–5000		Tigani IV Zas Cave / Grotta Tigani III Tigani II / Saliagos	Rakhmani Classical Dimini / Otzaki Sitagroi III / Dikili Tash II Sitagroi II	Karanovo V Karanovo VI Karanovo V - Marica Karanovo IV - Kalojanovec	Gumelnita Boian Hamangia	Tiszapolgar Vinča D Vinča C	Tiszapolgar Tisza	Vučedol Kostolac Sopot III / Butmir III / Hvar II/III Butmir II / Hvar I/II Butmir I / Hvar I / Danilo IV
5000–6000	Ilipinar V Ilipinar VI-VII Ilipinar VIII-IX / Classic Fikirtepe	Emporio VIII / Ayio Gala (upper) Emporio IX Tigani I / Emporio X Ayio Gala (lower layers)	Arapi / Tsangli / Larissa Sitagroi I / Dikili Tash I Zarko / Sesklo I-III	Karanovo III - Veselinovo Karanovo II	Dudasti	Vinča B Vinča A	Szakalhat Alföld Linear	Sopot II Kakanj III/Danilo III Kakanj II / Danilo II Sopot I / Kakanj I / Danilo I
6000–7000	Ilipinar X - Fikirtepe Pendik Mantese	Ulucak IV Ulucak V	Proto-Sesklo Argissa Franchthi	Karanovo I	Criş	Starčevo Iron Gates Mesolithic	Körös	Cardium Impresso III/II Impresso I, II
7000–8000	Agacli		Epigravettian		Pabiti Kamuni	Epigravettian		
8000							Epigravettian	

5.4. The relative chronology of the study region and neighbouring regions



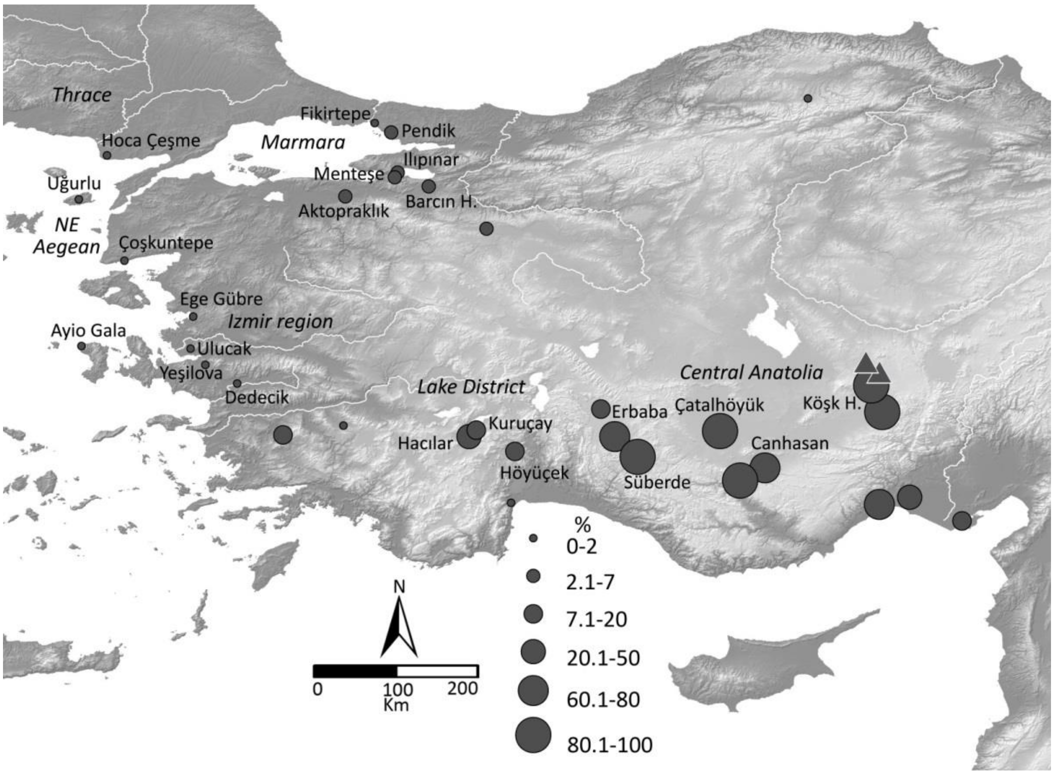
5.5. Absolute dates of major sites

5.6. Distinctive finds from the Fikirtepe culture sites (modified after Karul 2011, Figs. 4, 5, 7)

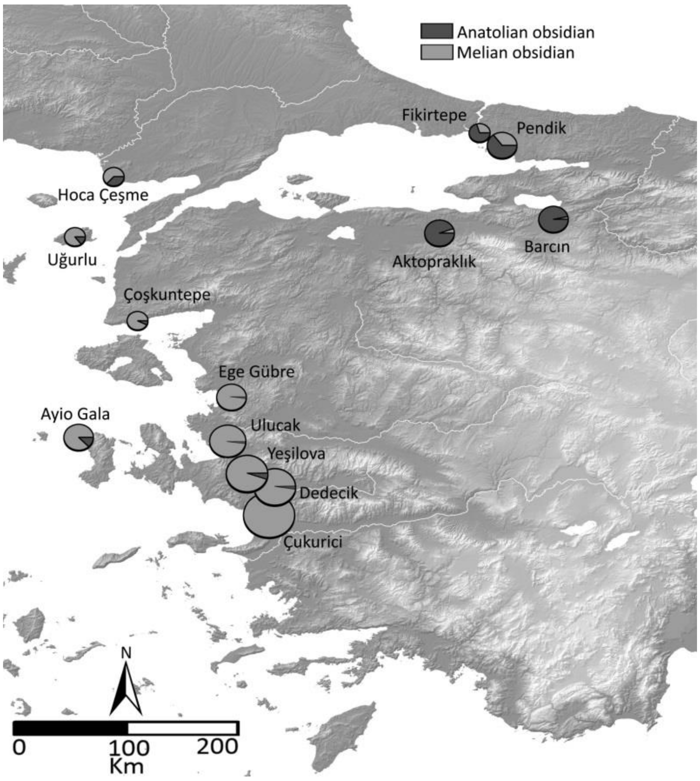
5.7. Distinctive finds from the eastern Aegean sites (modified after Çilingiroğlu *et al.* 2012, Figs. 11 and 27 (copyright of these images was not be obtained); and after Sağalamtimur 2012, Figs. 19 and 24)

5.8. Distinctive finds from the Vinča culture sites (modified after Nikolić (ed.) 2008, Figs. 34, 39, 56, 65, 166, 167, 174, 212)

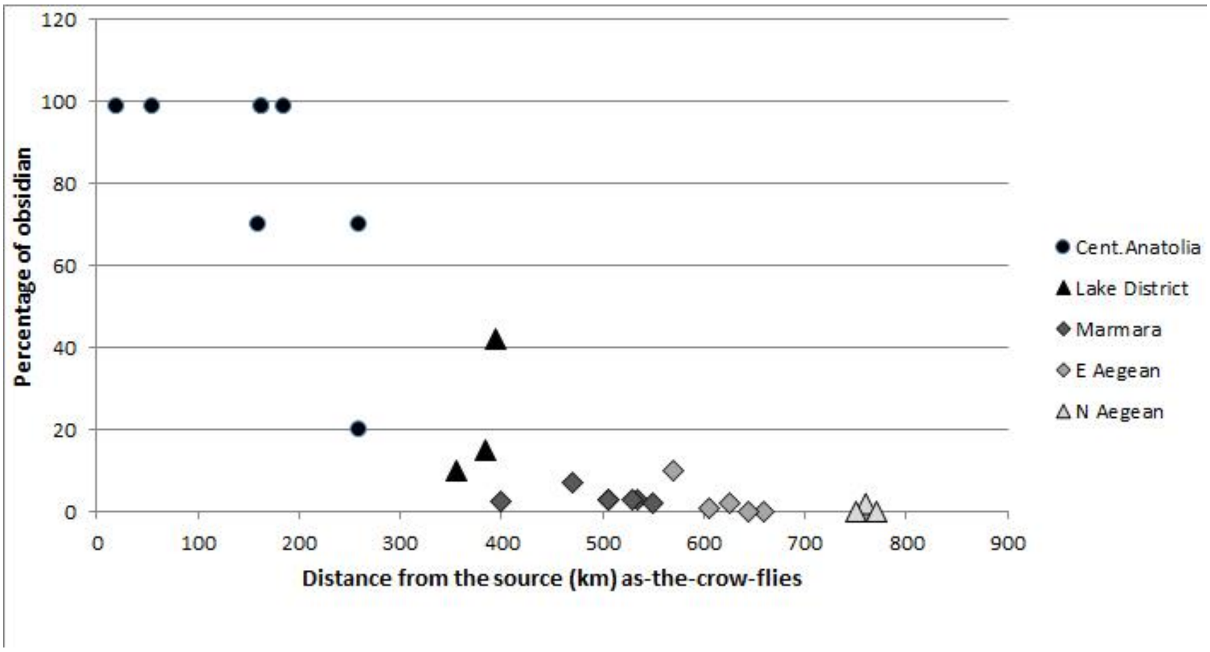
Chapter 6 Figures:



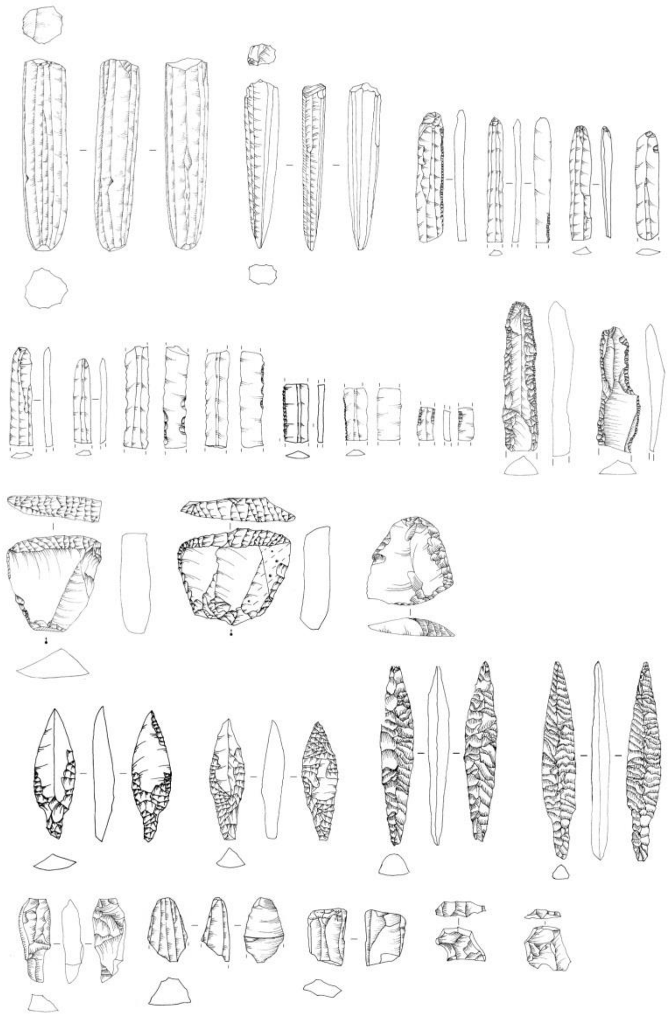
6.1. Distribution of central Anatolian obsidian with the key sites mentioned in the text. The symbol size represents the percentage of Anatolian obsidian in the overall lithics assemblage



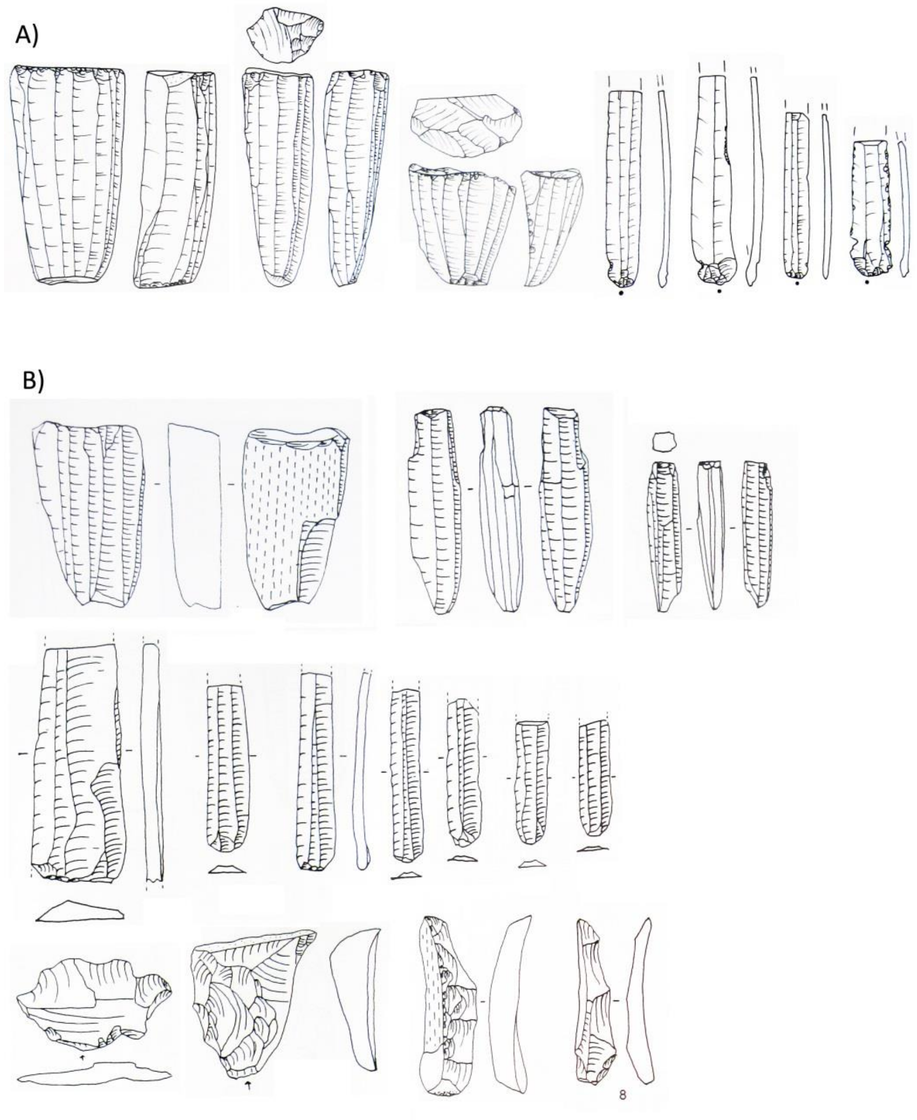
6.2. Pie charts presenting the relative proportion of central Anatolian and Melian obsidian within obsidian assemblages



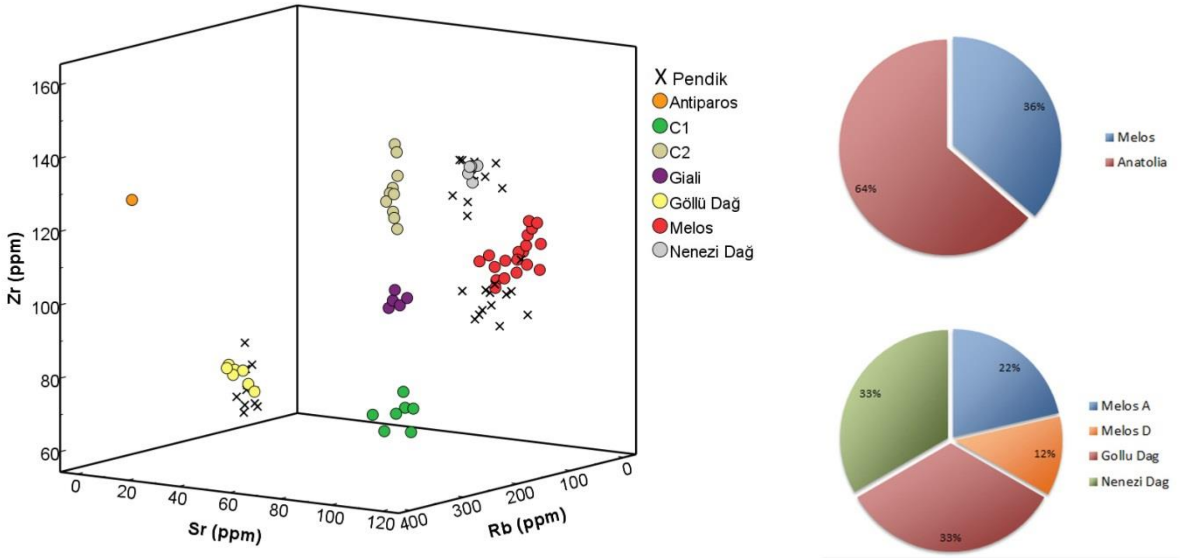
6.3. Westward distribution of central Anatolian obsidian: distance vs. obsidian frequency



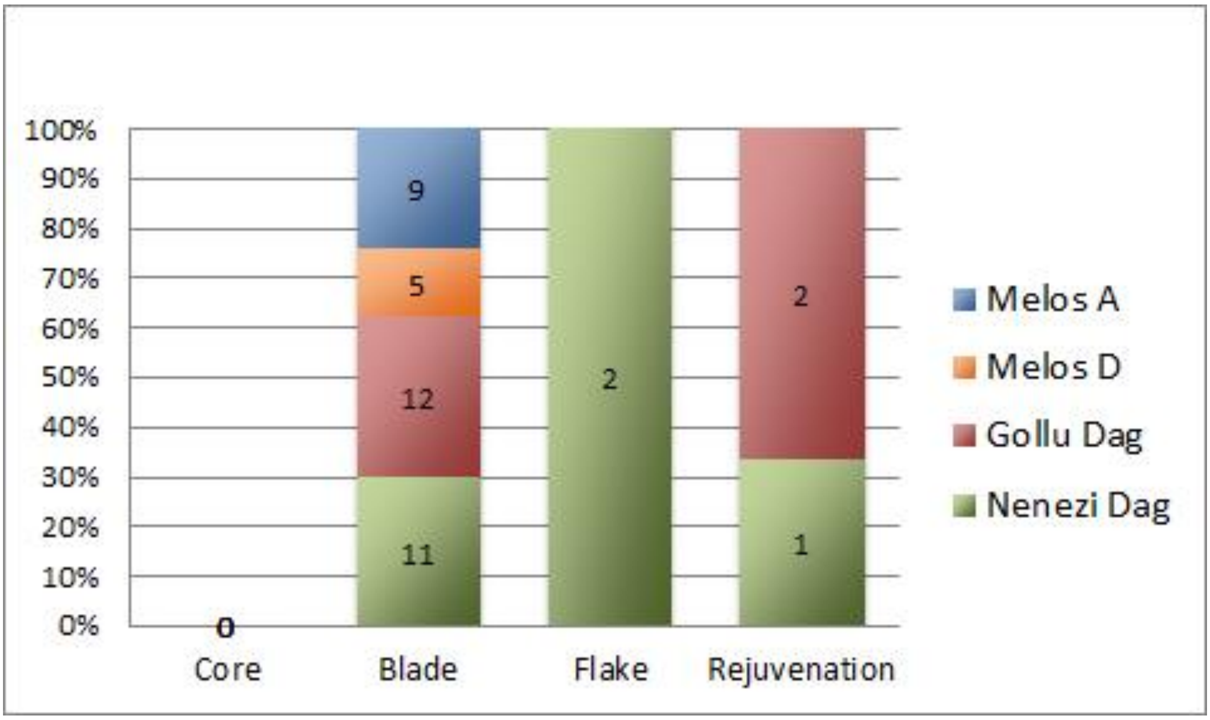
6.4. Obsidian assemblages from the inner area (Çatalhöyük, modified after Carter & Milić 2013, Figs. 21.4, 21.5, 21.6, 21.7, 21.8 and 21.10)



6.5. Obsidian assemblages from the Lake District (A: Kuruçay Höyük modified after Baykal-Seeher 1994, Figs. 242 and 243, and B: Höyücek modified after Balkan-Atli 2005, Figs. 198, 199 and 200)

