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LATE MAGDALENIAN LITHIC TECHNOLOGICAL ORGANIZATION
AT LAPA DO PICAREIRO, CENTRAL PORTUGAL

By
Melissa Jean Holst
B.A., University of Louisville, 2013

A Thesis
Submitted to the Faculty of the
College of Arts and Sciences of the University of Louisville
in Partial Fulfillment of the Requirements
for the Degree of

Master of Arts in Anthropology

Department of Anthropology
University of Louisville
Louisville, Kentucky

May 2017

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A Thesis Approved on

March 31, 2017

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For Lana and Henry

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ABSTRACT

LATE MAGDALENIAN LITHIC TECHNOLOGICAL ORGANIZATION AT LAPA DO PICAREIRO, CENTRAL PORTUGAL

Melissa J. Holst

March 31, 2017

Lapa do Picareiro, a cave located in Portuguese Estremadura, contains continuous deposits dated to the Late Pleistocene. As one of the highest elevation Upper Paleolithic sites currently known in Portugal, questions are raised about the function of the site during this time. This thesis presents a comprehensive analysis of the lithic assemblage recovered from the Late Magdalenian layer of F/G (13,442 to 14,011 cal BP). The data generated from this study, when looked at in conjunction with the previously analyzed faunal assemblage, helps to provide a broader understanding of the site's function during the Late Magdalenian. The analysis focuses on raw material preference and use, representation of reduction phases, and typologies present in the assemblage. These data are then compared with other contemporaneous sites in the region to see what, if any, inferences can be drawn about location and site function. This is important because this work ultimately contextualizes the observed patterns found in the lithic assemblage in the broader context of the Late Magdalenian in southern Iberia.

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CHAPTER I:

INTRODUCTION AND RESEARCH OBJECTIVES

In recent years, an influx of new information has led to a better understanding of hunter-gatherer raw material use and lithic technological adaptation during the latter half of the Upper Paleolithic in the Portuguese Estremadura (Gameiro 2012, Pereira 2010, Bicho 2000). In particular, there are now 12 sites with layers radiometrically dated to the Magdalenian, a time period spanning from roughly 20 to 10 ka cal BP. The majority of those dates came from the sites of Cabeço do Porto Marinho (CPM) (Marks *et al.* 1994), Lapa do Picareiro (Bicho *et al.* 2000), Lapa do Suão (Zilhão 1997a; Haws 2003), and Lapa dos Coelhos (Almeida *et al.* 2004); This allowed for a more refined and comprehensive understanding of the Magdalenian period in Portugal (Bicho and Haws 2012). The characterization of Magdalenian lithic technology derives from detailed analysis of CPM and Lapa dos Coelhos combined with preliminary results from Picareiro and Suão (Zilhão 1997a, Bicho 2000).

Using principles adopted from Foraging Theory, the purpose of this thesis is to form inferences about Magdalenian lithic technological organization through a detailed analysis of the Late Magdalenian lithic assemblage from Lapa do Picareiro. Resulting in the introduction of this crucial site to the discussion of the

human behavior and ecodynamics in the period comprised between the end of the Last Glacial Maximum (LGM) and the Holocene.

While there had previously been some preliminary analysis done on the excavated lithic artifacts from these layers at Picareiro, it was largely limited to a basic inventory of the types of lithic artifacts present and the raw materials utilized in their production (Bicho *et al* 2006). Presently, the only detailed analysis done on the Magdalenian lithic assemblage from Picareiro was performed within the scope of an undergraduate dissertation (Mendonça 2006). Important to note also is that the analysis from these two instances were limited to artifacts recovered from excavations dating before 2010, so with the continued excavation to present, there was substantially more material that has been recovered and thus requiring analysis.

This thesis provides an in-depth analysis of the lithic materials recovered from the Late Magdalenian occupation Layer F/G from Lapa do Picareiro. The analysis focuses on raw material preference and use, representation of reduction phases, and typologies present. In doing so, this allows for the data from the assemblage to be compared to other regionally contemporaneous sites.