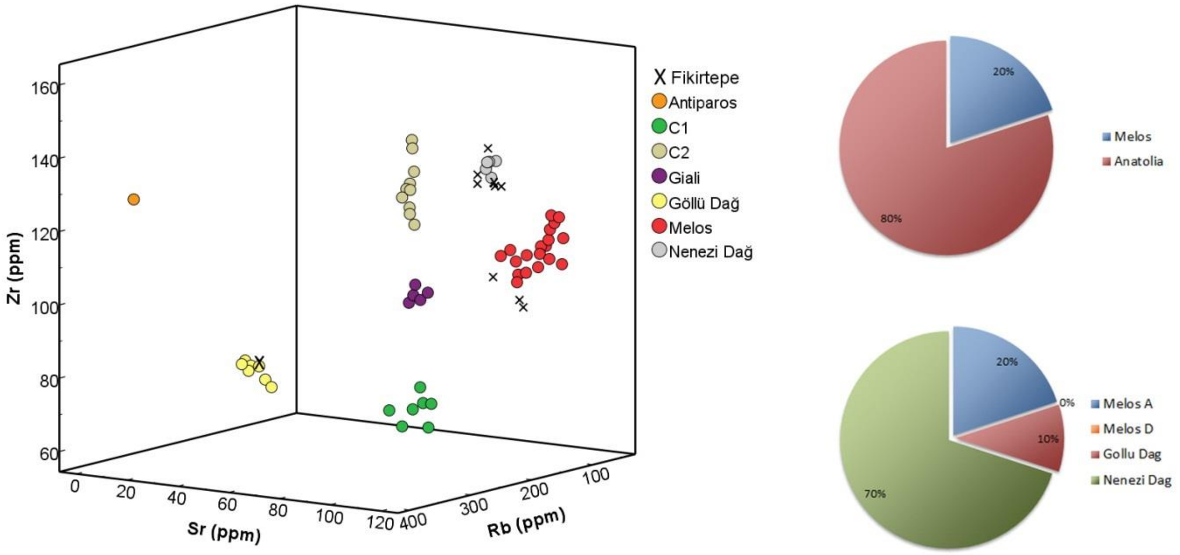


6.6. Pendik - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

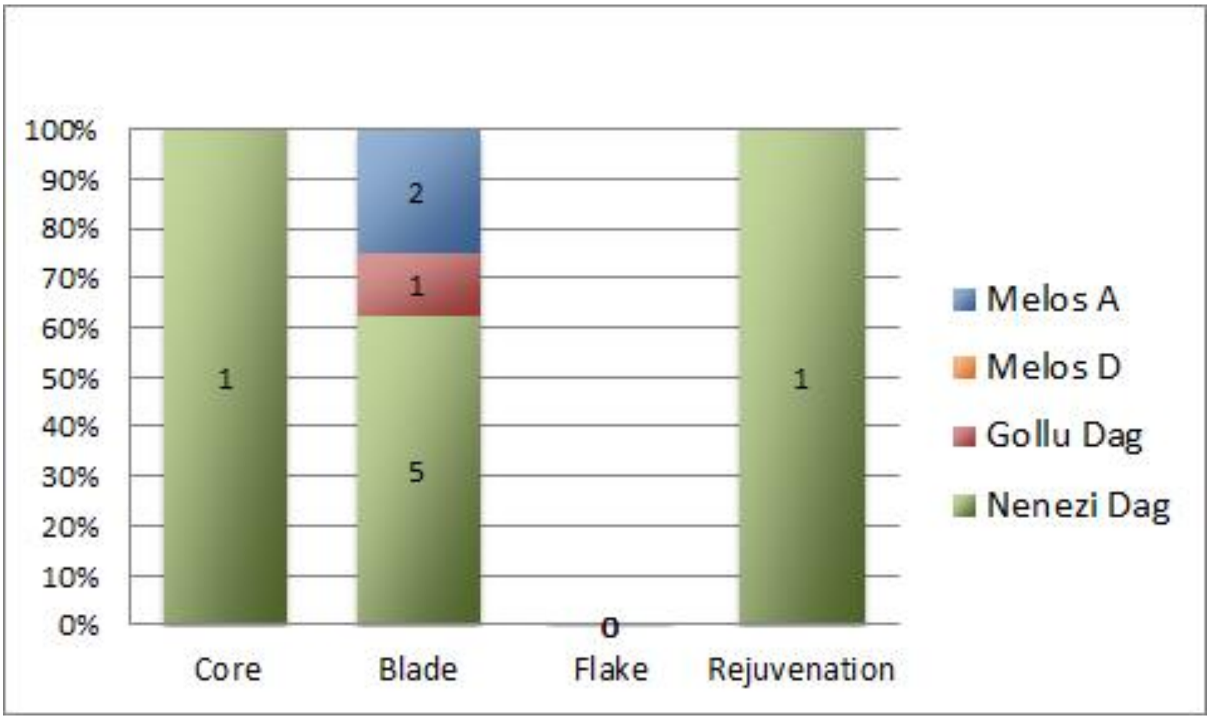


6.7. Pendik - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD

6.8. Pendik - obsidian artefacts by source

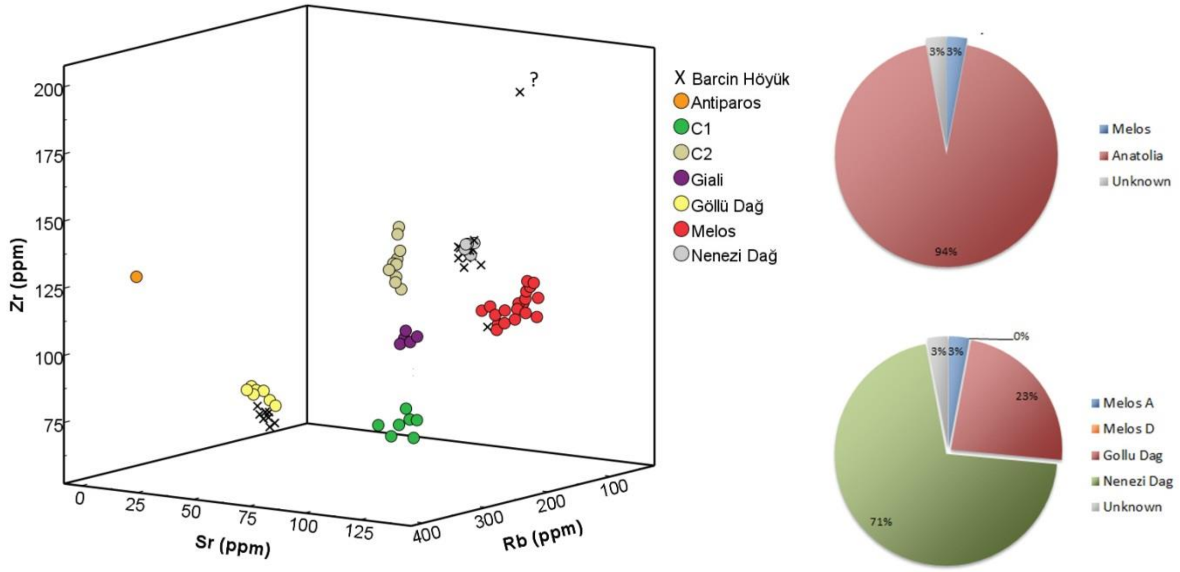


6.9. Fikirtepe - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

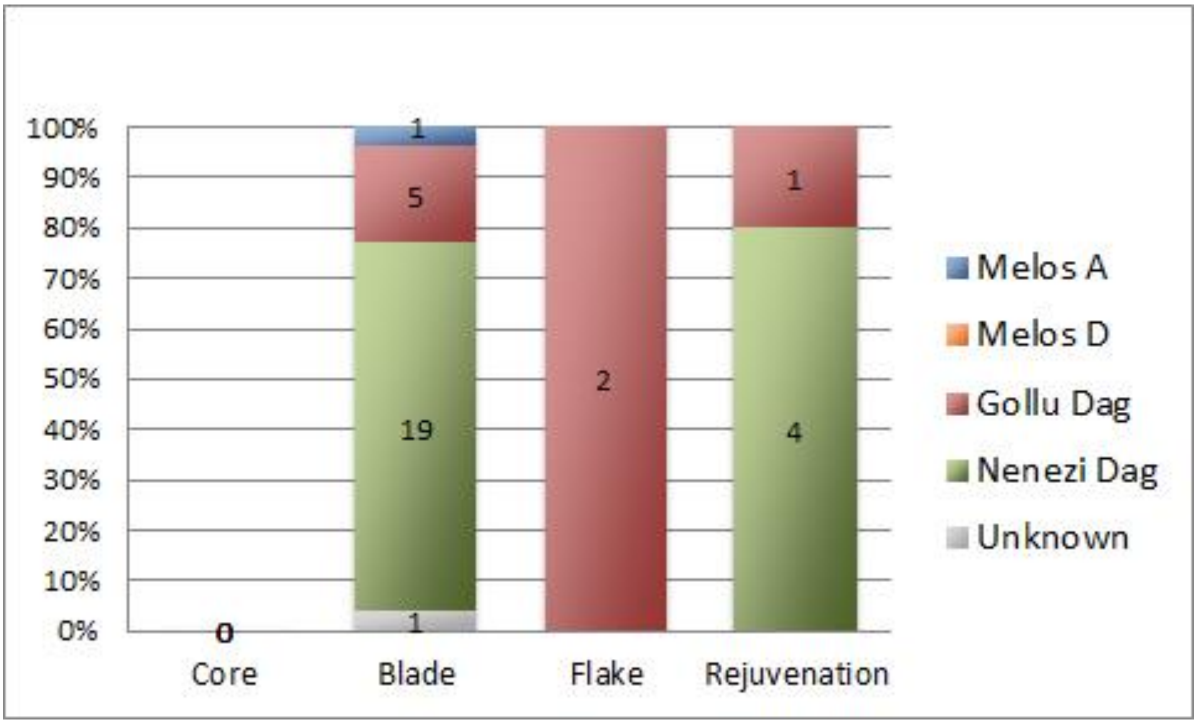


6.10. Fikirtepe - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD

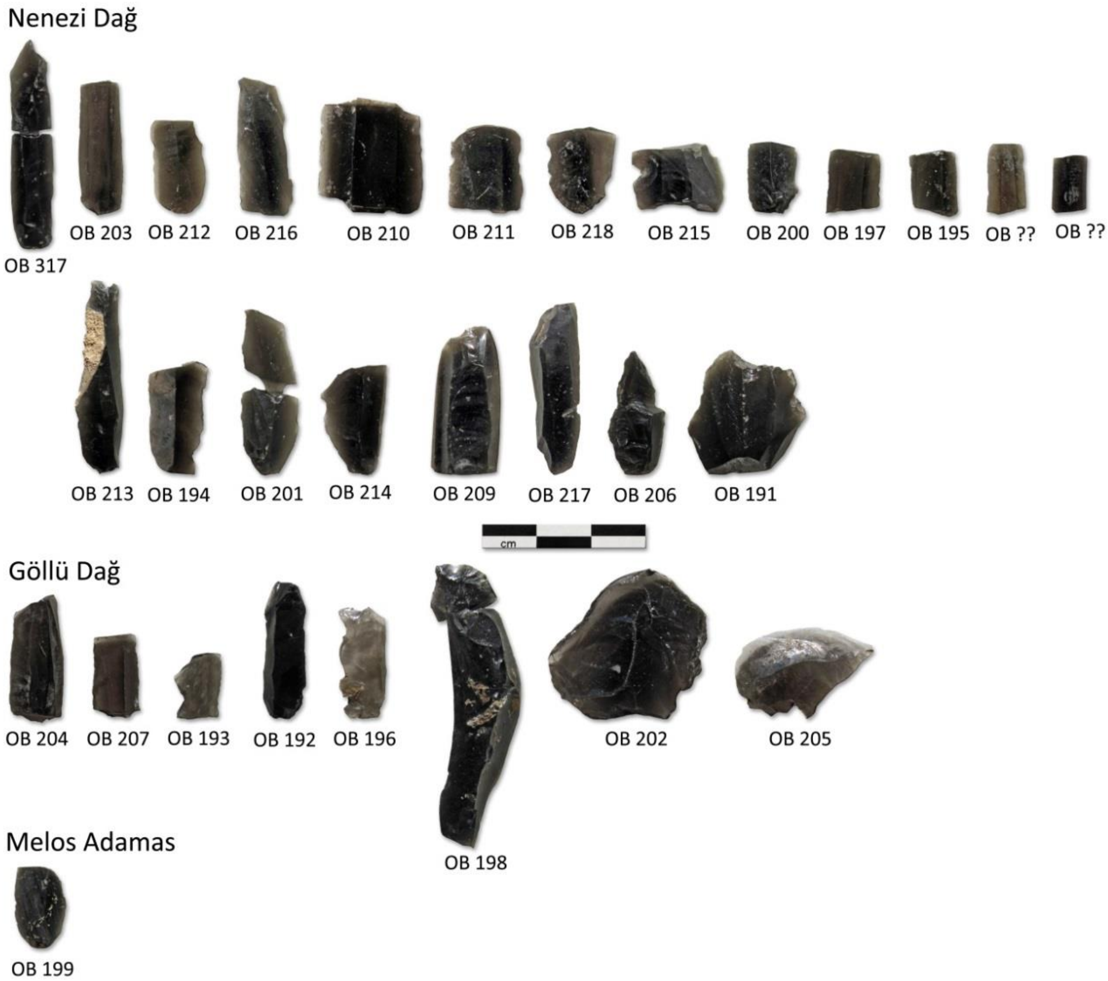
6.11. Fikirtepe - obsidian artefacts by source



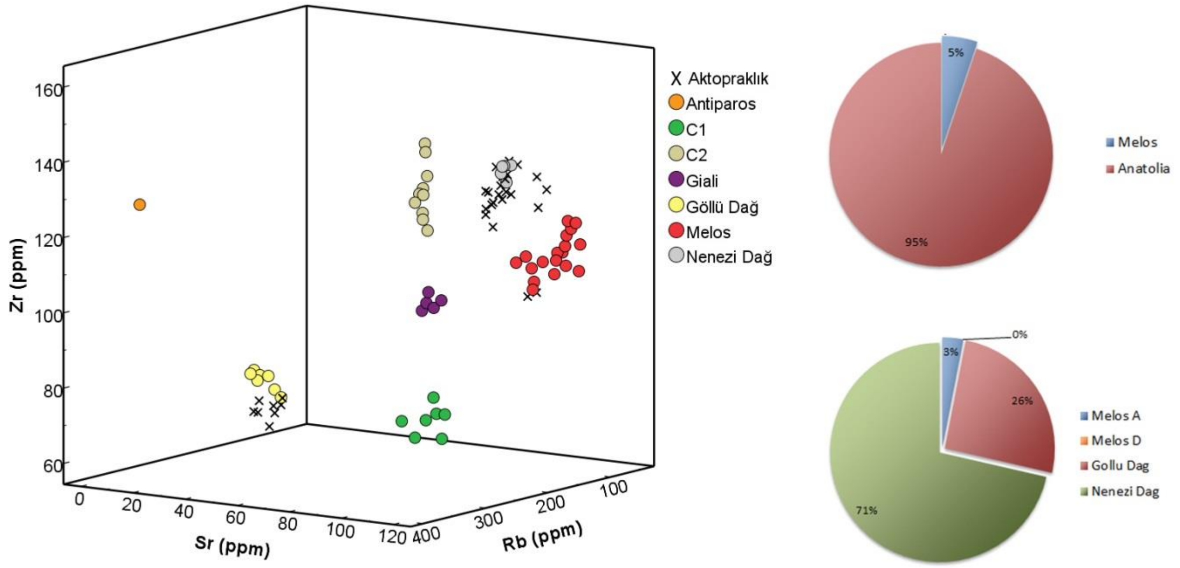
6.12. Barcın Höyük - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD



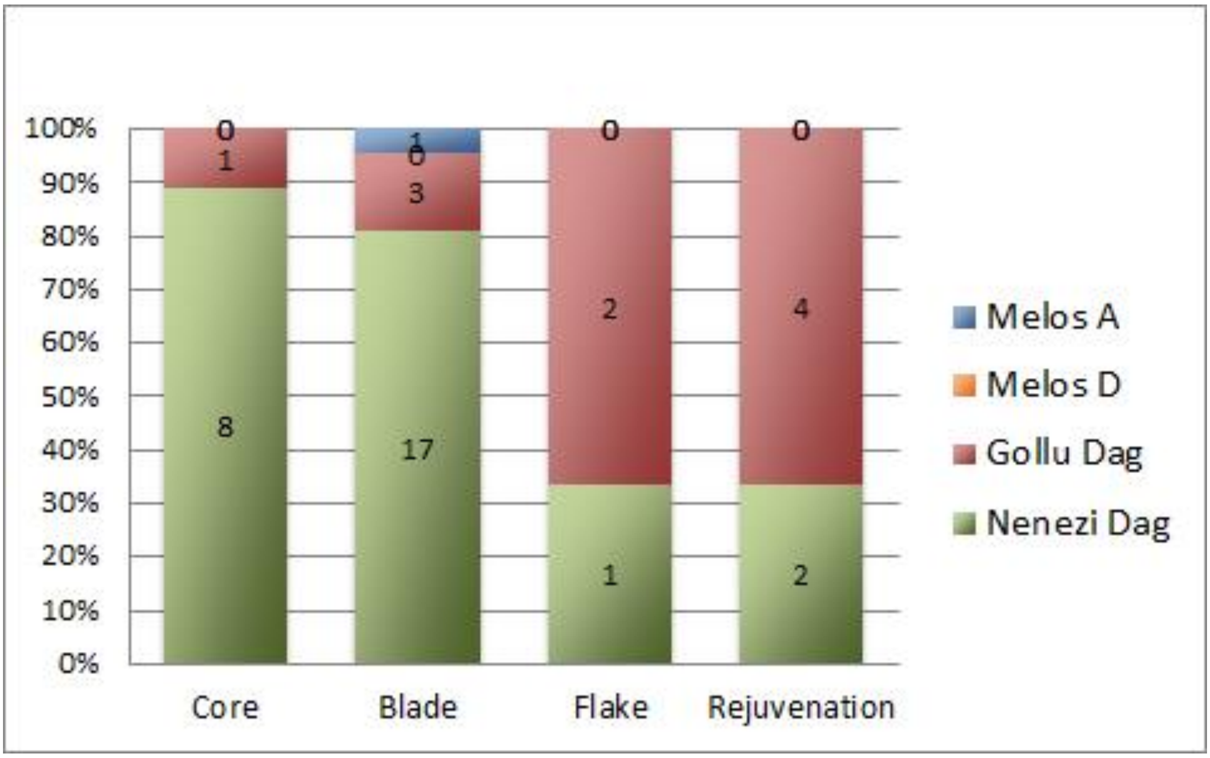
6.13. Barcın Höyük - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD



6.14. Barcın Höyük - obsidian artefacts by source



6.15. Aktopraklık - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

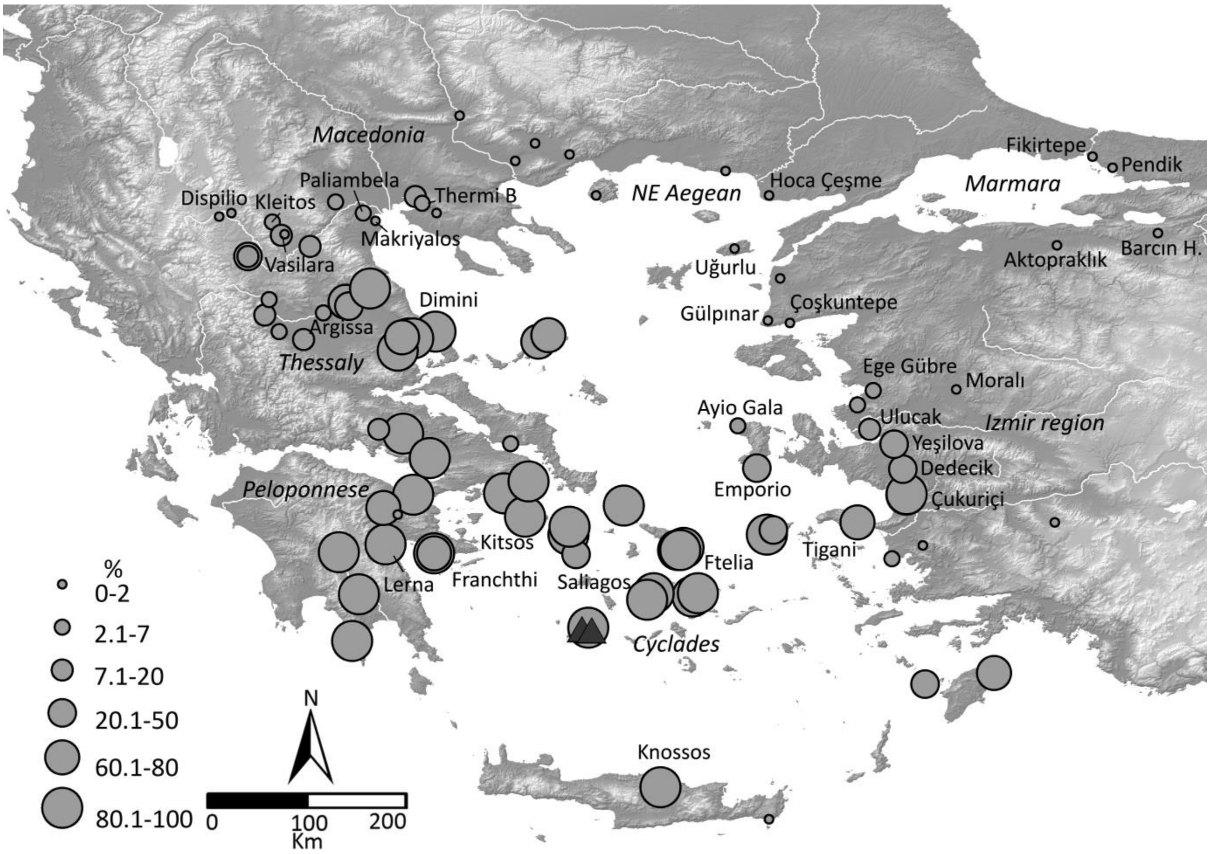


6.16. Aktopraklık - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD

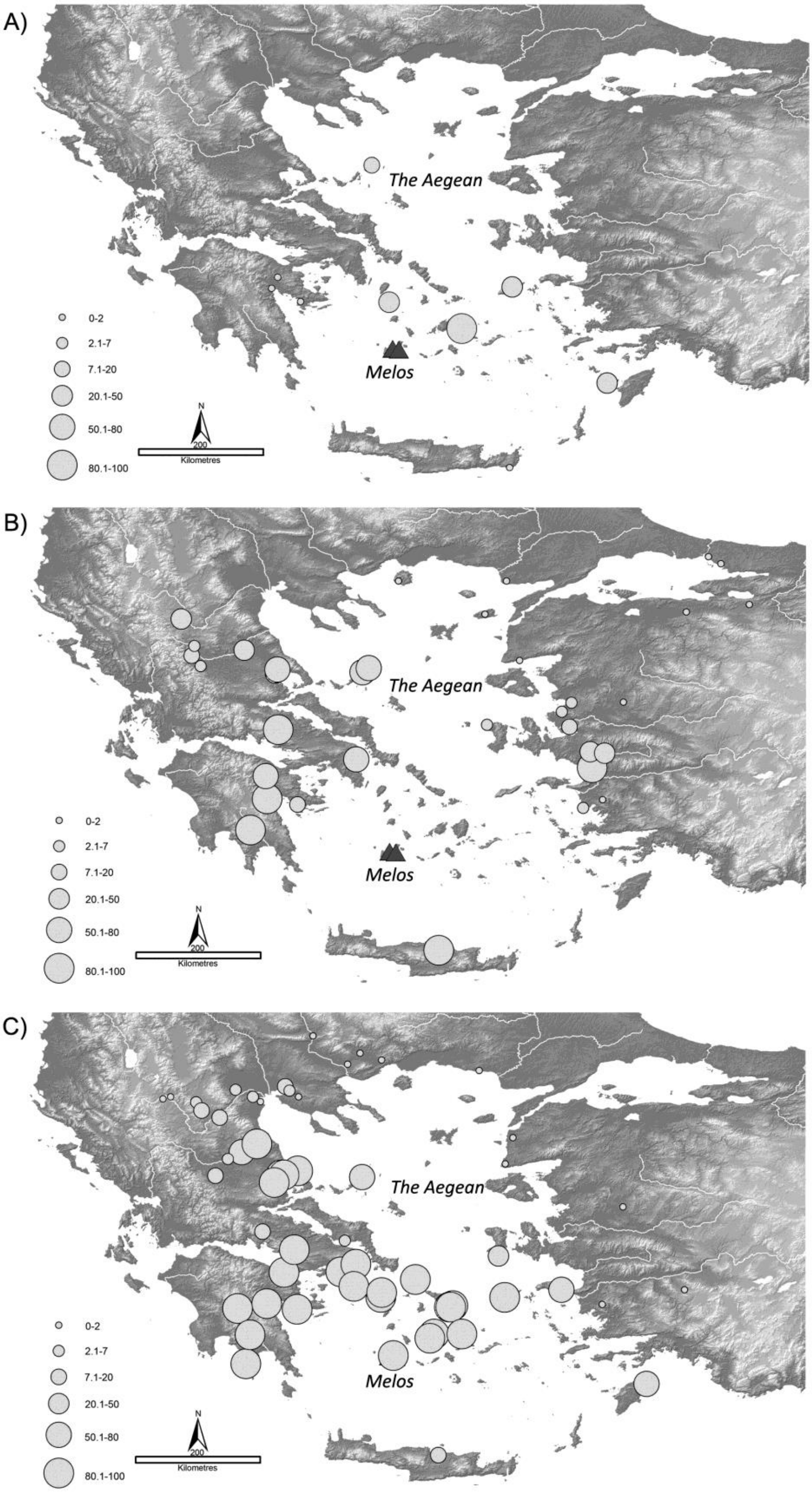
6.17. Aktopraklık - obsidian artefacts by source

6.18. Aktopraklık - flint bullet cores

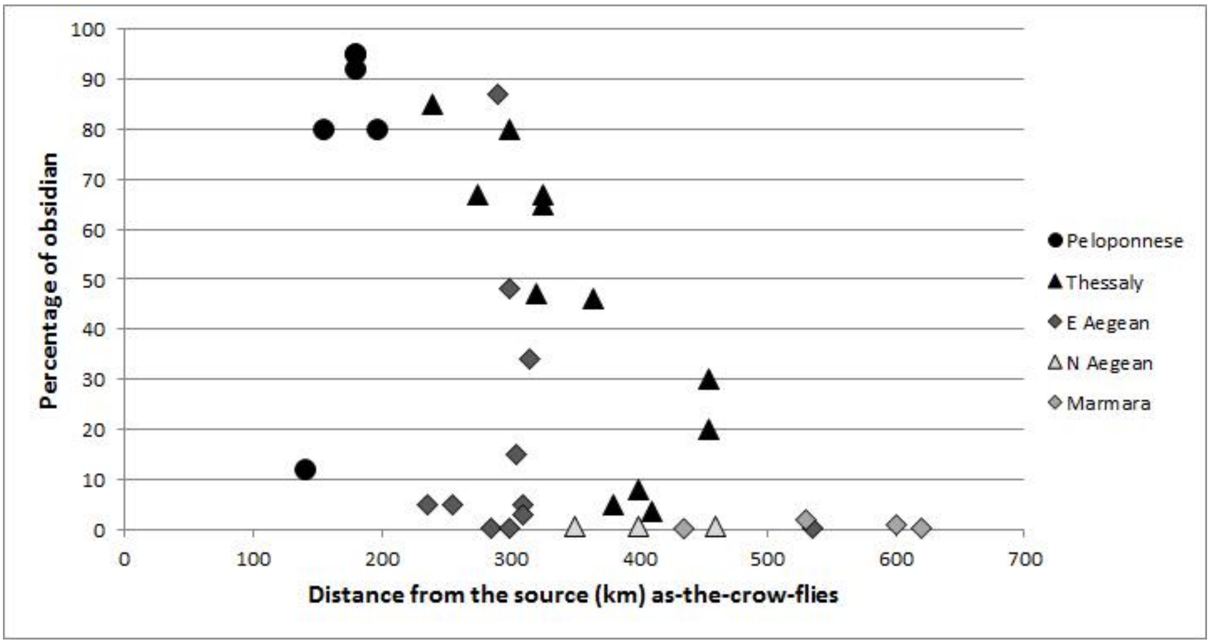
Chapter 7 Figures:



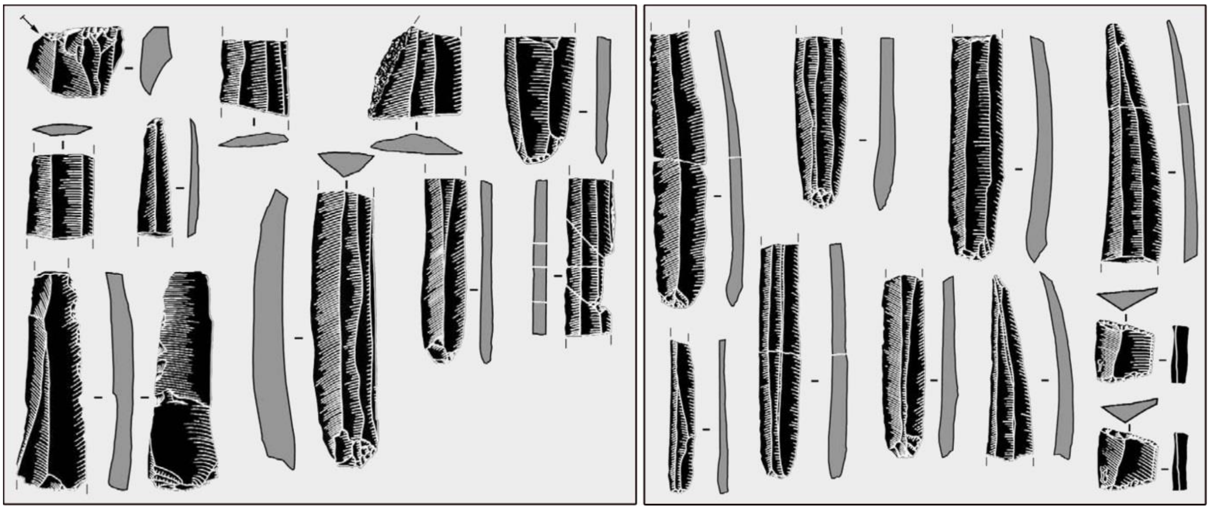
7.1. Distribution of Aegean obsidian with the key sites



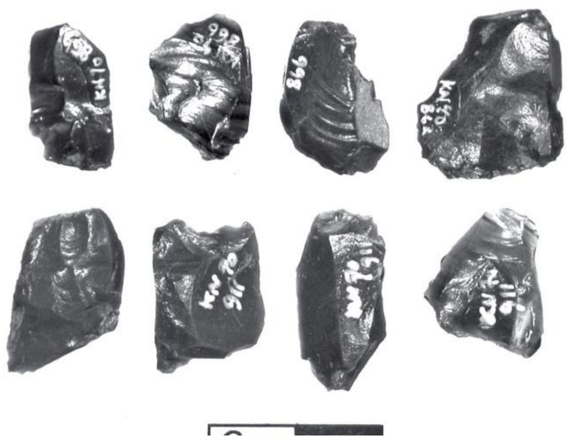
7.2. Diachronic distribution of Aegean obsidian in the A) Mesolithic, B) EN and MN, C) LN and FN periods (percentages of obsidian are plotted at all the sites where data is available)



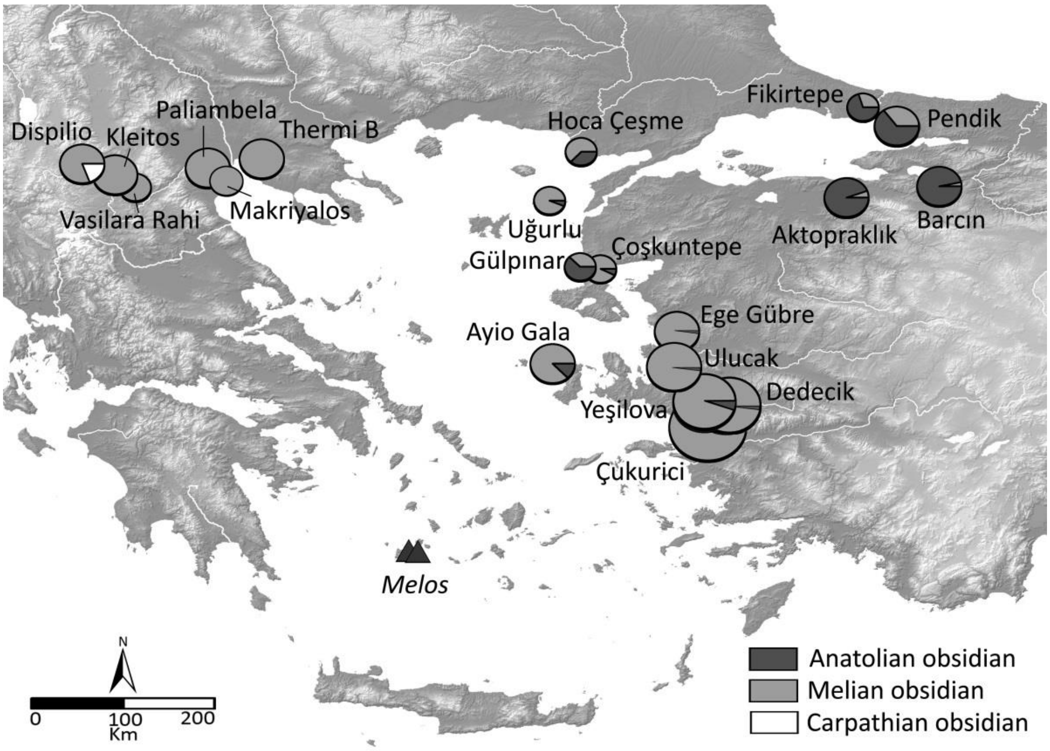
7.3. Distribution of Aegean obsidian during EN: distance vs. obsidian frequency



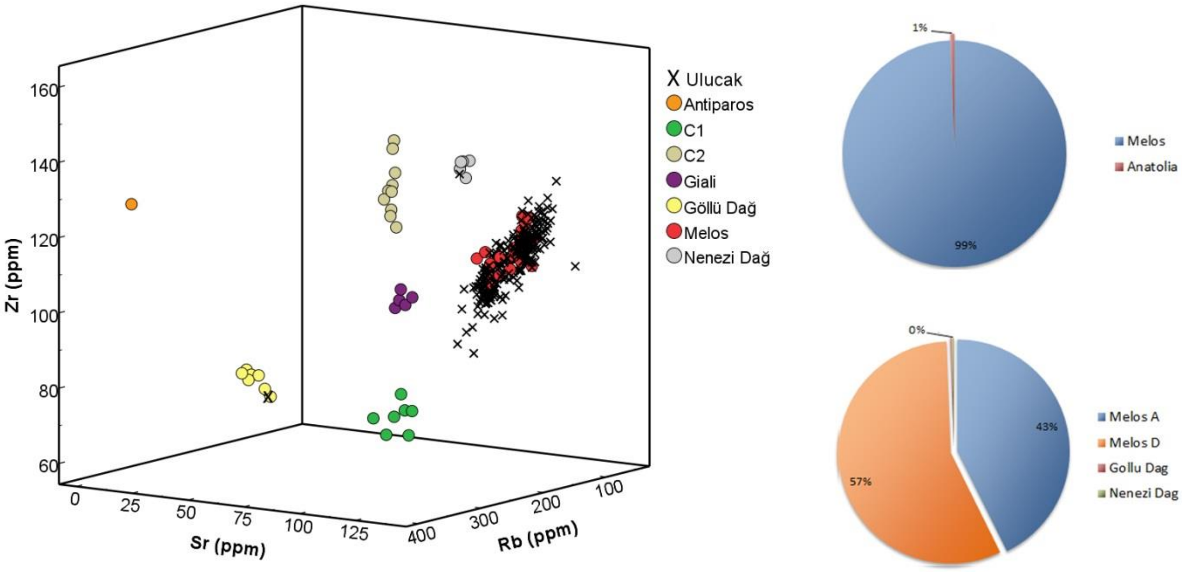
7.4. Pressure-flaked blades from EN Argissa and Franchthi Cave (modified after Perlès 2001, Figs. 5.3 and 10.1)



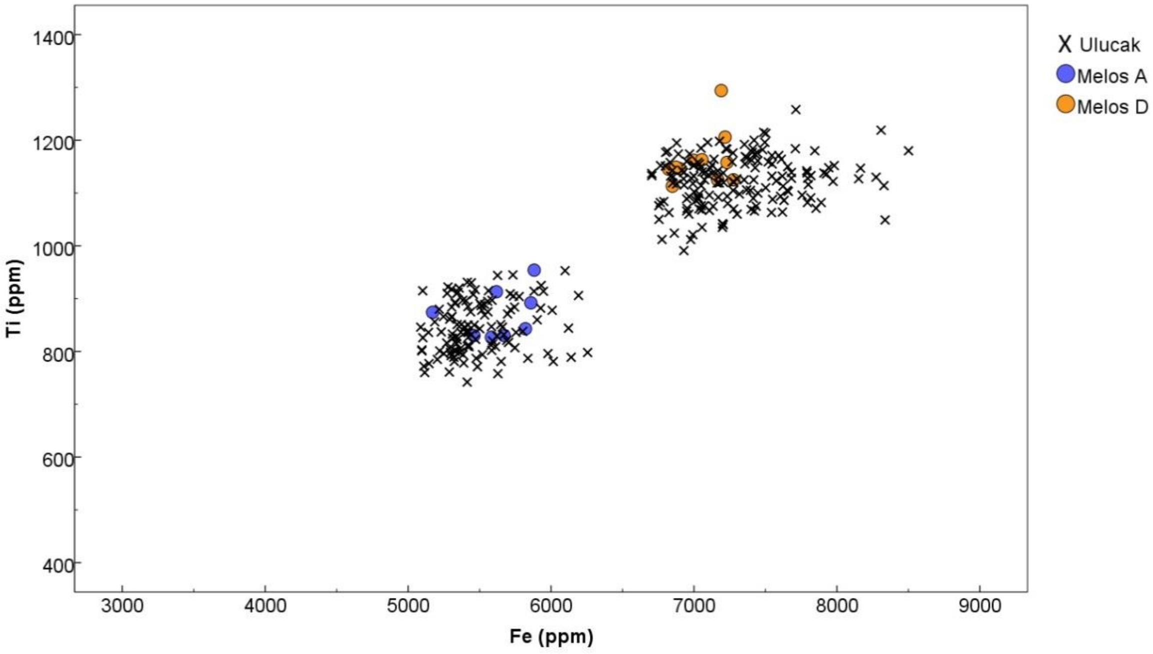
7.5. *Piece esquillee* tools from Knossos X (after Conolly 2008, Fig. 5.2)



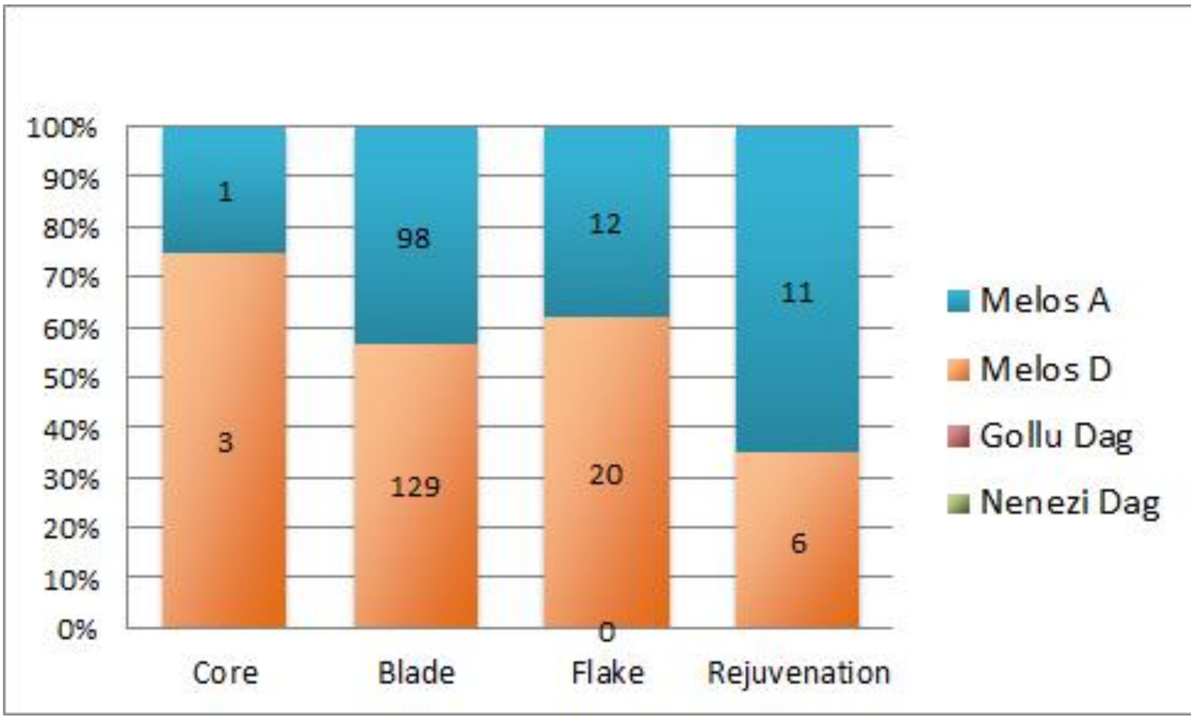
7.6. Pie charts presenting the relative proportion of each obsidian type within assemblages relevant to the study



7.7. Ulucak - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD



7.8. Ulucak - scatter plot of Ti and Fe discriminating obsidian from Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD

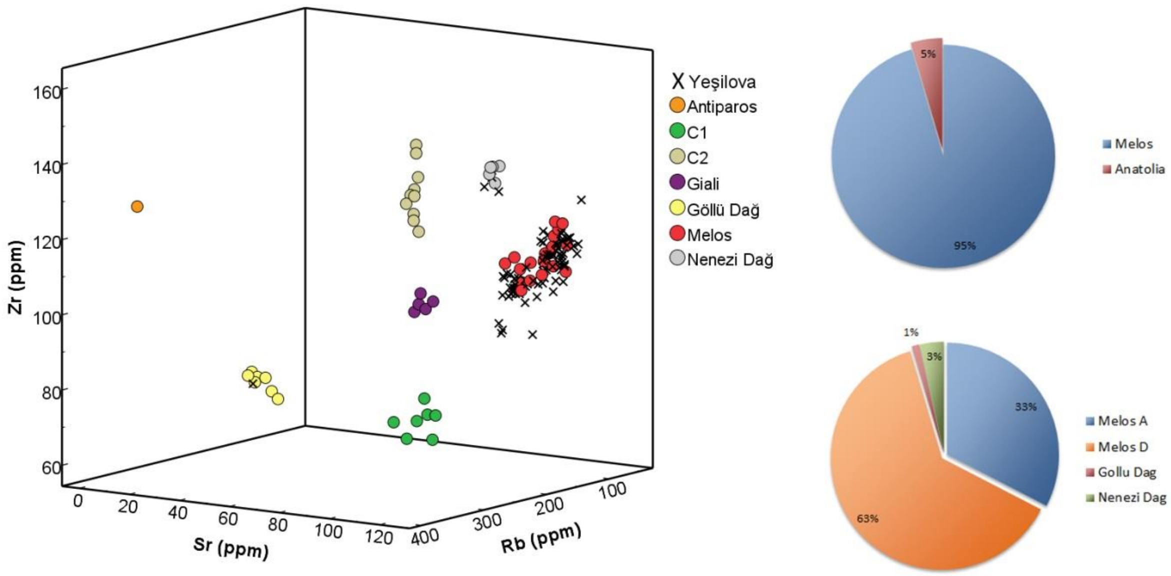


7.9. Ulucak - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD

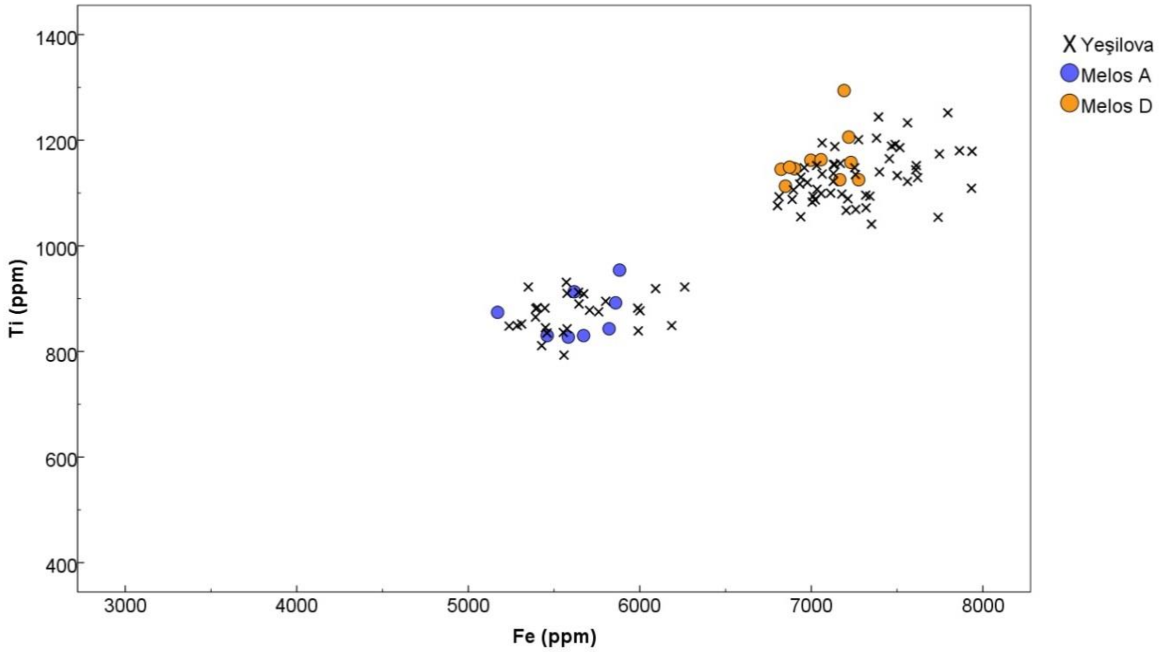
7.10. Ulucak - obsidian artefacts by source

7.10 Ulucak - obsidian artefacts by source (continuation)

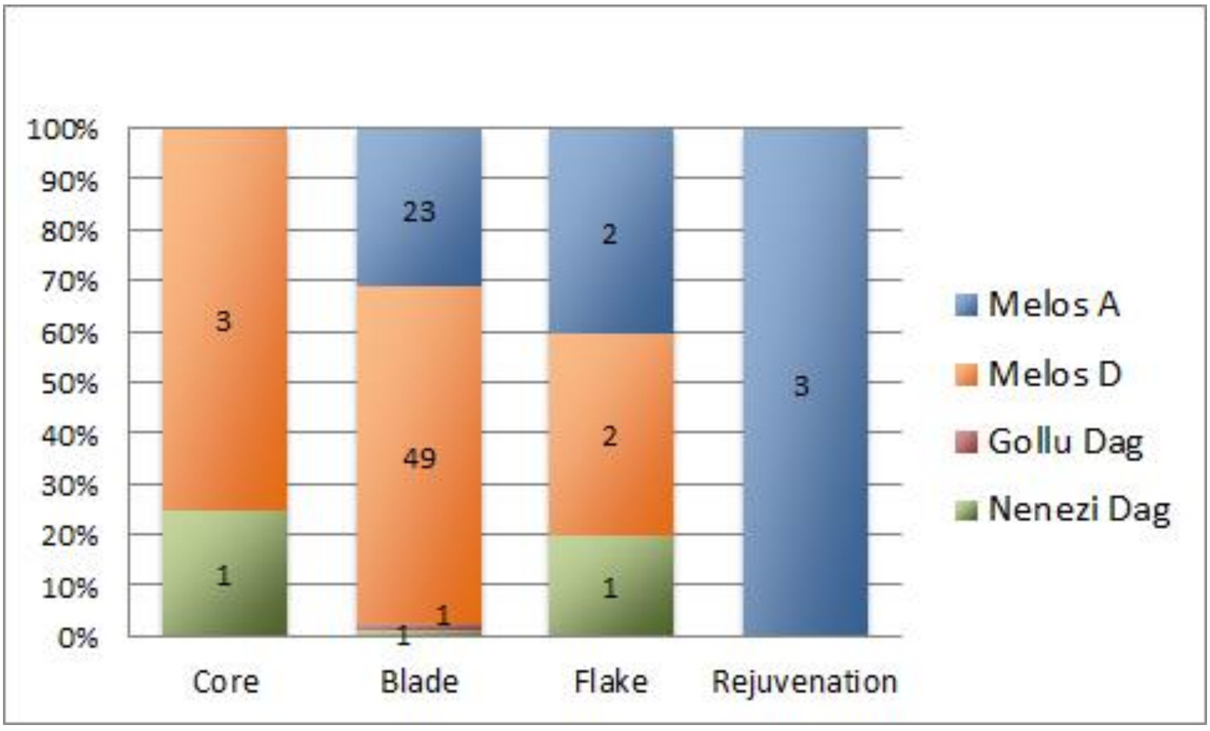
7.10 Ulucak - obsidian artefacts by source (continuation)



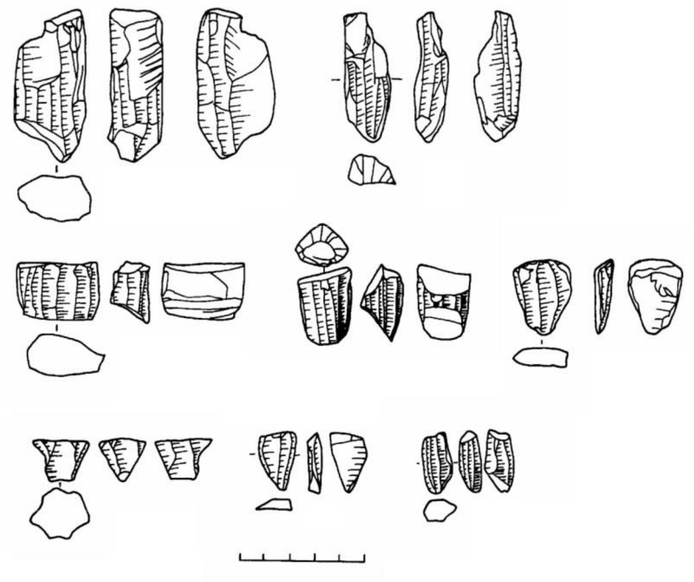
7.11. Yeşilova - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD



7.12. Yeşilova - scatter plot of Ti and Fe discriminating obsidian from Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD



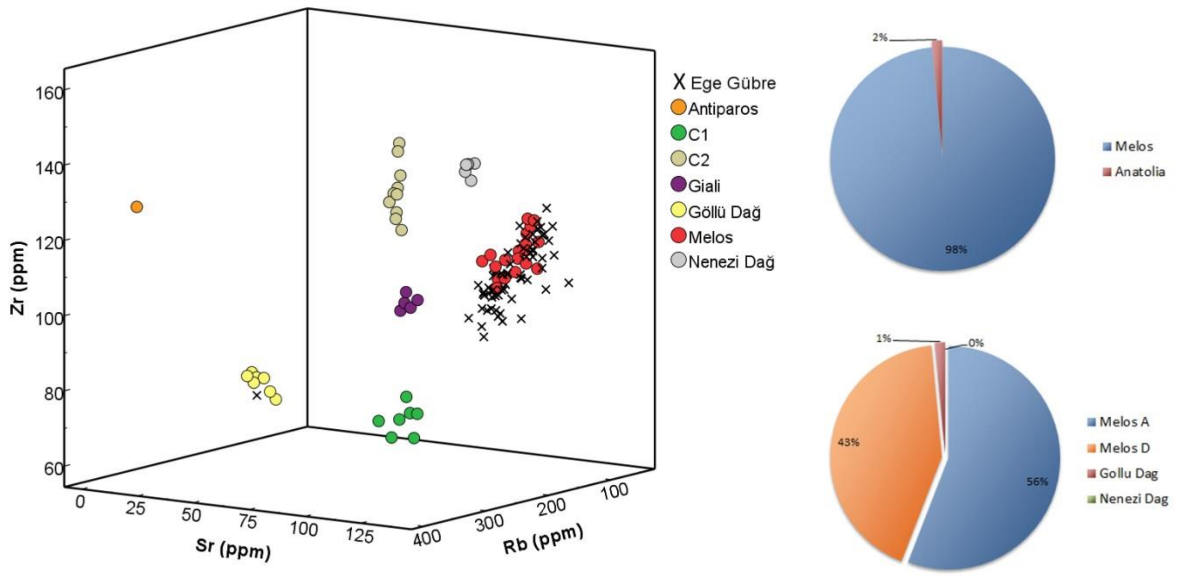
7.13. Yeşilova - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD



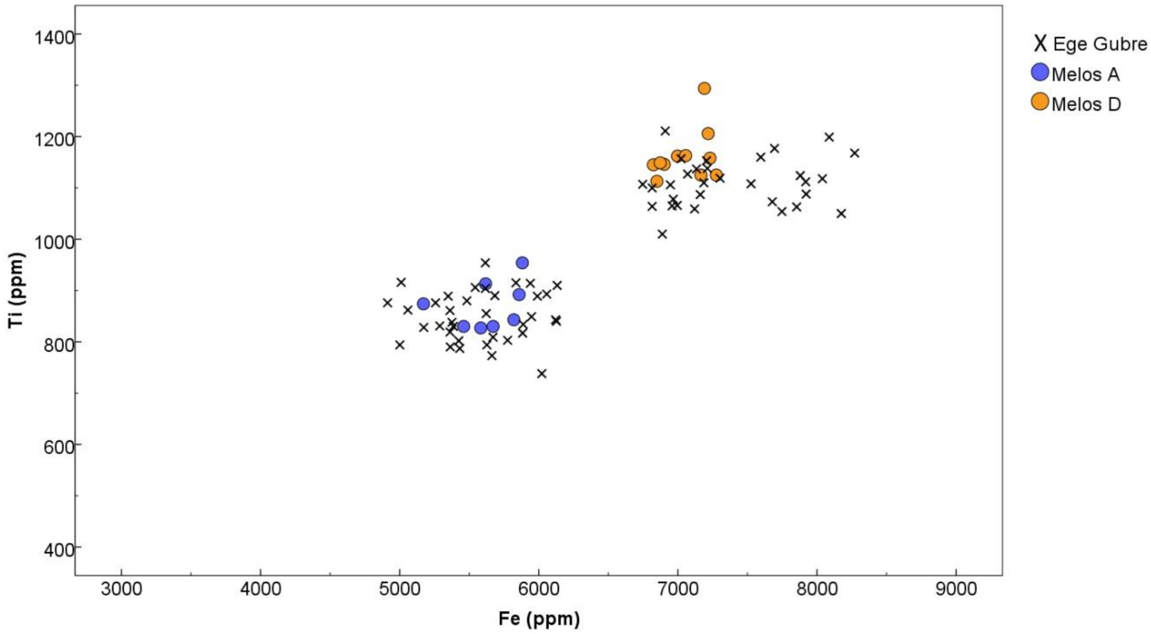
7.14. Obsidian cores from Yeşilova (modified after Ay 2008, Figs. 1, 3, 5, 7)

7.15. Yeşilova - obsidian artefacts by source

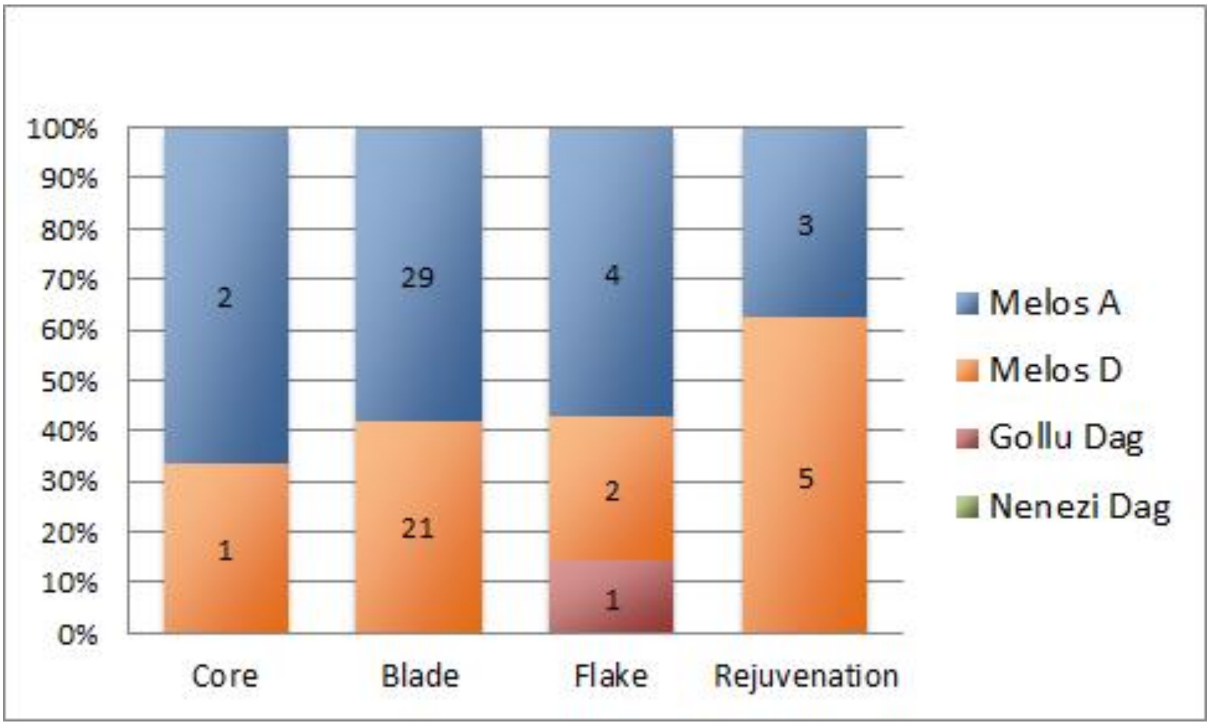
7.15 Yeşilova - obsidian artefacts by source (continuation)



7.16. Ege Gübre - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD



7.17. Ege Gübre - scatter plot of Ti and Fe discriminating obsidian from the Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD

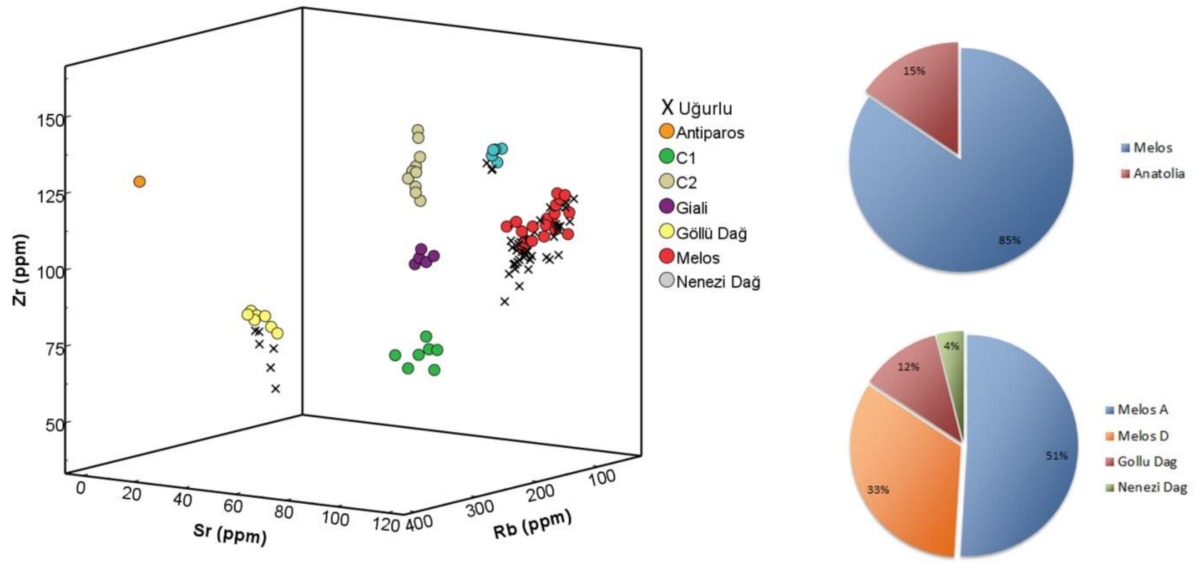


7.18. Ege Gübre - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD

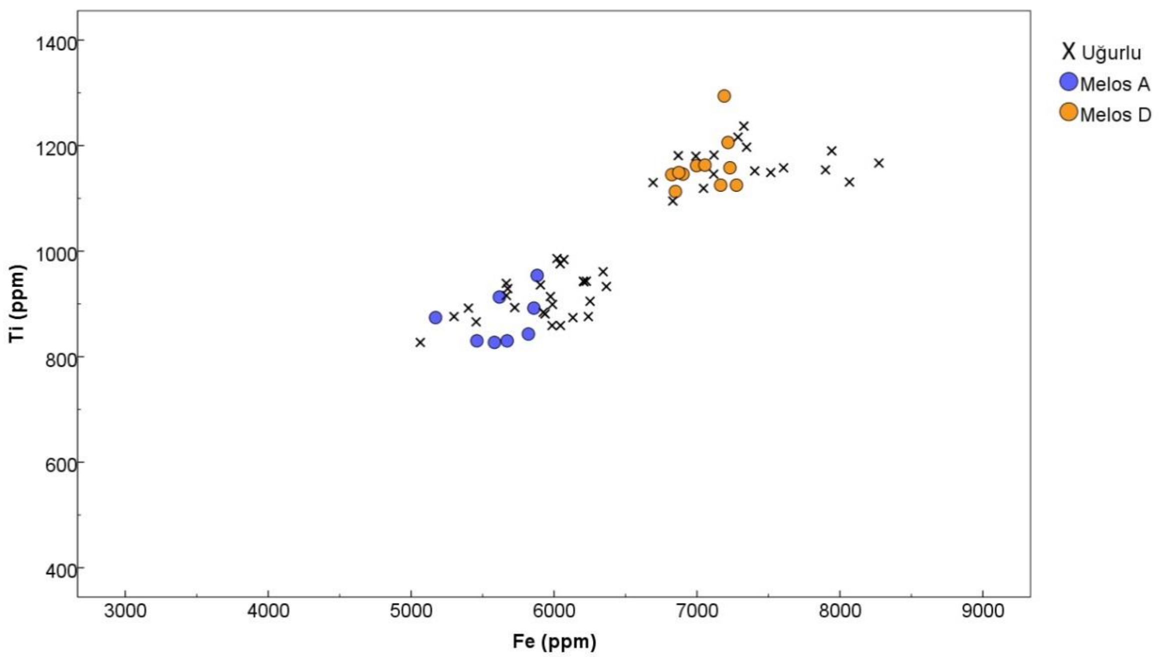
7.19. Ege Gübre - obsidian artefacts by source

7.20. Ayio Gala - obsidian artefacts by source

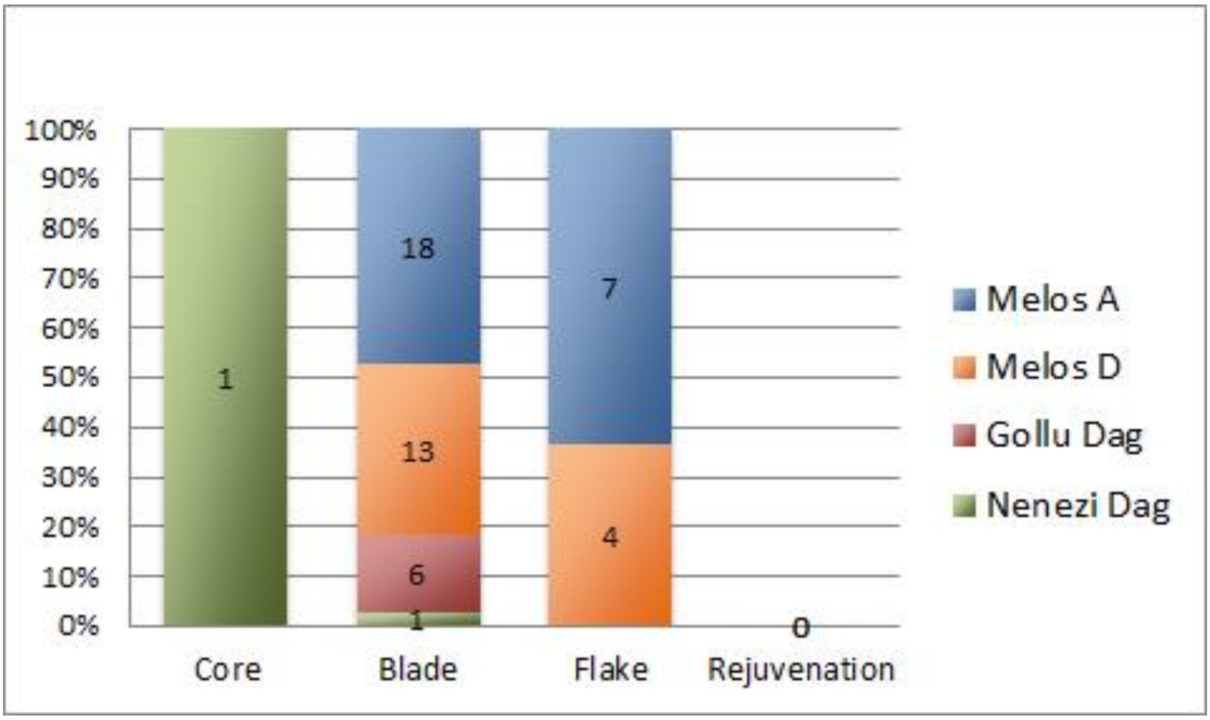
7.21. Flint cores and blades from Yeşilova (left; after Derin 2012, Fig.17) and Ulucak (right)



7.22. Uğurlu V and IV - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

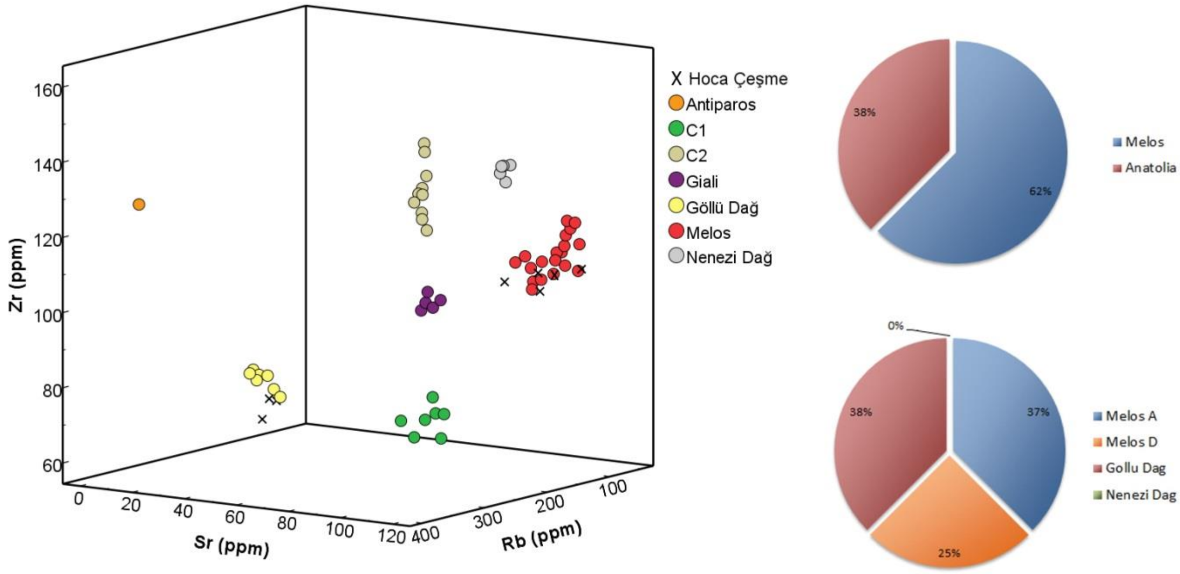


7.23. Uğurlu V and IV - scatter plot of Ti and Fe discriminating obsidian from Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD

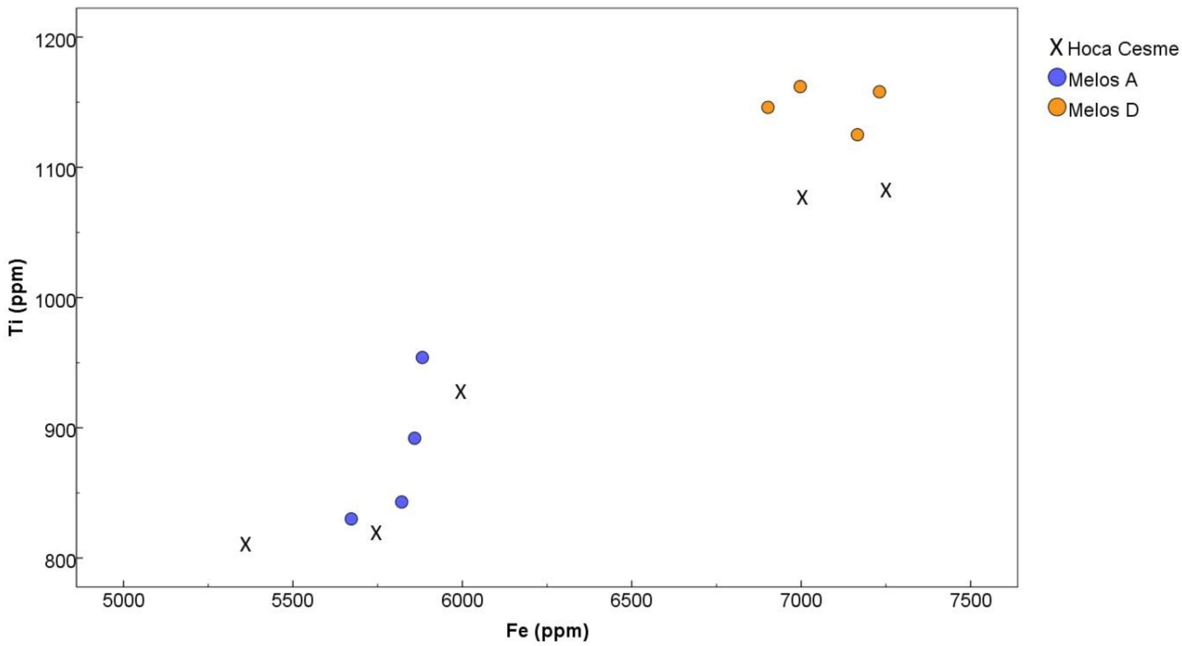


7.24. Uğurlu V and IV - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD

7.25. Uğurlu V and IV - obsidian artefacts by source

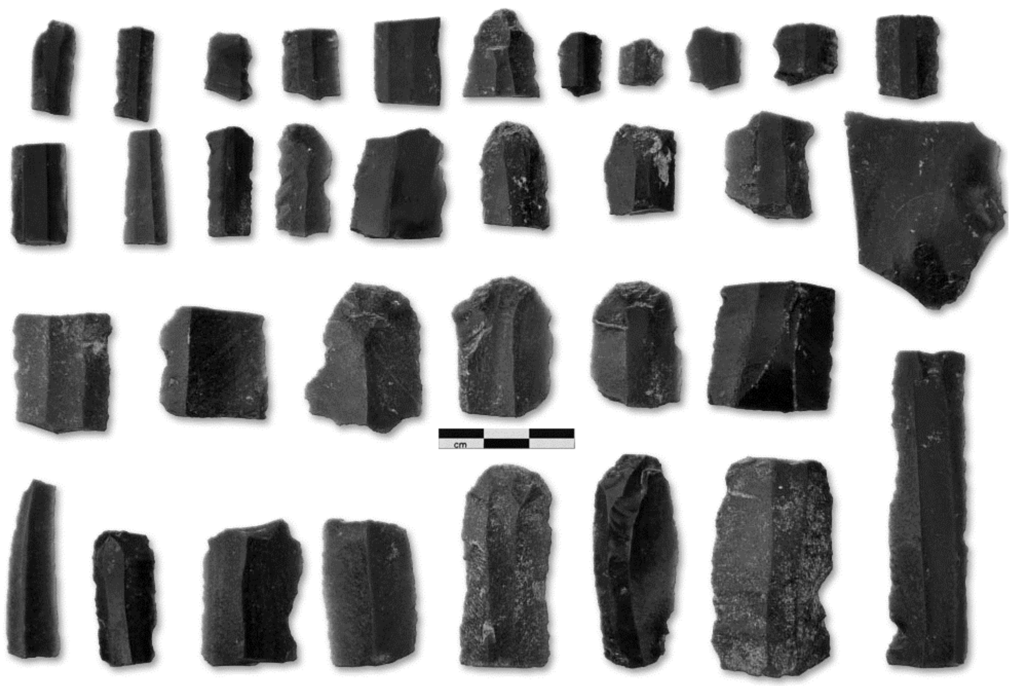


7.26. Hoca Çeşme - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

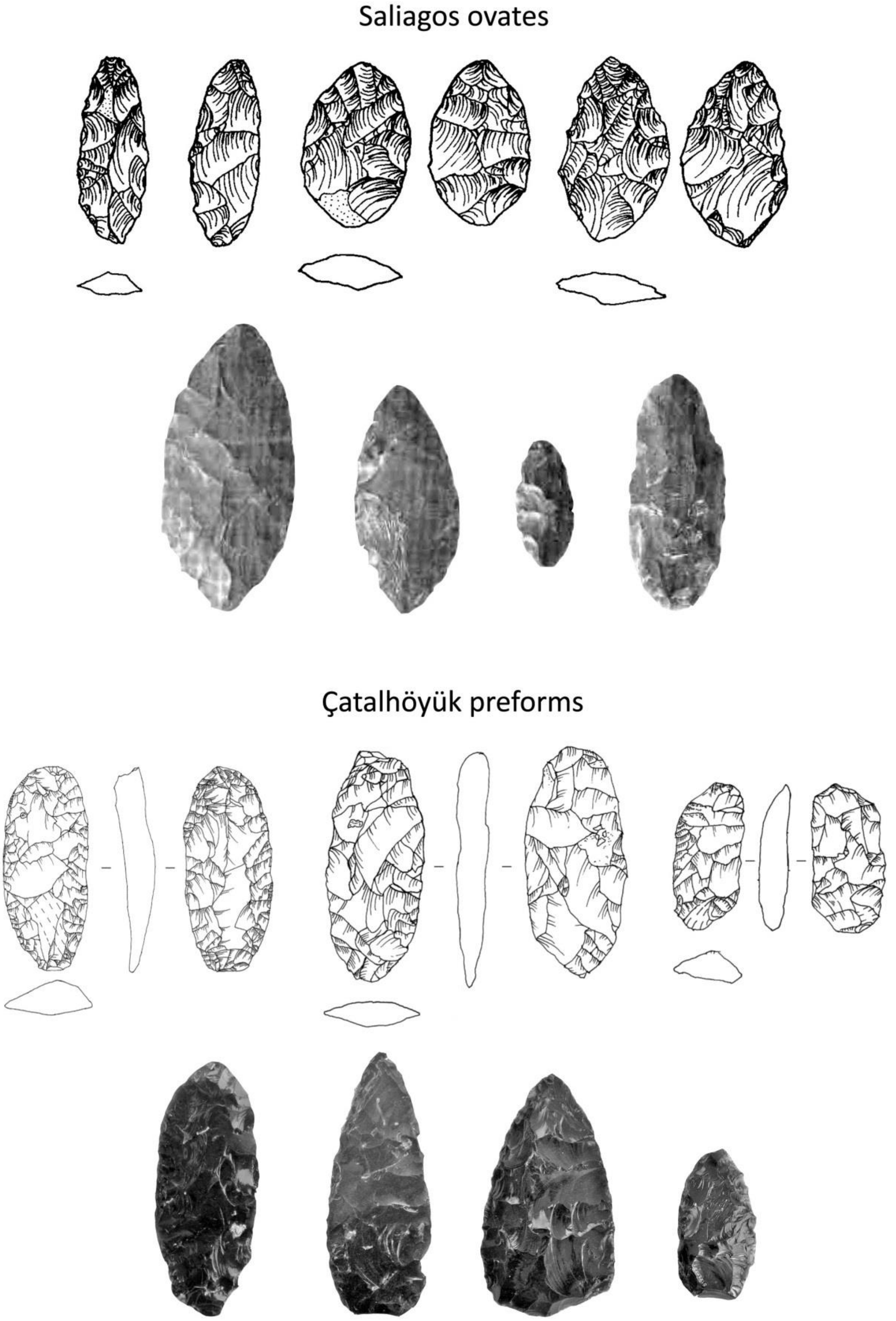


7.27. Hoca Çeşme - scatter plot of Ti and Fe discriminating obsidian from the Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD

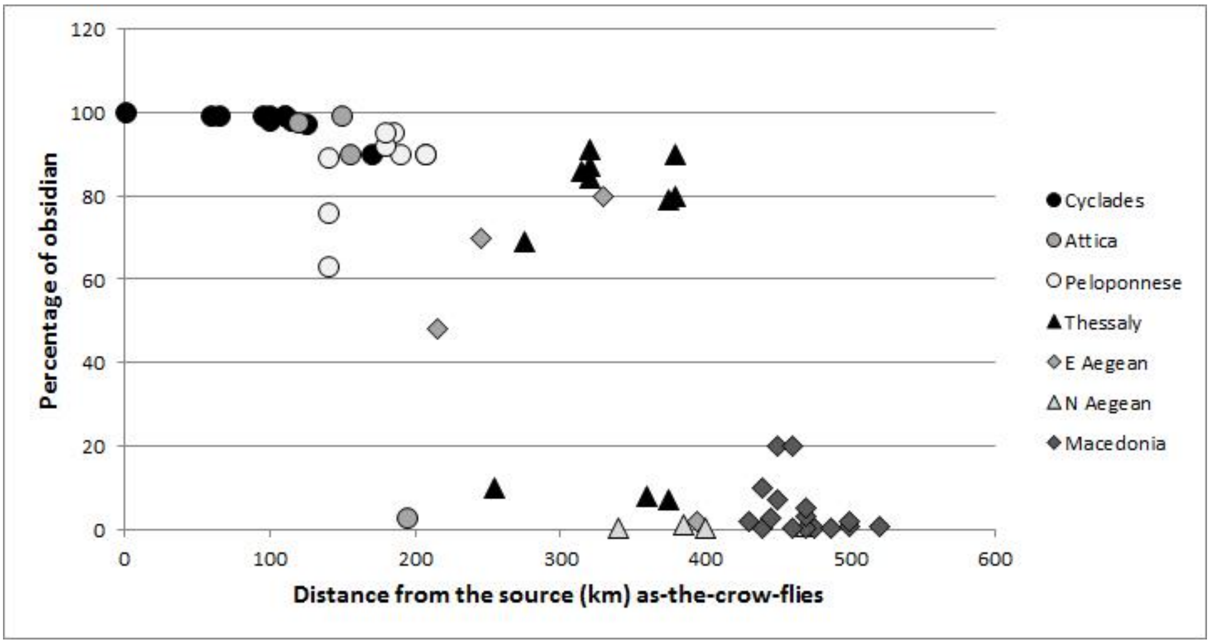
7.28. Hoca Çeşme - obsidian artefacts by source



7.29. Obsidian assemblage from Coşkuntepe (modified after Perlès *et al.* 2011, Fig. 2)

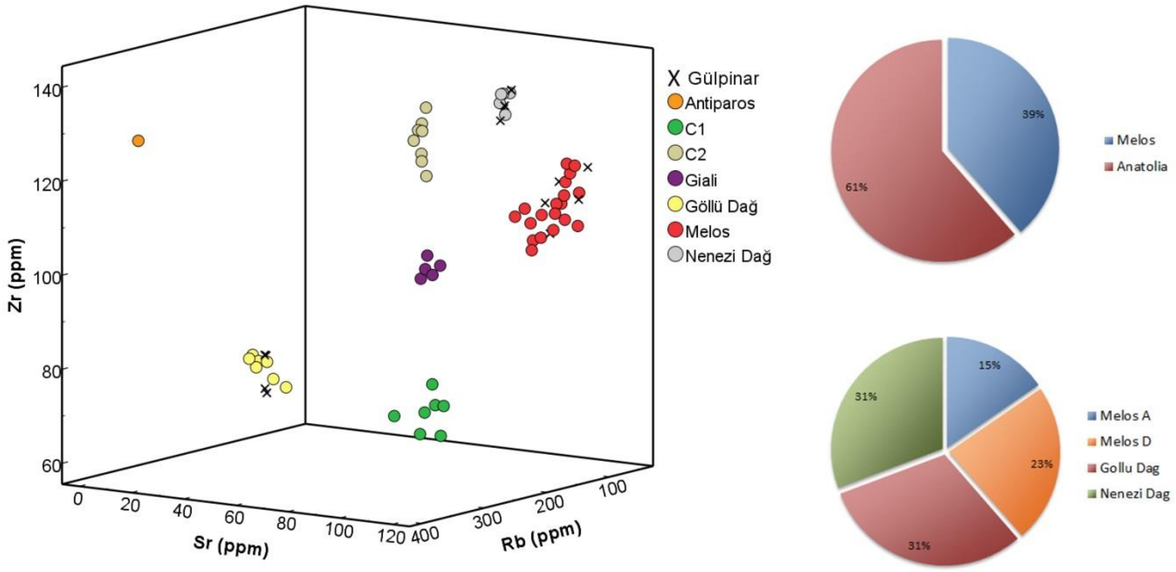


7.30. Ovates from Saliagos (modified after Evans & Renfrew, Fig. 65 and Plate XXXVI) and projectile preforms from Çatalhöyük (drawings after Carter & Milić 2014, Fig. 21.16 and photographs from personal collection)

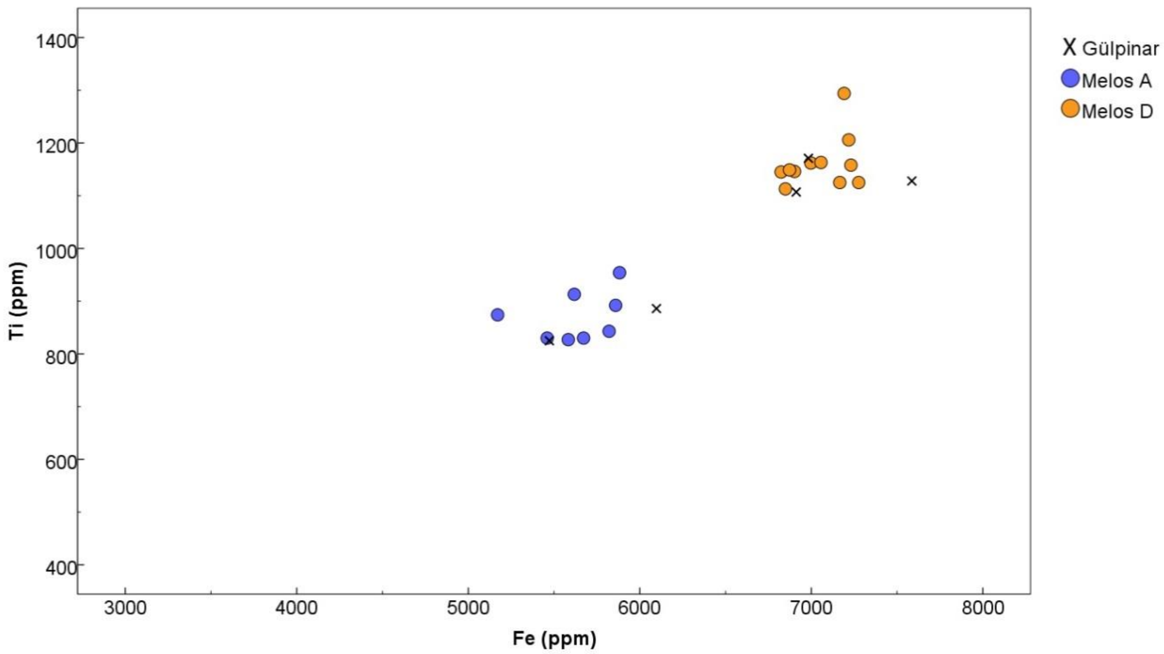


7.31. Distribution of Aegean obsidian during LN: distance vs. obsidian frequency

7.32. Obsidian assemblages from Emporio VIII

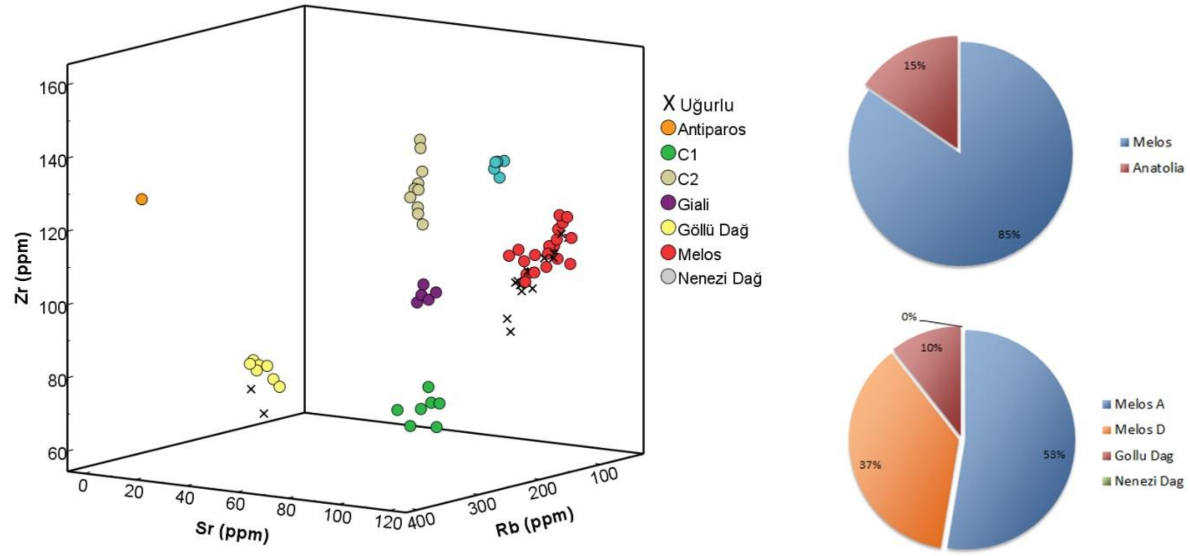


7.33. Gülpınar - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

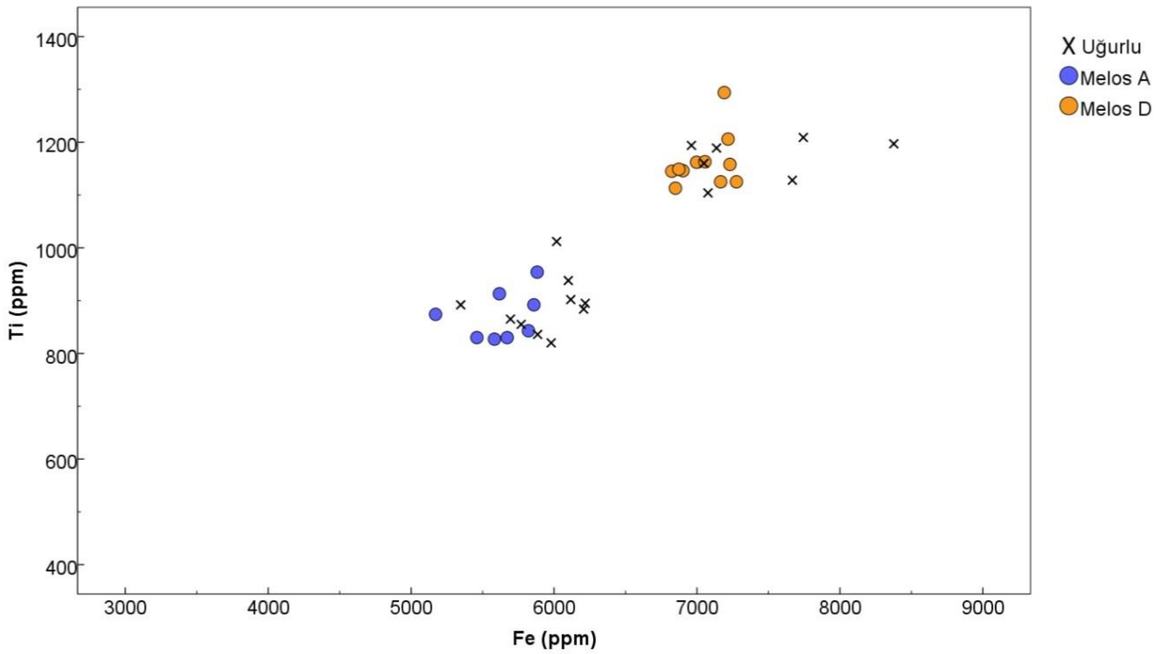


7.34. Gülpınar - scatter plot of Ti and Fe discriminating obsidian from Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD

7.35. Gülpınar - obsidian artefacts by source

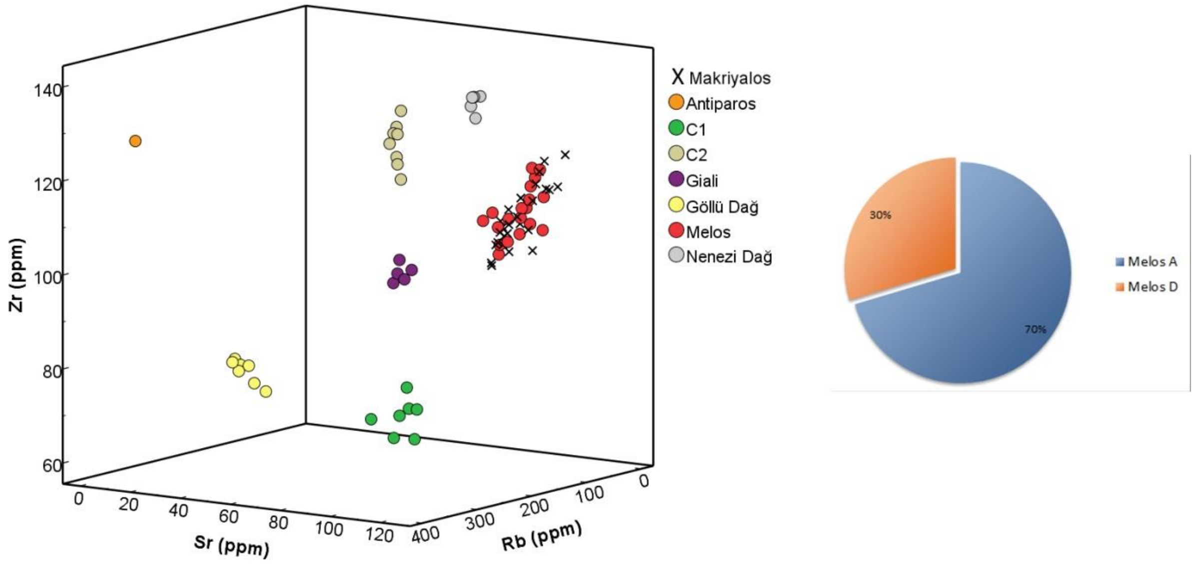


7.36. Uğurlu III and II - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

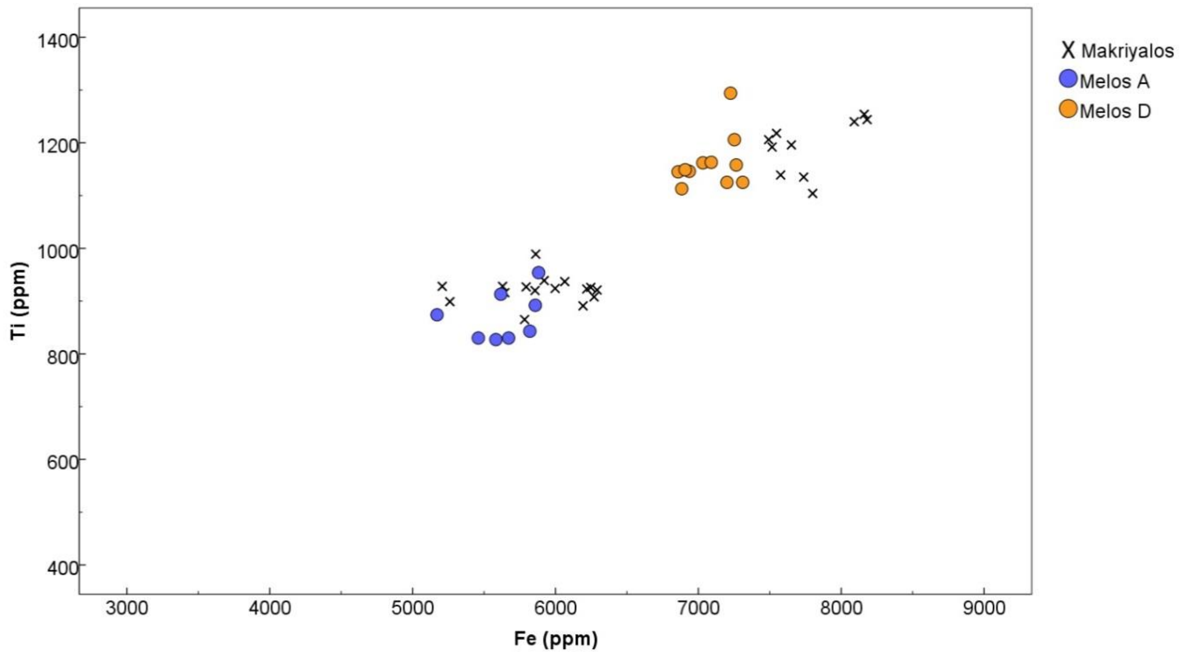


7.37. Uğurlu III and II - scatter plot of Ti and Fe discriminating obsidian from the Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD

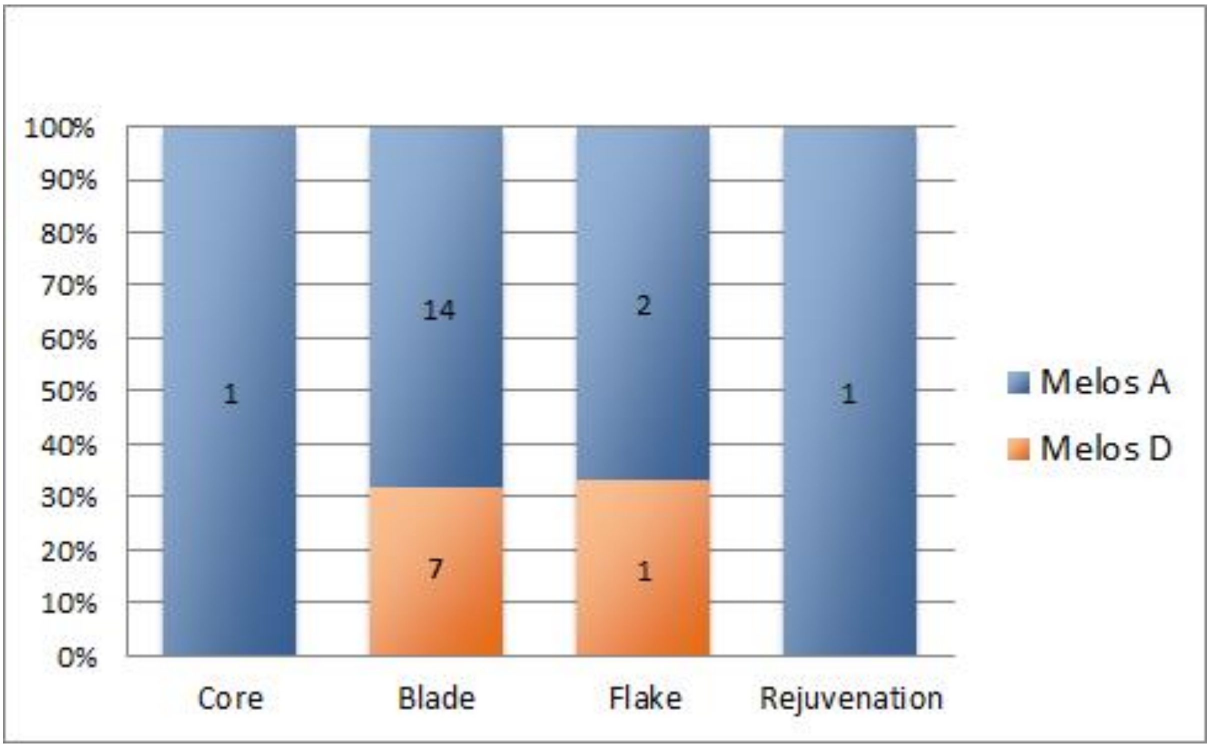
7.38. Uğurlu III and II - obsidian artefacts by source