This data generated from this thesis, when looked at in conjunction with the analyzed faunal assemblage, allowed the previously held assumptions about the role of Picareiro during the late Magdalenian to be tested. It also allowed for the observed patterns found in the lithic assemblage to be contextualized within the broader context of the Late Magdalenian in central Iberia.

This thesis will be organized into seven additional chapters. Chapter II provides an introduction and background into the Upper Paleolithic, ultimately discussing how it is exemplified in the Portuguese archaeological record. From this point, the site of Lapa do Picareiro is introduced and the history and chronology of the site is described. Chapter III is dedicated to the establishment of the climate, paleo-environment, subsistence, and mobility during the Late Pleistocene in Portugal. This chapter helps contextualize the cause and effects of what was going on at Lapa do Picareiro. Chapter IV presents the various analyses that were conducted on the Late Magdalenian assemblage at Lapa do Picareiro in the past. Chapter V presents the methodology for this thesis research conducted on the lithic assemblage. Chapter VI is a presentation of the data collected from the analysis of the lithic assemblage. Chapter VII presents the conclusions of this work, comparisons of the assemblage to other regionally contemporaneous sites, and future opportunities for further analysis and investigation.

CHAPTER II:

BACKGROUND AND HISTORY OF INVESTIGATION

The Upper Paleolithic

Western Europe became home to the first Modern Humans roughly 35 ka cal BP, during the Aurignacian phase of the Upper Paleolithic. These peoples inhabited a variety of settings, ranging from caves to open air camps, and subsisted by exploiting an array of resources ranging from locally foraged plants, hunting large and small game animals, and even taking advantage of aquatic resources via the development of fishing practices (Sonneville-Bordes 1963). While their lithic toolkits still contained type artifacts associated with the Middle Paleolithic, such as Mousterian side scrapers, Upper Paleolithic assemblages were identified by the introduction of specialized lithic technologies, such as intense blade technologies and micro-blades, the use and development of various types of bone and antler tools, such as needles, fishing hooks, and projectiles, they wove nets and ropes out of natural fibers to be utilized in hunting endeavors, and they produced works of artistic expression in the form of figurines, cave and rock art paintings, and engravings (Ambrose 2001; Sonneville-Bordes 1963).

Most of the archaeological information from the Magdalenian is drawn from the “classical” or “type” sites in the southwest of France, between the Loire

River and the Pyrenees mountains (e.g. Le Madeleine) and Spain, primarily from Cantabria (e.g. La Riera Cave) (Straus 1996). Due to the rich depositional history of these regions, the assignment of chronological titles and typologies for most of the Paleolithic originated there (Aurignacian, Magdalenian, Azilian, etc.) (Sonneville-Bordes and Perrot 1954-1956). The Magdalenian, when compared with previous chronological time frames, is most often identified by the exhaustive exploitation of raw material, the miniaturization of the tools produced, the presence of antler and bone harpoons, and an increase in diversity within lithic assemblages, including a multitude of burins, endscrapers, points, and backed blades and bladelets (Straus 1996; Zilhão 1997a; Bicho 2000; Gameiro 2012).

Upper Paleolithic in Portugal

Interest in the Paleolithic of Estremadura in Portugal can be traced back to the early 19th century investigation conducted by Carlos Ribeiro and Joaquim Filipe Nery Delgado of the Serviços Geológicos (Bicho 1992, 2000; Zilhão 1997a; Pereira 2010; Haws 2003). The primary reason for this investigation was to establish if there was coexistence of extinct Pleistocene animals and prehistoric human populations in Portugal, as had been found in northern France (Haws 2003). As a result of this investigation, there were many archaeological sites identified and excavated, including excavations led by Manuel Heleno in the Rio Maior valley (Zilhão 1997a; Bicho 2000; Haws 2003; Pereira 2010). During this time, George Zbyszewski and Henri Breuil established the classification of the Portuguese Upper Paleolithic in the “classical” chronology utilized in the type

sites of France (Haws 2003; Pereira 2010). More recently, Anthony E. Marks and João Zilhão developed a project in the late 1990's to ultimately produce a detailed chronology for the Upper Paleolithic of Portuguese Estremadura (Bicho 2000; Marks *et al.* 1994). Ultimately, the utilization of the "classical" chronology associated with the type sites of France is still utilized today when discussing the Portuguese Upper Paleolithic. The chronology is thus defined as: Aurignacian (33,000-25,000 BP), Gravettian (25,000-22,000 BP), Solutrean (22,000-17,000 BP), and Magdalenian (17,000-10,000 BP) (Haws 2003; Straus 1996; Zilhão 1997a).