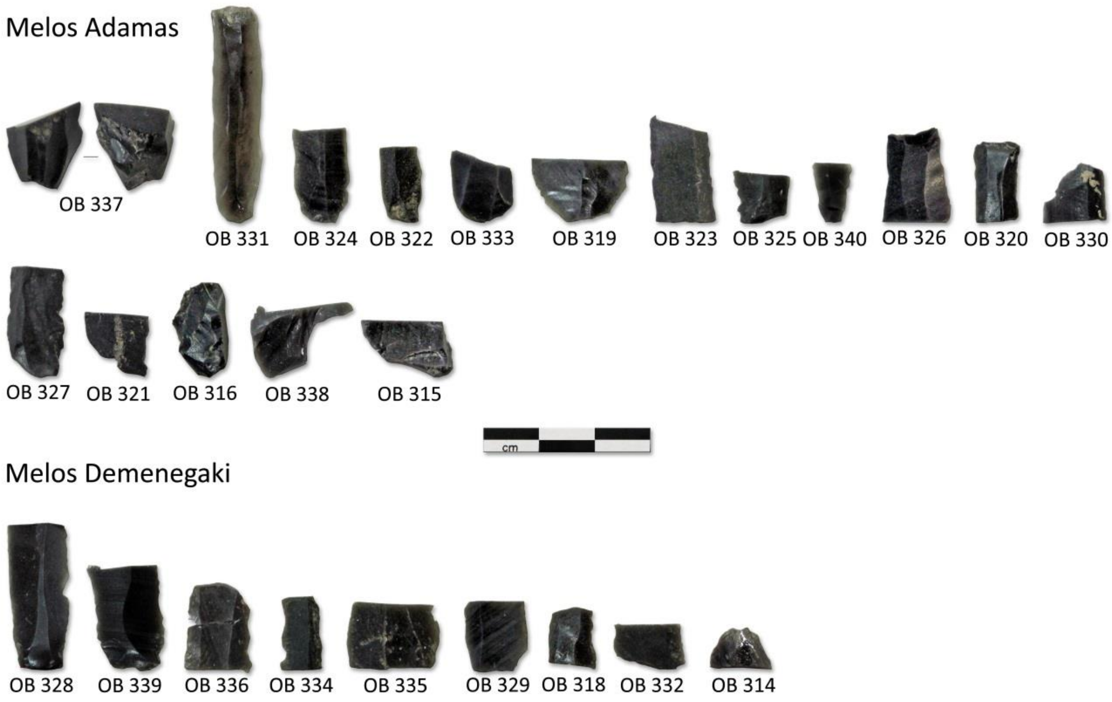
7.39. Makriyalos - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD



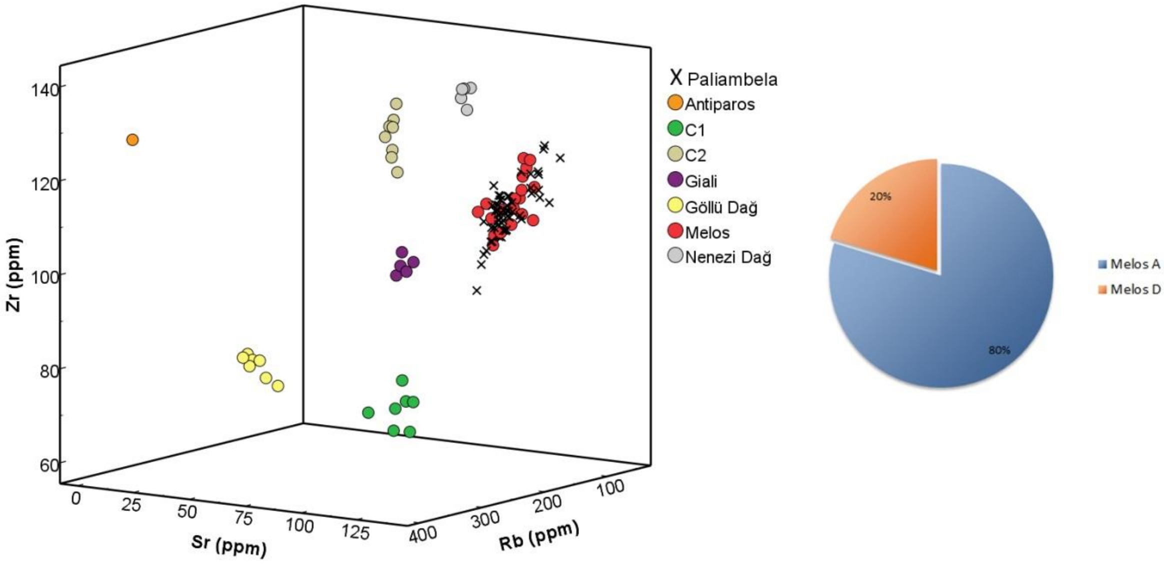
7.40. Makriyalos - scatter plot of Ti and Fe discriminating obsidian from the Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD



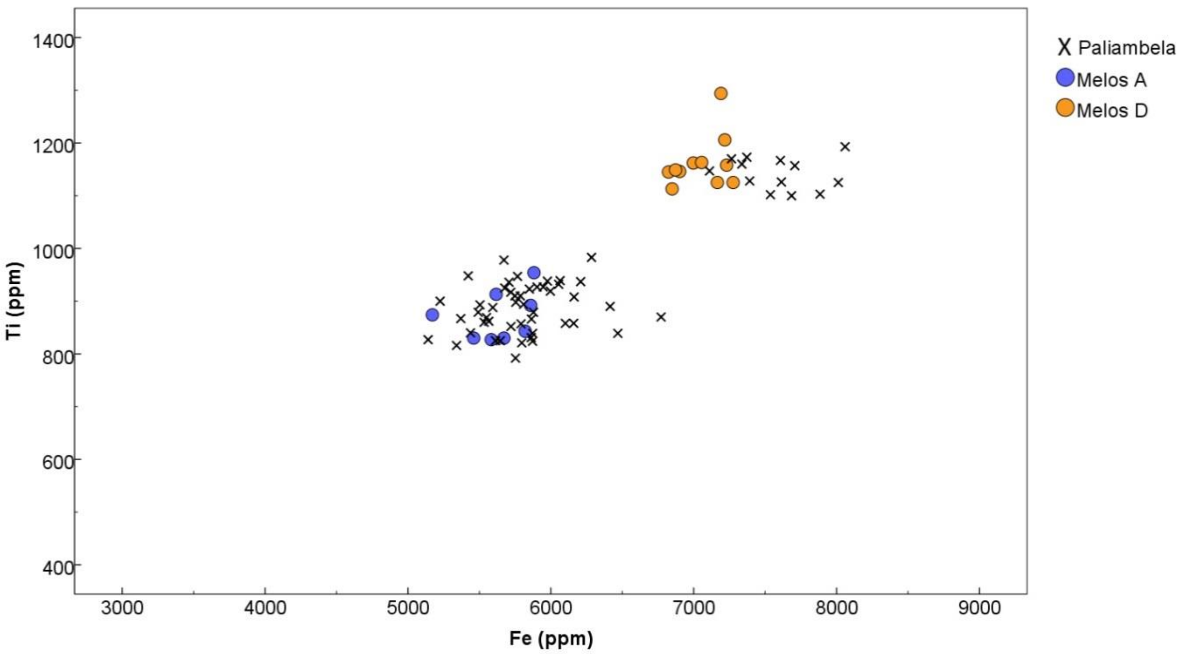
7.41. Makriyalos - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD



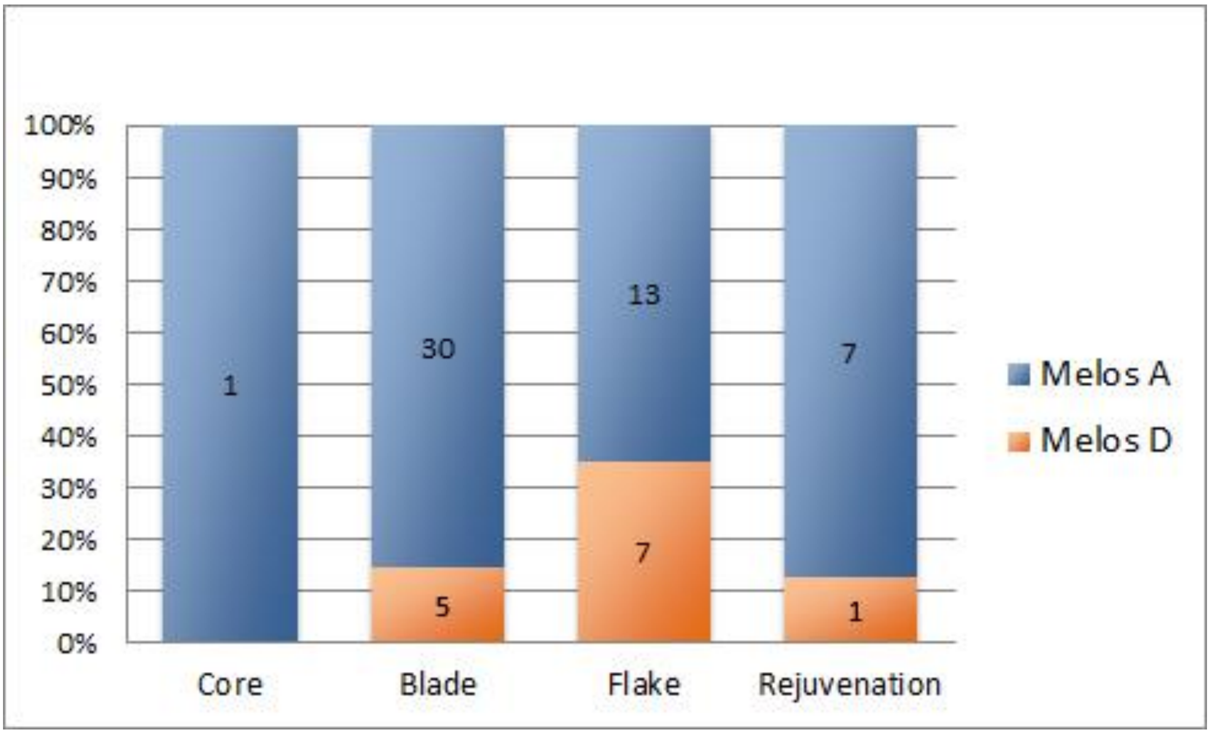
7.42. Makriyalos - obsidian artefacts by source



7.43. Paliambela - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

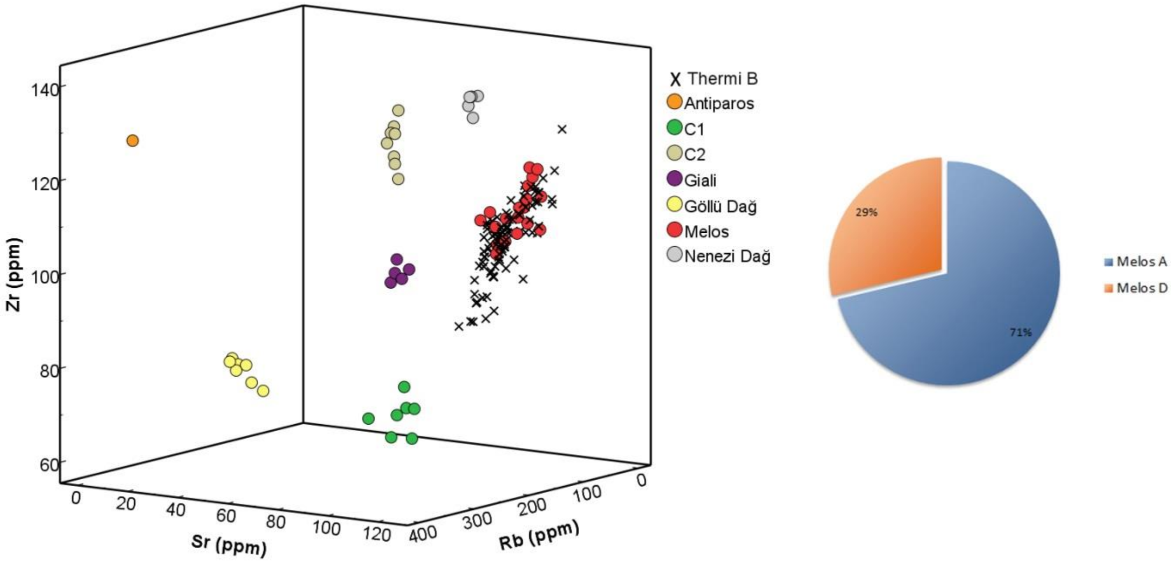


7.44. Paliambela - scatter plot of Ti and Fe discriminating obsidian from the Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD

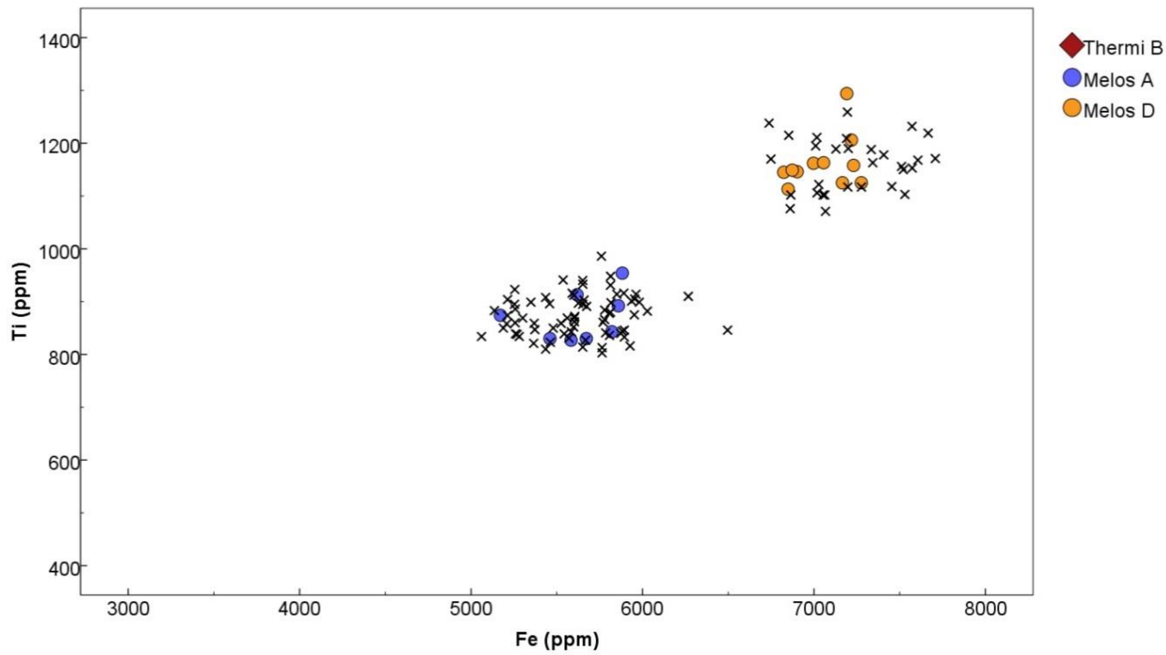


7.45. Paliambela - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD

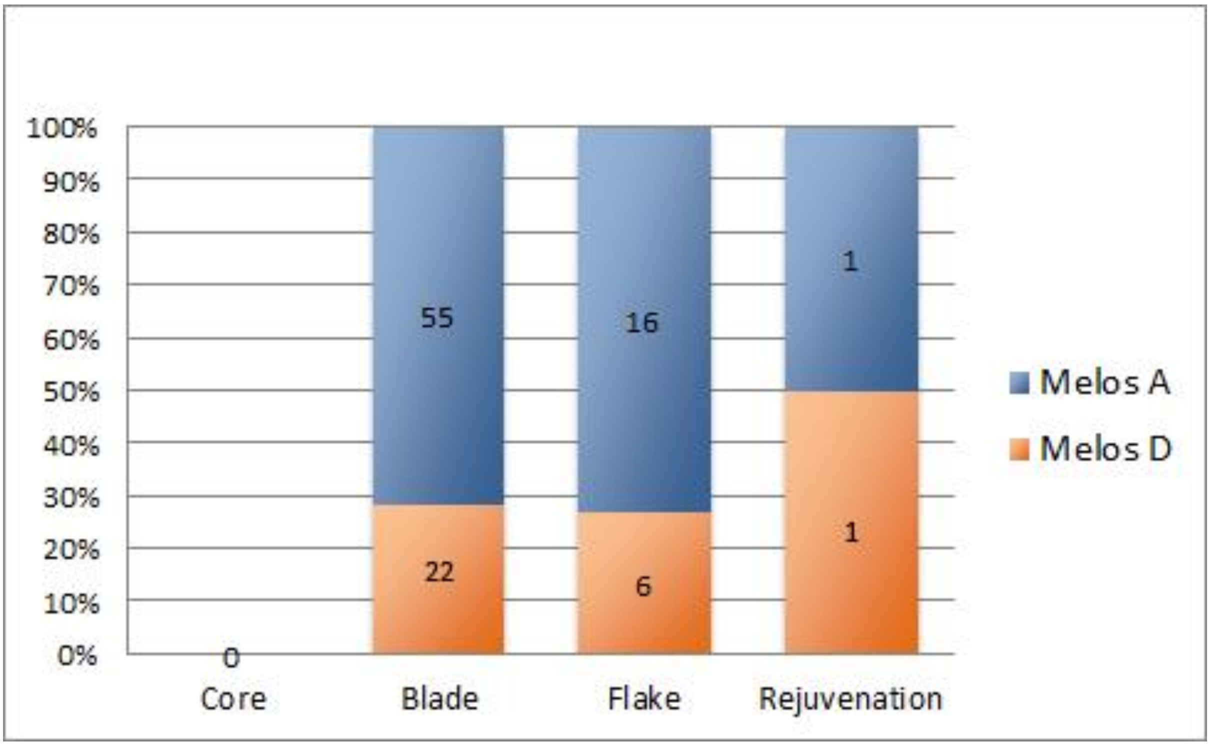
7.46. Paliambela - obsidian artefacts by source



7.47. Thermi B - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

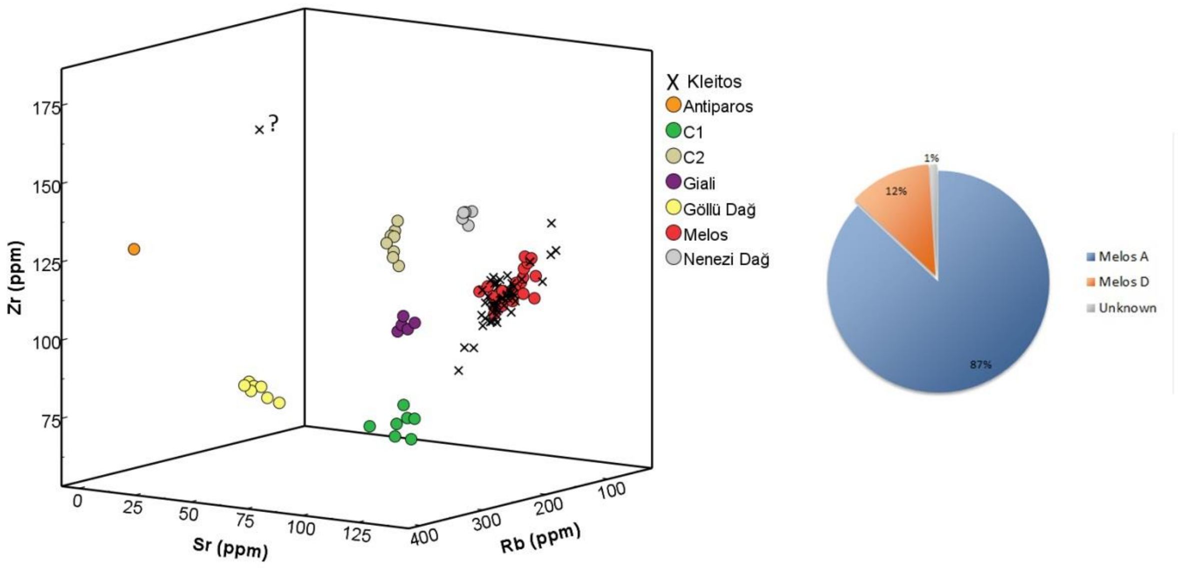


7.48. Thermi B - scatter plot of Ti and Fe discriminating obsidian from the Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD

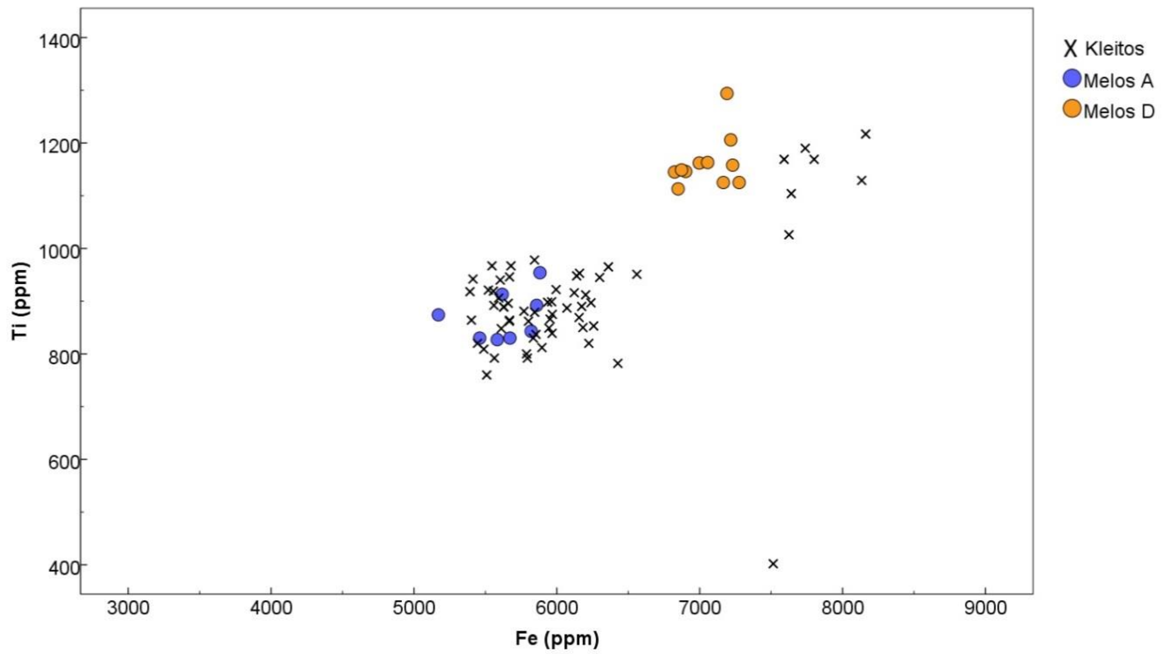


7.49. Thermi B - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD

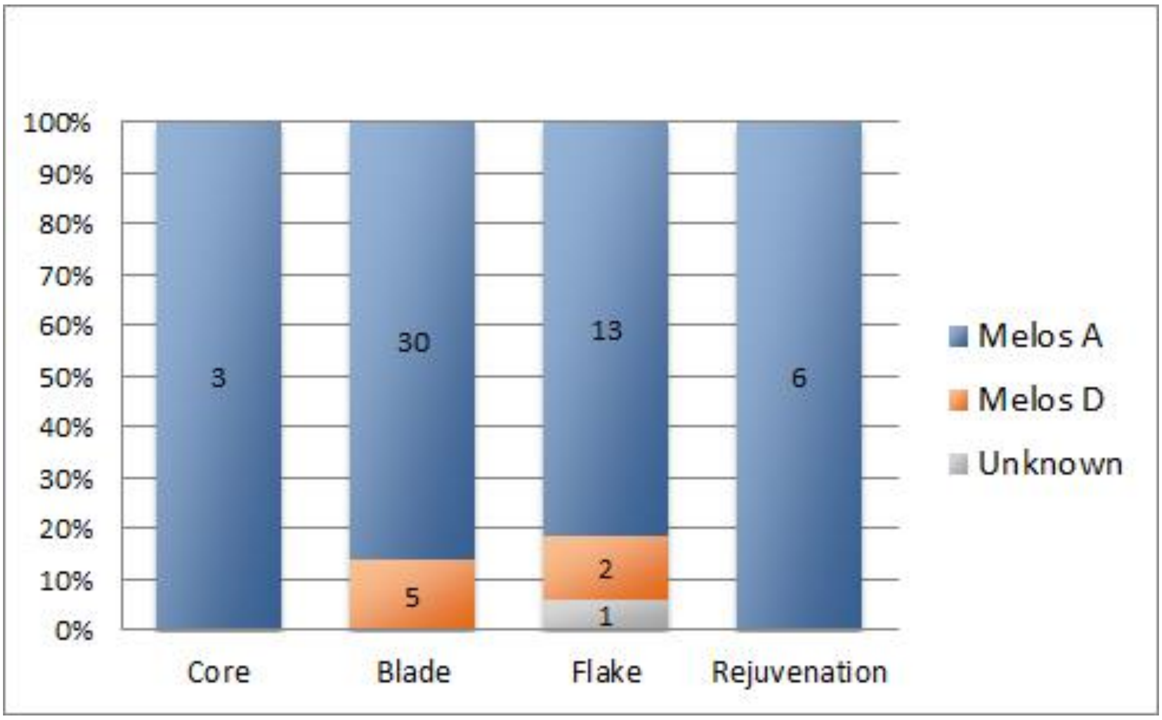
7.50. Thermi B - obsidian artefacts by source