Portuguese Estremadura and the Magdalenian Period

The Portuguese Estremadura encompasses the central coastal portion of Portugal bordered on the north by the Mondego River basin, on the south by the Tejo River basin, on the east by the mountainous Serra da Estrela, and stretching all the way to the Atlantic Ocean on the west (Haws 2003). This region is home to the Serra d'Aire limestone massif that rises to 650m above sea level, marked by karstic caves and shrubby vegetative cover; the rest of the region consists of sporadic mountainous rises surrounded by plains and valleys (Haws 2003). The landscape is heavily cultivated with olive, fruit, and eucalyptus trees, resulting in the exposure of open air Paleolithic sites due to deep plowing (Haws 2003). Outside of anthropogenic activities, Estremadura has also been shaped by eustatic and climactic fluctuations along with tectonic and karstic processes (Marks *et al.* 1994).

During the Upper Paleolithic, this region possessed many desirable ecological traits for prehistoric humans. Primarily that the region was largely dominated by Mediterranean plant species with some Atlantic species, making it an ideal home of many large and small game species, and it possessed locally available high quality chert sources (See Matias 2012 for in depth discussion of chert sources; Pereira *et al.* 2015; Zilhão 1997a, Haws 2003, Marks *et al.* 1994).

The Magdalenian Lithic Assemblages of Estremadura

The Magdalenian was once considered to be an identifiable and homogeneous culture across the whole of Europe; however the concept is now utilized more as a chronological definer than as being representative of a cultural group (Zilhão 1997a; Gameiro 2012; Bicho 2000; Bicho and Haws 2012). The Magdalenian in Portugal for example, possesses many temporal, typological, and technological variations when compared with the more traditional core sites of Southwestern France and Northern Spain from the same time frame (Zilhão 1997a; Marks *et al.* 1994; Bicho 2000; Bicho *et al.* 2012; Bicho and Haws 2012). Despite these differences being well known in the archeological community, the term Magdalenian is still dominantly utilized in the literature thus, the traditional chronological definers established for the Portuguese Upper Paleolithic by Zbyszewski and Breuil will also still be utilized in this work for continuity.

In Estremadura, there are four sub-phases of the Magdalenian identifiable within the region: the Early Magdalenian dating between 20 and 18 ka cal BP, the Middle Magdalenian dating between 18 and 15 ka cal BP, the Late Magdalenian dating between 15 and 12 ka cal BP, and the Terminal

Magdalenian dating between 12 and 10 ka cal BP (Zilhão 1997a; Gameiro 2012). Technologically the Magdalenian in Portugal is marked by a lack of bifacial technology and a decrease in overall tool size, while typologically it is marked by an increase in backed bladelets and micropoints, but is mostly comprised of non-retouched flake blanks (Zilhão 1997a; Gameiro 2012; Marks et al. 1996; Bicho 2000; Bicho and Haws 2012; Bicho *et al.* 2011).

More specifically, the Early and Middle Magdalenian in Portugal can generally be identified by a lower frequency of chert, and a higher frequency of quartz and quartzite (Gameiro 2012; Bicho and Haws 2012). The flakes produced during this time commonly possess unfaceted platforms (with large amounts being cortical), have triangular cross sections, and are randomly shaped; the bladelets most commonly have feathered and converging terminations (but are rarely pointed) and unfaceted platforms (Bicho and Haws 2012). The Late and Terminal Magdalenian can generally be identified by an increase in utilization of chert, and a general decrease in use of quartz and quartzite (Gameiro 2012; Zilhão 1997a; Bicho and Haws 2012). The flakes produced during this time possess unfaceted or faceted platforms (cortical platforms becoming relatively uncommon), have triangular and flat cross sections, and vary in their shapes; bladelets become more common and frequently possess feathered terminations (however hinged and plunging terminations are also common) (Gameiro 2012; Zilhão 1997a; Bicho and Haws 2012).

Despite the differential fluctuation in representative use during the different stages of the Magdalenian, the utilization of multiple types of raw material is nonetheless very common and consistent throughout this time period in Portugal (Gameiro 2012; Pereira 2010; Zilhão 1997a). Throughout the literature, there are two main theories on the differential utilization of raw materials throughout the Upper Paleolithic, the first being that hunter-gatherers were utilizing “low quality” raw materials to produce expedient technologies conserving the “high quality” raw materials for more intensive reduction sequences (e.g. Zilhão 1997a), the other being that raw material was selected based upon the intended use of the tool (e.g. Bicho 2000; Aubry *et al.* 2008; Almeida 2000, Pereira *et al.* 2012; see Chapter III section Raw Material Availability and Pereira 2010 for more in depth discussion).

History and Chronology of the Site

Lapa do Picareiro is a cave site in Estremadura, located near the town of Covão do Coelho in the Serra d’Aire limestone massif (39°31'48.99" N, 8°39'10.68" W). Opening on the western face of the mountain range, the cave overlooks a wide valley that lies roughly 10km south of the town of Fatima and 40km to the west of the Atlantic coast (Bicho *et al.* 2000). Sitting at roughly 570 meters above sea level, it represents the highest currently known elevation Upper Paleolithic site in central and southern Portugal (Bicho *et al.* 2011).

Interest in Picareiro can be traced back to the late 1960s, when Antonio Marques and Jorge Andrade performed a trench test of the site. This trench later proved to yield evidence of Iron Age deposits including several human burials

associated with decorated pottery (Bicho *et al.* 2000; Haws 2003). The site lay largely disregarded until João Zilhão and members of the Sociedade Torrejana de Espeleologia e Arqueologia (STEA) revisited the site in 1988 and recovered materials suggesting the potential for Upper Paleolithic deposits (Haws 2003; Zilhão 1997a). Scientific investigation of the site did not really occur again until 1994 when, as part of a larger research endeavor, Nuno Bicho tested the site and took samples resulting in the confirmation of the presence of archaeological layers corresponding to the Upper Paleolithic (Bicho *et al.* 2000; Haws 2003).

Figure 2.1: Map of the Iberian Peninsula with Lapa do Picareiro identified in the Serra d'Aire mountain range in central Portugal.

Figure 2.2: Western face of the Serra d' Aire mountain range with locations of Lapa do Picareiro indicated.

In the following year, 1995, Bicho initiated what would become a long term interdisciplinary archaeological excavation of Lapa do Picareiro (Bicho *et al.* 2000). During the systematic excavation of the site, utilizing 1m² units on an alpha-numeric grid, identifiable archaeological and faunal materials were piece-plotted. The removed sediment was then dry screened and/or water screened utilizing 4mm and 1mm mesh screens to recover any small or missed archaeological and faunal materials (Bicho *et al.* 2000; Haws 2003). The excavation ultimately revealed the presence of 19 stratigraphic layers labeled A-S; Six of those layers (D, E, F, and G) were successfully dated (Layer D: 8,300 ±120 BP, Layer E: 10,070-11,500 ±120 BP, Layer F: 11,700-12,300 BP, Layer G:

12,300 BP) (Haws 2003; for current accepted chronological dates see Appendix I). Archaeological excavation of the site resumed in 2005, under the direction of Jonathan Haws. Excavation and analysis of the site continue to the present day.