7.51. Kleitos - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

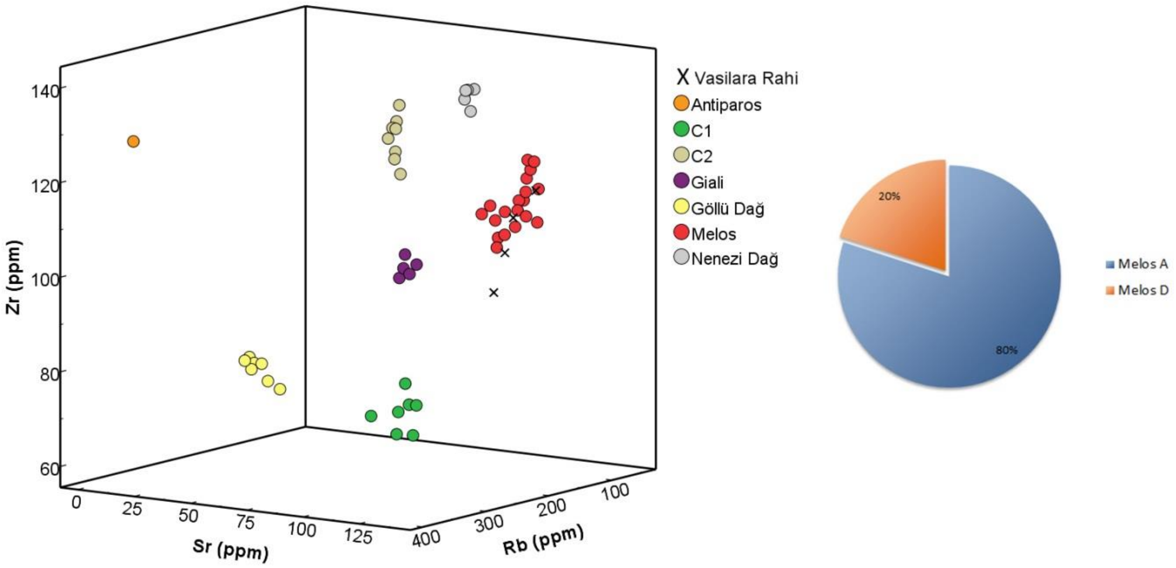


7.52. Kleitos - scatter plot of Ti and Fe discriminating obsidian from the Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD

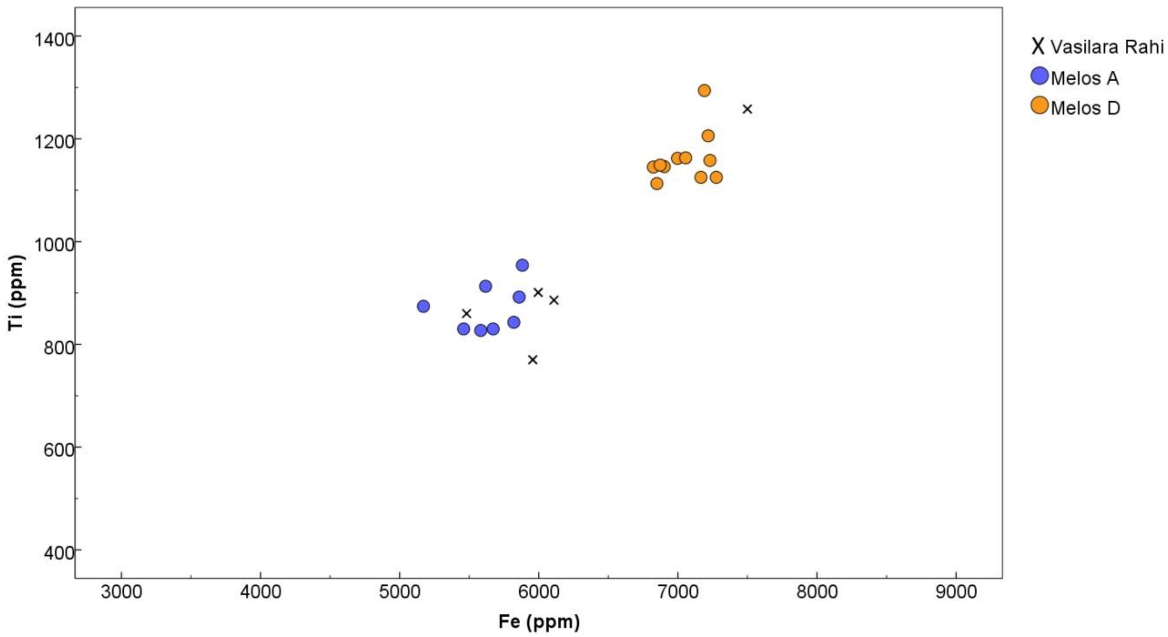


7.53. Kleitos - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD

7.54. Kleitos - obsidian artefacts by source

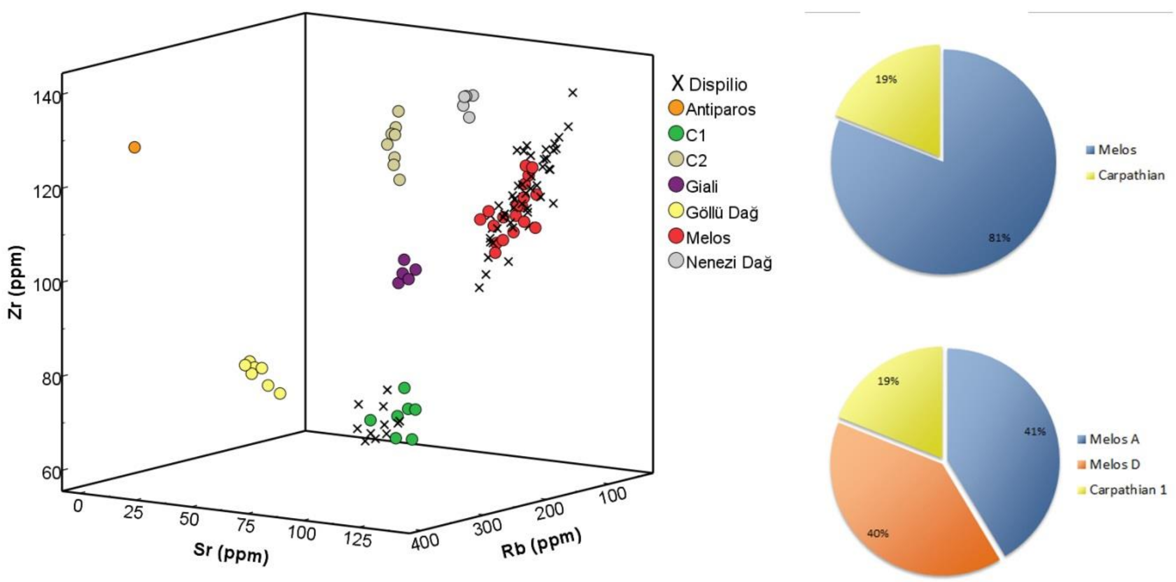


7.55. Vasilara Rahi - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD

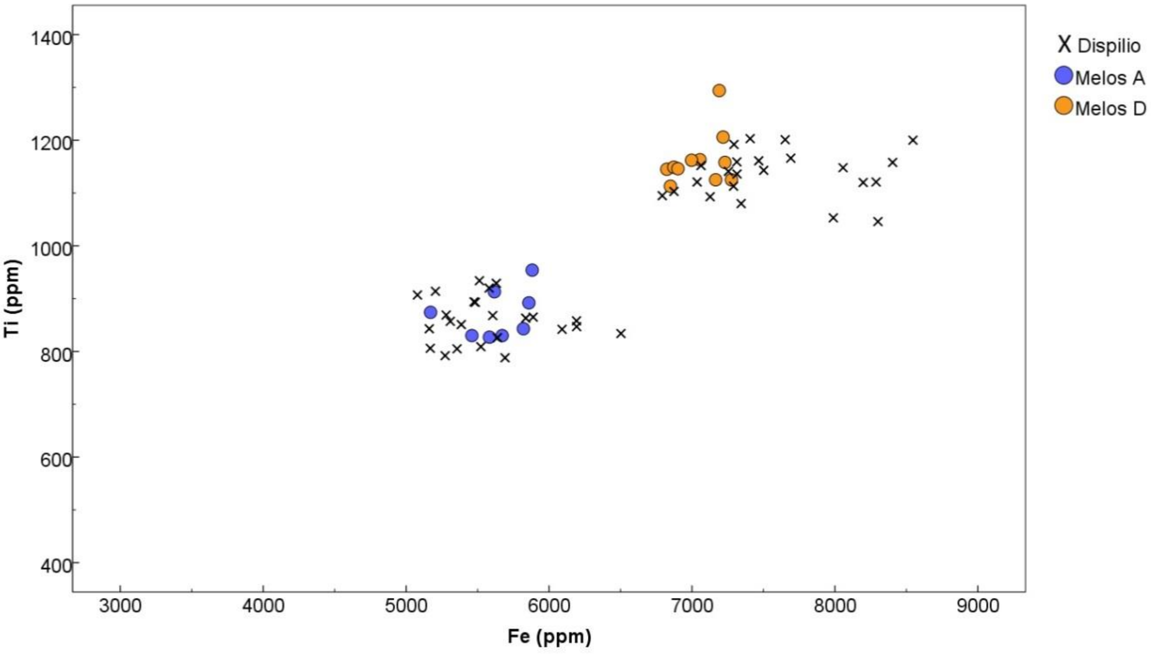


7.56. Vasilara Rahi - scatter plot of Ti and Fe discriminating obsidian from the Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD

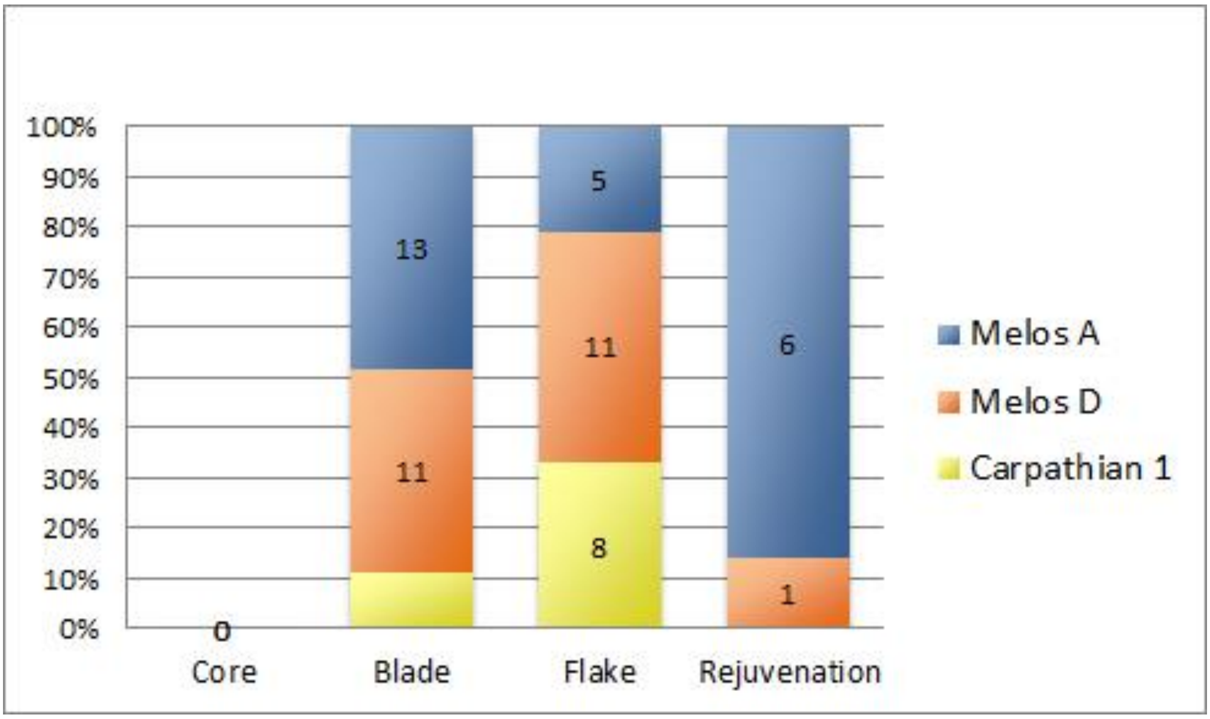
7.57. Vasilara Rahi - obsidian artefacts by source



7.58. Dispilio - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie charts showing the relative proportion of each obsidian type (right). Trace elemental data is provided in Data 4 on CD



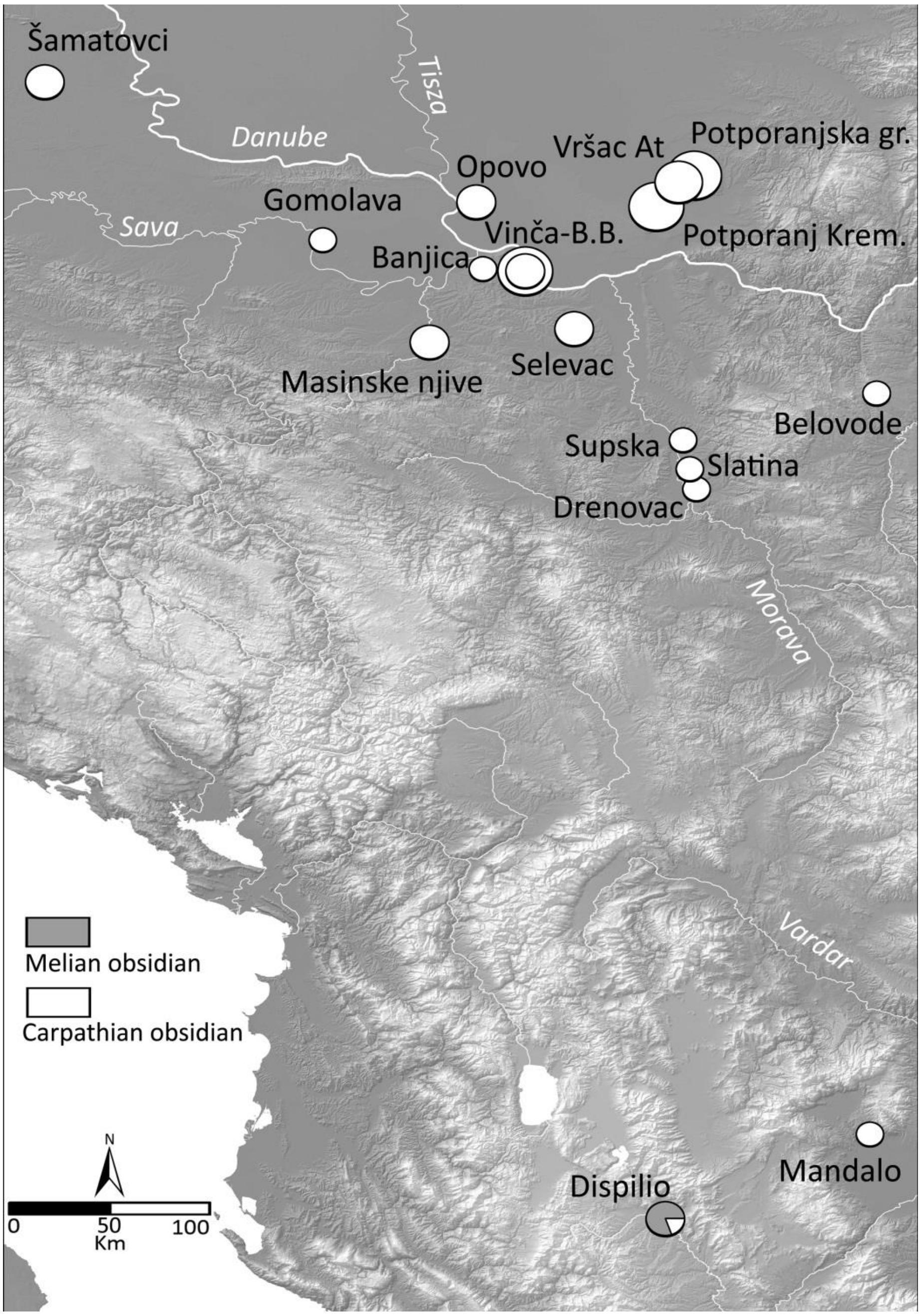
7.59. Dispilio - scatter plot of Ti and Fe discriminating obsidian from the Adamas and Demenegaki sources. Trace elemental data is provided in Data 4 on CD



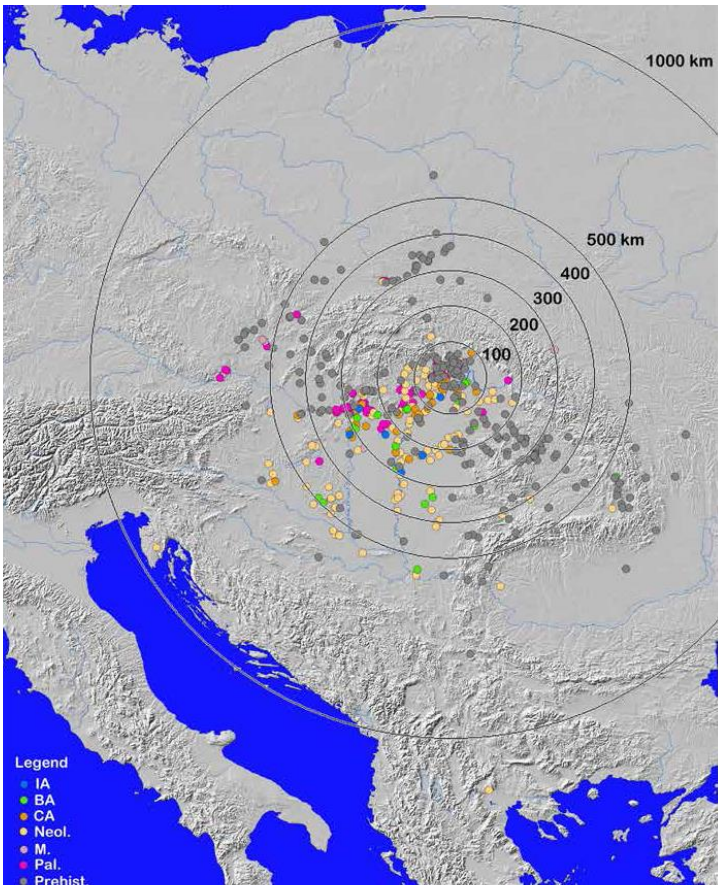
7.60. Dispilio - the relative proportion of débitage category of each obsidian type. Classification data is provided in Data 5 on CD

7.61. Dispilio - obsidian artefacts by source

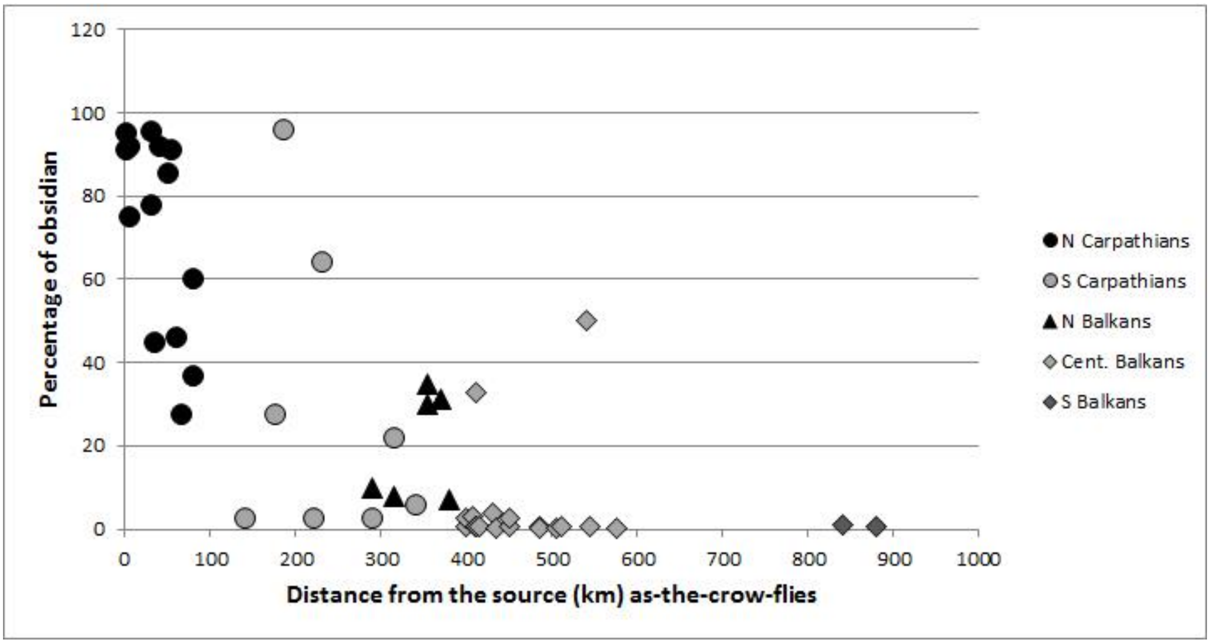
Chapter 8 Figures:



8.1. Distribution of Carpathian obsidian with the key sites discussed in this study



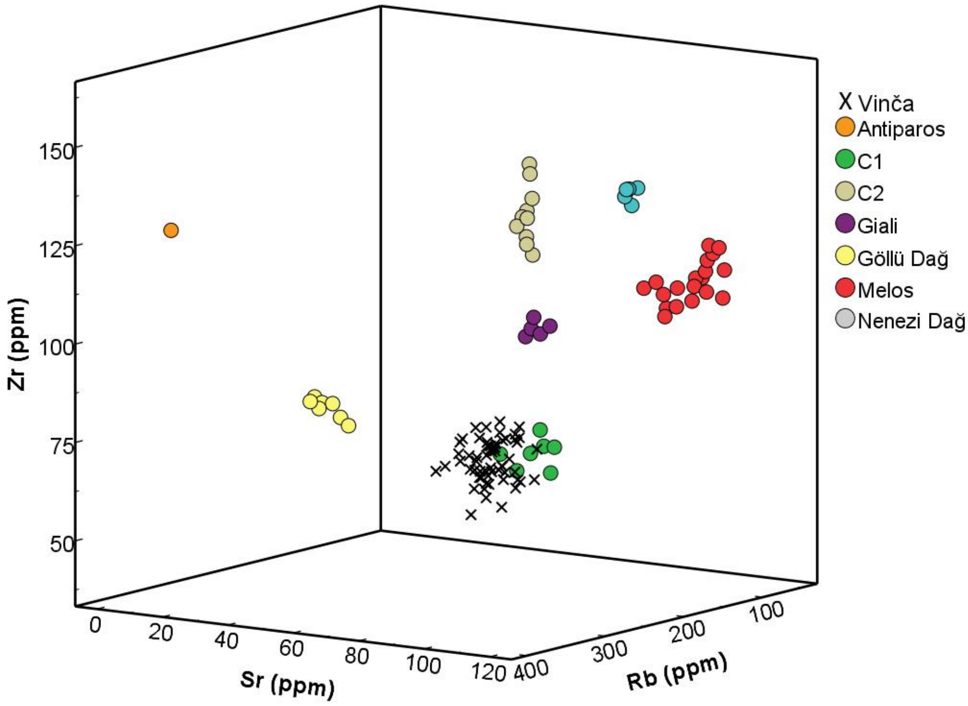
8.2. Distribution of Carpathian obsidian showing distances of finds as-the-crow-flies from the sources (after Biró 2014, Fig. 6)



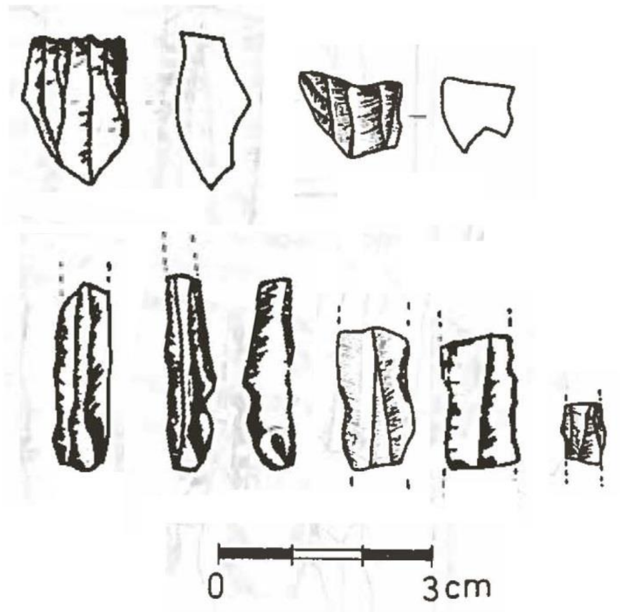
8.3. Southern distribution of Carpathian obsidian in LN: distance vs. obsidian frequency

8.4. Obsidian and flint assemblages from Méhtelek (after Kalicz *et al*. 2011, Fig. 54; copyright of this image was not be obtained)

8.5. Obsidian core hoard from Nyírlugos (after Kasztovszky *et al*. 2014, Fig. 10)

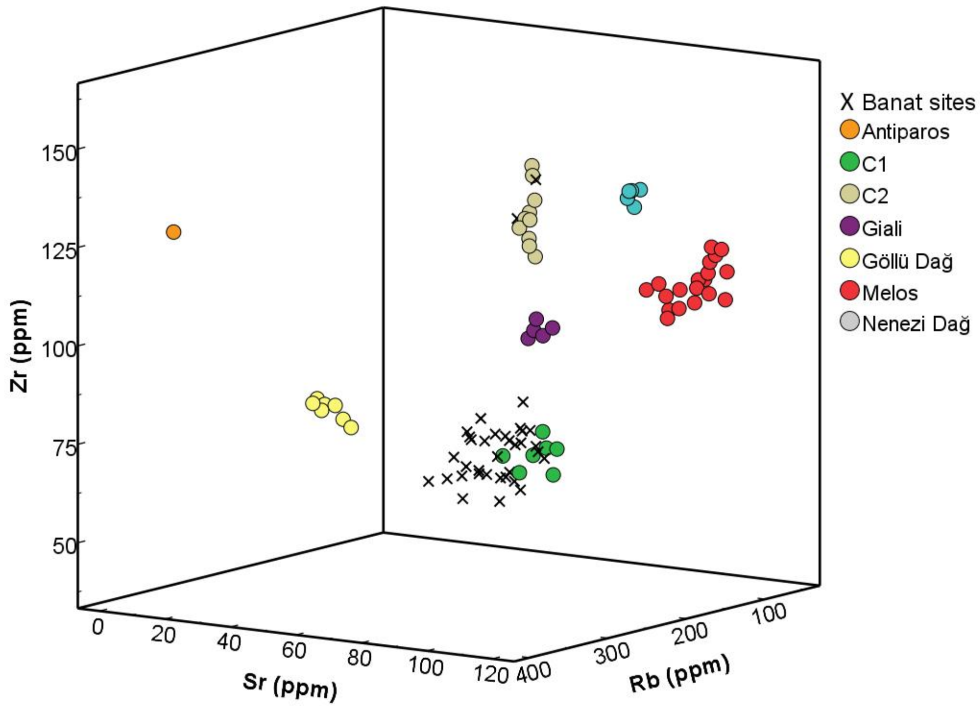


8.6. Vinča-Belo Brdo - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (sites results obtained using EDXRF technique; from Tripković & Milić 2008)



8.7. Obsidian micro-cores and micro-blades from Vinča Belo-Brdo A-B (modified after Radovanović *et al.* 1984, Figs. 30 and 31)

8.8. Obsidian assemblage from Vinča-Belo Brdo analysed using EDXRF

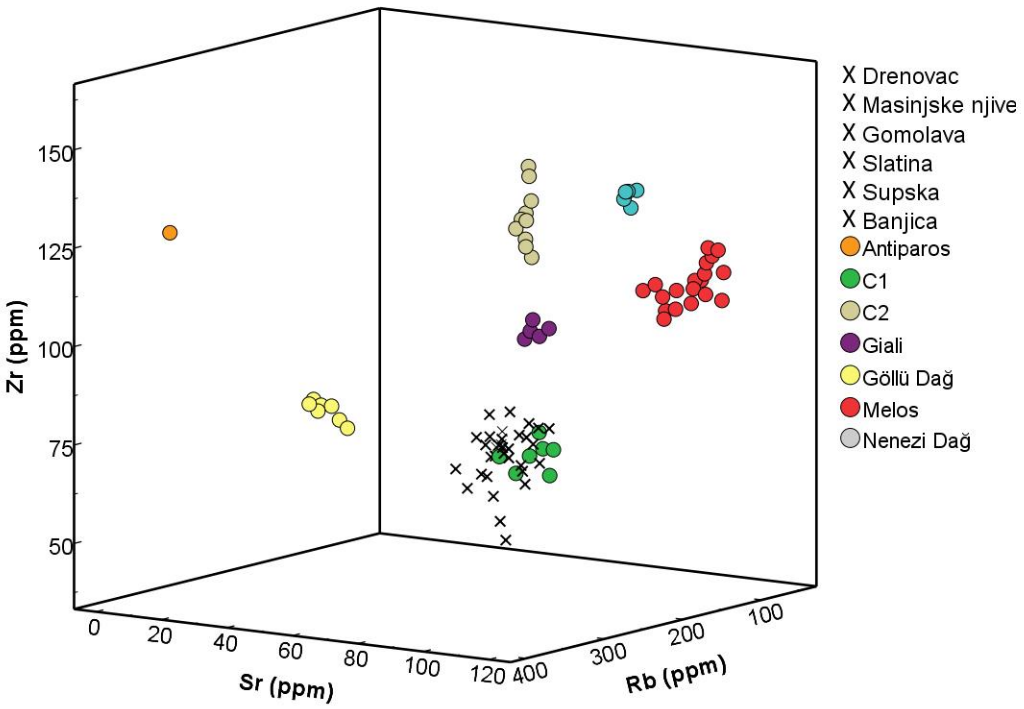


8.9. Banat sites - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (results obtained using EDXRF technique; the work is part of an ongoing collaboration with B. Tripković)

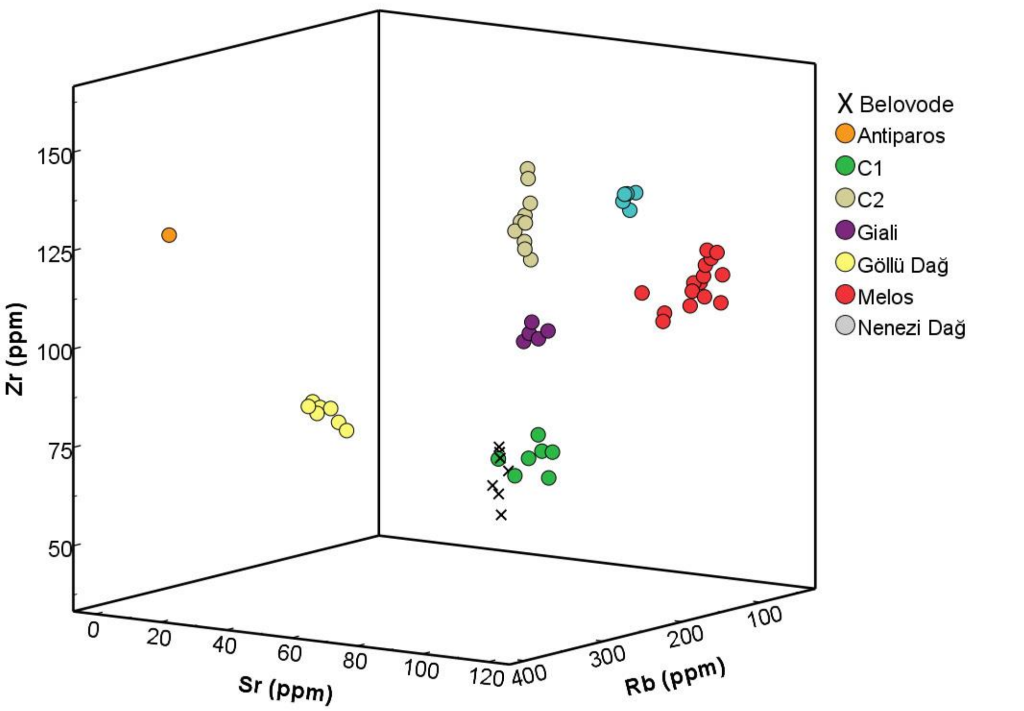
8.10. Obsidian assemblage from Vršac-At in Banat

8.11. Obsidian micro-cores from Potporanj-Kremenjak, representing typical Vršac types

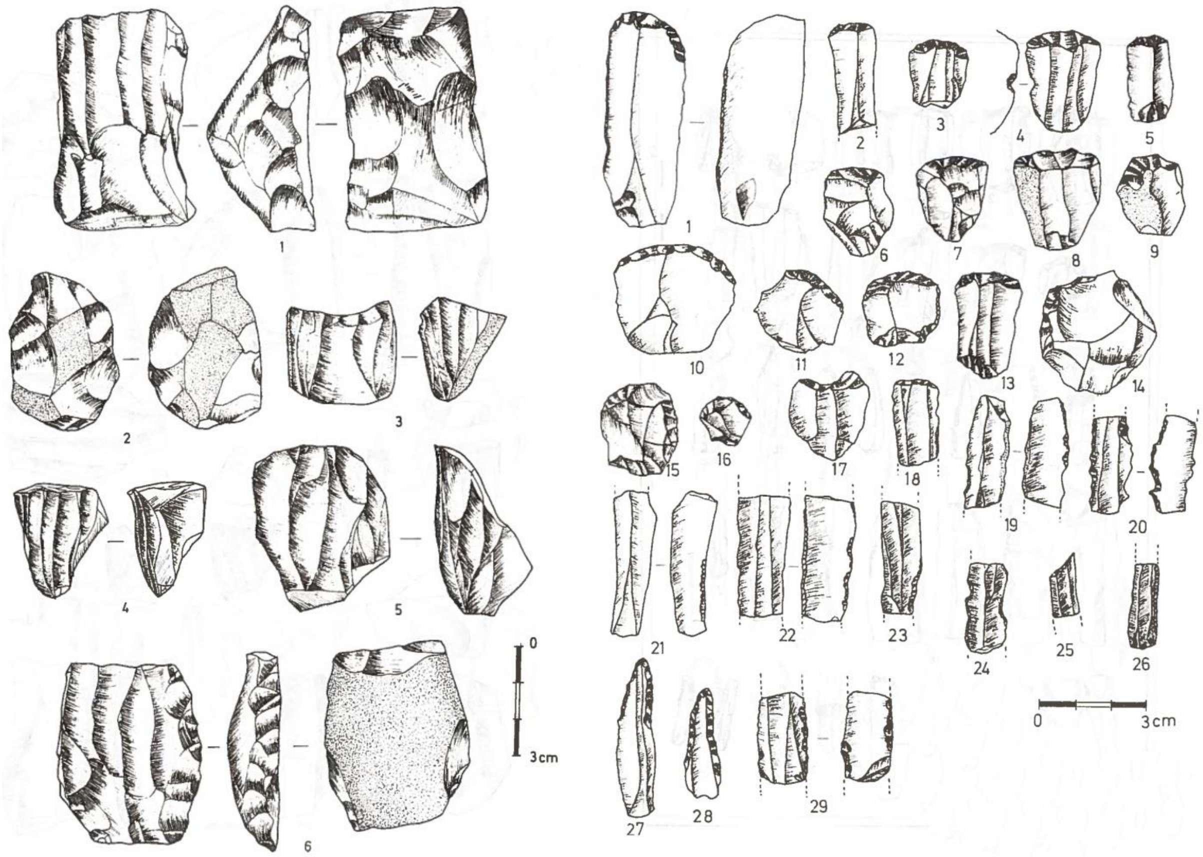
8.12. Obsidian assemblages from central Balkan sites of Gomolava, Banjica, Masinske njive, Supska, Drenovac, Slatina and Belovode



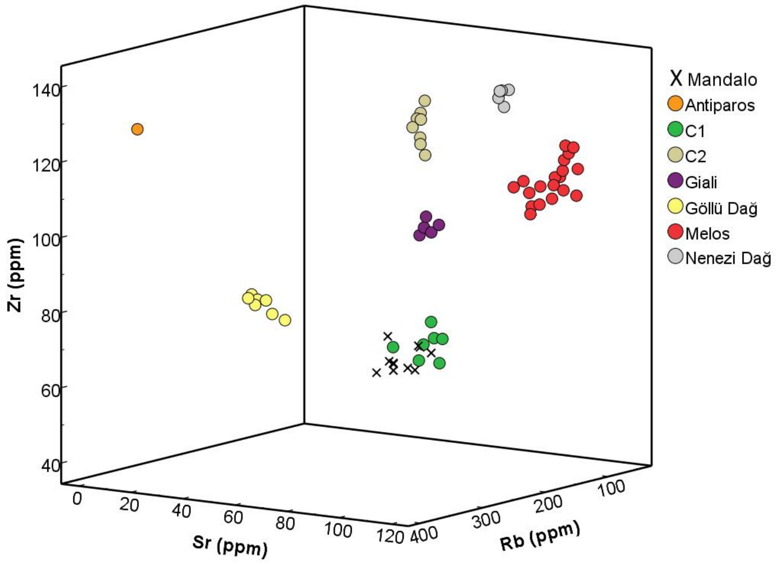
8.13. Central Balkan sites - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (sites results obtained using EDXRF technique; the work is part of an ongoing collaboration with B. Tripković)

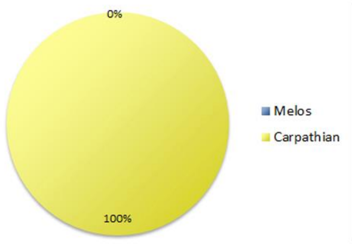


8.14. Belovode - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (analysed with pXRF). Trace elemental data is provided in Data 4 on CD



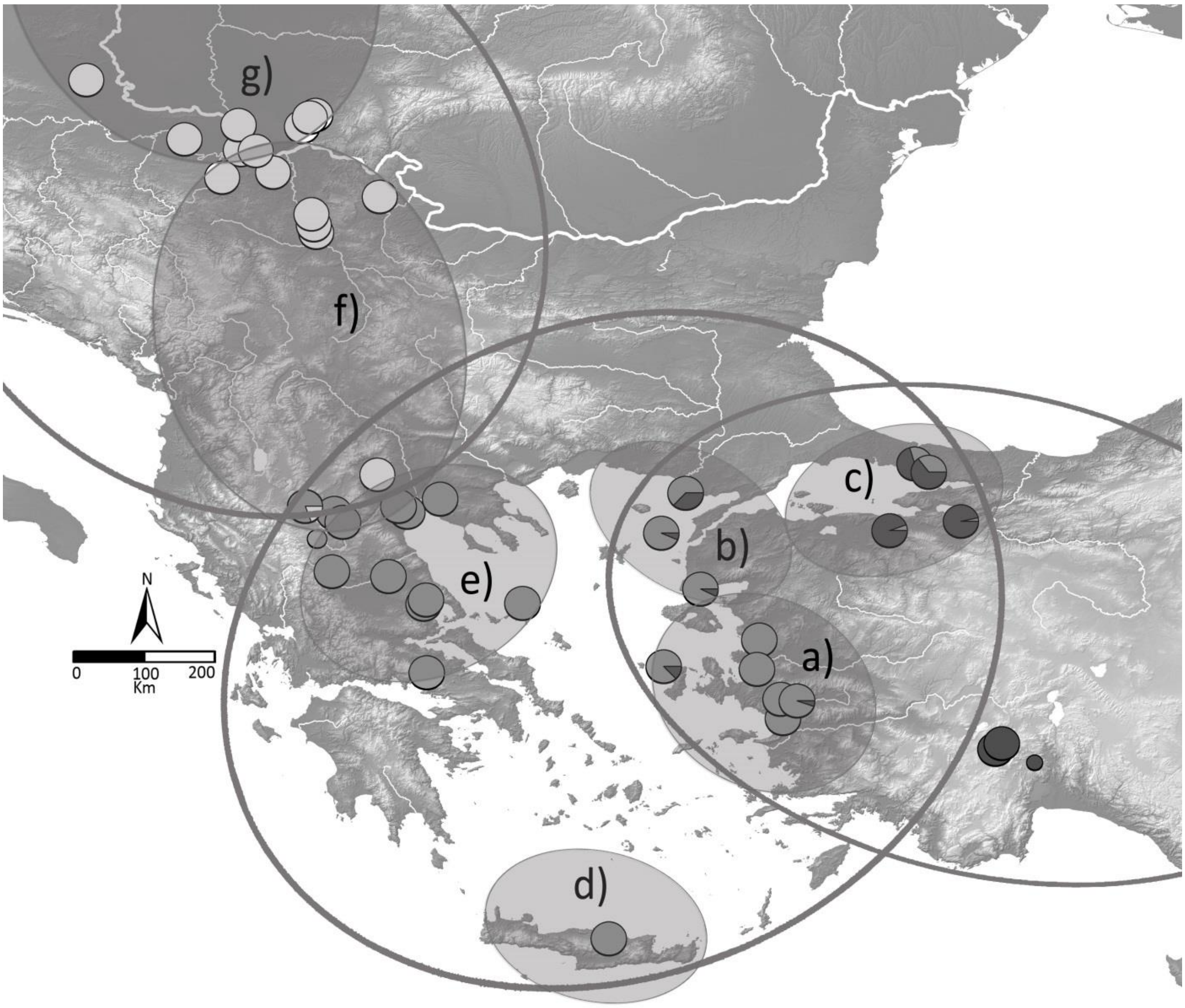
8.15. Flint cores (left) and retouched pieces (right) from Vinča-Belo Brdo (modified after Radovanović *et al.* 1984, Figs. 14 and 30)





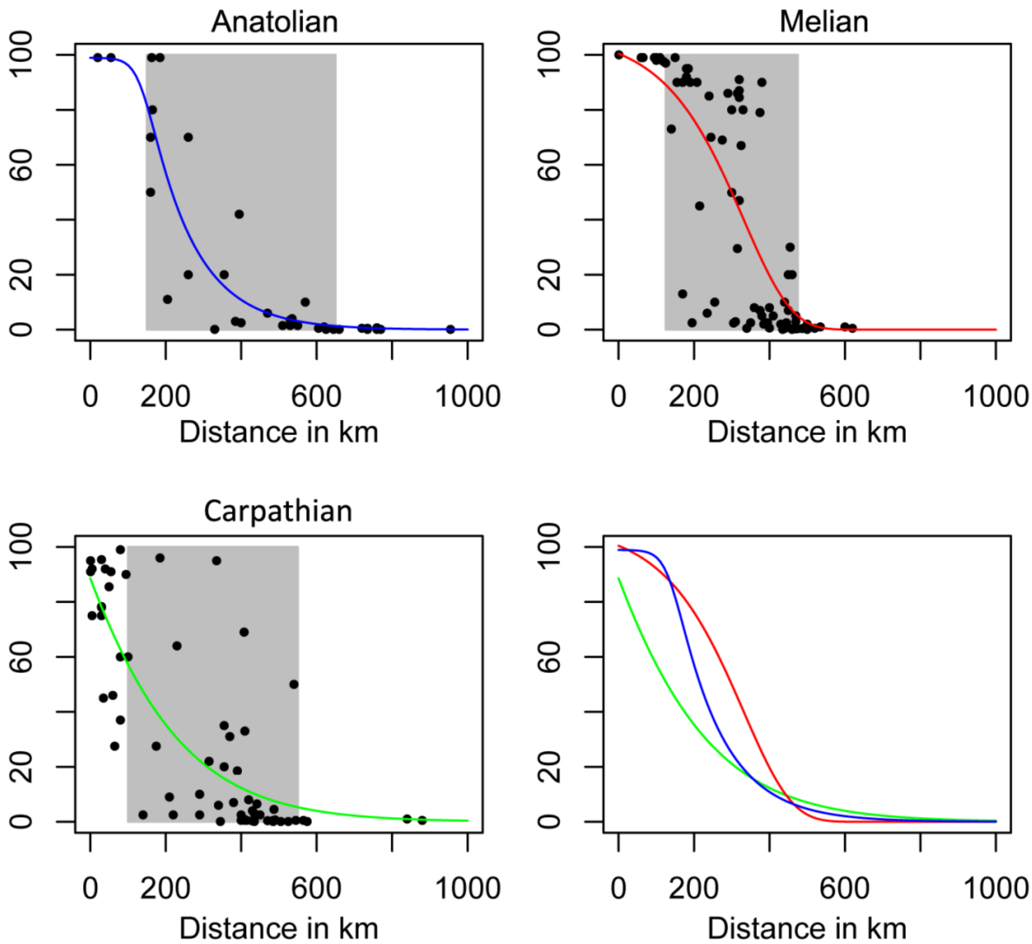
8.16. Mandalo - 3D scatter plot of Zr, Sr and Rb discriminating obsidian types (left); pie chart presenting presence of exclusively Carpathian sources (right). Trace elemental data is provided in Data 4 on CD

8.17. Obsidian assemblage from Mandalo



9.1. Map showing the proposed micro-regions of obsidian consumption (based on the quantity of obsidian present, source and technology): a) the eastern Aegean; b) the north-eastern Aegean; c) the Marmara region; d) Crete (Knossos); e) Macedonia (and Thessaly); f) the central and southern Balkans (south of the Danube); g) Southern Pannonia and north of the Danube

9.2. Obsidian from Ulucak VI (photograph by Özlem Çevik)



9.3. Fall-off curves showing the distribution of obsidian from the central Anatolian, Melian and Carpathian sources