Currently, Lapa do Picareiro has been excavated to expose over 10 meters of sediment sequence spanning roughly 50,000 years with bedrock and the horizontal limits of the cave yet to be reached. The techniques utilized for excavation have been kept consistent between the two site directors. Both utilized the grid that divides the cave into 1 m² units and maintained vertical control during the excavations by following the geologic layers present, and subsequently dividing those into 5cm thick spits (Bicho *et al.* 2006). A characteristic that makes Picareiro stand out from many other contemporaneous sites in the region is its continuous depositional sequence. The sediment filling the cave is largely the result of the chemical and physical erosion of the cave itself, resulting in the deposition of clasts of various sizes and quantities relative to the climatic influences of the time (Bicho *et al.* 2006). The continued excavation has now exposed 40 deposition layers, labeled A through NN. The current excavation, while maintaining the methodology utilized by Bicho to systematically excavate the cave, is working to improve the accuracy of the piece-plotting of archaeological and faunal materials recovered during the excavation. The excavation implemented the use of an electronic total station in 2013 and currently utilizes a Sokkia CX-103 total station. The Enterprise Data Management (EDM) system, designed by Harold H. Dibble and Shannon P. McPherron and available at Oldstoneage.com, is used to organize data

collection. It was specifically designed for the organization of piece plotted artifacts found at Paleolithic sites.

Figure 2.3: 2015 Excavation inside Lapa do Picareiro

Figure 2.4: Profile of Lapa do Picareiro (Provided by Jonathan Haws 2017)

Figure 2.5: Interior plan of the cave with excavated units and their correlating excavated deposits (Provided by Jonathan Haws 2017).

CHAPTER III:

CLIMATE, PALEO-ENVIRONMENT, SUBSISTENCE, AND MOBILITY DURING THE LATE PLEISTOCENE IN PORTUGAL

One major challenge that archaeologists must face when trying to understand past human societies is how their adaptive responses were shaped by changes in climate (Naughton *et al.* 2015:1). The peoples of the late Pleistocene experienced drastic and abrupt fluctuations in climatic conditions all across Europe, resulting in many adaptive responses that effected their mobility, settlement patterns, subsistence, and technological strategies (Naughton *et al.* 2015; Haws 2003). While a general typological analysis of an assemblage can provide some basic interpretations about any lithic assemblage, if you don't understand the broader context from whence it came, any meaningful information pertaining to prehistoric human behavior and adaptive responses would be lost (Thacker 1996); Thus, the need for a broad understanding of the external processes and pressures that influenced prehistoric human adaptive capabilities. Possibly the most important of which is the influence of climate and climatic events. The data available for understanding what the climate and environmental conditions were like during the late Pleistocene in Portugal is largely limited to geologic stratigraphy, deep sea cores, charcoal samples, pollen analysis, and faunal analysis (Haws 2003: 103; Naughton *et al.* 2015). It is through an

interdisciplinary analysis of this data, and the syntheses of this data regionally (e.g. Zilhão 1997a) that is ultimately conducive to understanding the conditions that elicited varying adaptive responses (Haws 2003).

Climatic events and their impact on the paleo-environment

During the late Pleistocene, there were two types of climatic events that resulted in significant impacts on Western Europe; namely the Heinrich Events (HEs) and Dansgaard-Oeschger stadials (D-O stadials). D-O stadials are cyclical climatic events that represent abrupt atmospheric changes over Greenland, consisting of oscillations between warm phases (interstadials) and cold phases (stadials); while HEs represent the southward expansion of polar waters from icebergs that broke off the Laurentide Fenno-Scandinavian ice sheet and melted as they moved southward into the North Atlantic (Fletcher and Sánchez Goñi 2008; Sánchez Goñi *et al.* 2000; NOAA 2008). These events are recorded in marine sediments as continuous layers of coarse grained sediment, referred to as Ice Rafted Detritus (IRT), and high percentages of planktonic foraminifer (*Neogloboquadrina pachyderma*) in the North Atlantic (Sánchez Goñi *et al.* 2000; Sánchez Goñi *et al.* 2008; NOAA 2008). They also are marked by abrupt cooling of sea surface temperature (SST), decrease salinity of the ocean water, and sharp increase in magnetic susceptibility (Sánchez Goñi *et al.* 2000:395).

To study these depositional layers, samples (called cores) were removed from the ocean floor by drilling with a hollow tube. This tube, as it bores down, collects the deposited sediment in its original stratigraphic sequence which can then be analyzed with its chronology still intact. Several of these marine cores

have been retrieved from the Iberian margin and studied in detail; these include MD95-2042, MD95-2040, MD03-2697, MD99-2331, SU81-18 among many others (Moreno *et al.* 2002; Salgueiro *et al.* 2014; Sánchez Goñi *et al.* 1999; Sánchez Goñi *et al.* 2008; Naughton *et al.* 2015). There are very few regions in the world that have been cored as extensively as the Iberian margin (Salgueiro *et al.* 2014: 318). Analysis of these marine cores, in conjunction with other climate-proxy data such as the Greenland ice cores, palynological studies, charcoal analysis, and faunal analysis, has allowed for the establishment of a chronology for paleo-climatic conditions in western Iberia during the late Pleistocene (Sánchez Goñi *et al.* 2000; Moreno *et al.* 2002; NOAA 2008; See table 1.1). Through the interdisciplinary analysis and comparison of these various climate-proxies it has been largely concluded that during D-O cycles and HEs, there were significant changes in terrestrial vegetation and sea surface temperatures within a range of about 150 thousand years as direct results of a climatic event (Sánchez Goñi *et al.* 2002: 104; Sánchez Goñi and d'Errico 2005). Specifically relevant to the understanding of the adaptive responses employed during the Magdalenian in central Portugal would be to look at more closely the climatic events of HE1, the Bølling-Allerød interstadial, and the Younger Dryas (see table 3.1).

HE1/Oldest Dryas occurred 17,000 to 15,000 cal BP and is initially marked by an abrupt SST cooling, roughly 8° to 10° Celsius, an increase of planktonic foraminifer, and an increase in deposition of IRD, and a large increase in magnetic susceptibility (Naughton *et al.* 2015; Salgueiro *et al.* 2014; Combourieu

Nebout *et al.* 2009). During this event, the palynological records indicate that the on the Iberian Peninsula there was a reduction in arboreal pollens and an increase in semi-desert/grassland plants (Combourieu Nebout *et al.* 2009: 511; Naughton *et al.* 2015). Despite some warming within the HE1 event, it was largely a dramatically cold climatic event. Reconstructed annual temperature and precipitation indicate extremely cold conditions (Combourieu Nebout *et al.* 2009: 513).

The Bølling-Allerød interstadial spans roughly 14,700 to 12,900 cal BP, (Salgueiro *et al.* 2014). It is characterized by a sudden and substantial increase in SST, and thus a decrease in planktonic foraminifer; this period is characterized as being the closest to current day temperatures out of all the late Pleistocene climatic fluctuations (Naughton *et al.* 2015). The palynological records indicate a massive expansion of Mediterranean/temperate plant species; however the semi-desert/grassland plants were still present but their palynological footprint decreased as the Bølling transitioned into the Allerød period being indicative of a continuous increase in temperature and moisture availability as time progressed (Naughton *et al.* 2015: 8; Combourieu Nebout *et al.* 2009: 511). During this time period, the sea level rose to roughly 40m below the current sea level resulting in the loss of about 25% of the available land in central Portugal (Haws 2003: 107).

The Younger Dryas, also referred to as Dryas III, occurred 12,500 to 11,750 cal BP (Combourieu Nebout *et al.* 2009; Salgueiro *et al.* 2014). This climatic event was characterized by a relatively significant decrease in SST (2° to 4°C) resulting in the presence of planktonic foraminifer, but there was no peak in

IRD indicating that there was no icebergs that made it to the Iberian margin of the Atlantic (Naughton et al. 2015:8). According to Combourieu Nebout et al. (2009) this period can be divided into two parts: an initial very dry and cold period followed by a more humid and cold period; this fluctuation could be the result of a shift in the hydrologic cycle among other possibilities (Combourieu Nebout et al. 2009: 514). The palynological record indicates a decrease in Mediterranean/temperate plant species and a major increase in grasses but with only minor increase semi-desert plants, being indicative of an overall cold but moist climate for Iberia (Combourieu Nebout et al. 2009: 511; Naughton et al. 2015). During this period sea level was 60m below the present level (Haws 2003:17).

Late Pleistocene mobility and subsistence

Based on pollen analysis from various marine cores taken off the coast of Iberia changes in vegetation in the Iberian Peninsula coincided with the cycle of D-O stadials and interstadials, presenting evidence for the rapid response of vegetation to the fluctuations in climatic conditions (Sánchez Goñi and d'Errico 2005; Combourieu Nebout *et al.* 2009). As generally described in the previous section, the cold episodes corresponded to the expansion of semi-desert grassland consisting largely of heather (*Calluna* and *Ericaceae* species) and juniper (*Juniperus*) and the warm episodes corresponding to expansion of Atlantic/Mediterranean forests consisting primarily of pine (*Pinus pinaster*), birch (*Betula pubescens*), and evergreen and deciduous oak (Haws 2003: 115; Sánchez Goñi and d'Errico 2005; Combourieu Nebout *et al.* 2009: 511).

Figure 3.1: Climatic events that occurred during the Late Pleistocene and the resulting signatures they left in both marine and terrestrial cores. The climatic event corresponding to layer F/G of the cave, is highlighted (Adapted from Naughton *et al.* 2015:7).

Due to the intensity of the cold conditions that accompanied the HE1/Oldest Dryas, resulting in extremely dry conditions, terrestrial game animals would have been nutritionally stressed and greatly decreased in available numbers. Thus prehistoric populations would have been forced to exploit coastal and marine resources such as shellfish, fish, and marine mammals for protein and fat (Haws 2003: 290-291). The archaeological record shows that during this event there is a major decrease in inland site habitation, some areas representing a complete hiatus (Haws 2012: 7). This shift to reliance on aquatic resources for sustenance would result in prehistoric peoples settling along the coast, but unfortunately if this is the case, with 40km of the continental shelf underwater, all evidence of this would be submerged under several meters of water (Haws 2003:107, 291).

When the climate ameliorated, entering into the Bølling-Allerød interstadial, prehistoric hunter-gatherers found themselves surrounded by a landscape lush with highly productive plants and an increase in available terrestrial game animals. Rabbit (*Oryctolagus cuniculus*), wild boar (*Sus scrofa*), and red deer (*Cervus elaphus*) were among some of the game animals available on the landscape during this period (Haws 2003). This abundance of edible resources, along with the available marine and coastal resources allowed for a more diverse and nutritional diet, resulted in healthier populations and thus population growth (Haws 2003:291). Resuming the dry summer/wet winter cycle, hunter-gatherers would have utilized coastal settlements during the dry summer months and inland cave/open air settlements during the winters (Haws 2003).

At the very end of the Pleistocene, prehistoric peoples would have experienced the Younger Dryas cooling event. This event resulted in an abrupt climatic deterioration from that of the previous Bølling-Allerød, and again there is a hiatus within the archaeological record (Haws 2012:7). However, at the end of the Younger Dryas climatic event, there was significant amelioration with the landscape largely returning to its pre-Heinrich Event 1 state. These landscapes would thus be inhabited by a variety of herbivores and vegetation would be composed of deciduous oak (*Quercus*), pine (*Pinus pinaster*), wild olive (*Olea europaea*), willow (*Salix*), and ash (*Fraxinus angustifolia*) (Haws 2003; Bicho and Haws 2012). Faunal remains indicate that rabbit (*Oryctolagus cuniculus*), red deer (*Cervus elaphus*), and horse (*Equus caballus*) were still present on the landscape with a major decrease in ibex (*Capra pyrenaica*) and a complete disappearance of chamois (*Rupicapra rupicapra*) (Bicho et al 2015)(See Table 3.1). This climatic event would have initially resulted in more reliance on coastal settlements much like during the HE1 climatic event, but as the climate ameliorated there would have been a shift back to seasonal mobility as was the case during the Bølling-Allerød.

NISP of fauna from Magdalenian levels in Picareiro

Taxon	D	E	F/G	I	J	K	L	M	N	O
Mammals										
<i>Cervus elaphus</i>	9	107	440	12	51	14	10	1	21	12
<i>Capreolus capreolus</i>										
Cervidae		71	3		2				1	2
<i>Capra ibex/pyrenaica</i>			4		4		3		3	5
<i>Rupicapra rupicapra</i>		1	1				1	1		
Capridae					1					
<i>Bos primigenius</i>		8	1	1	1					
<i>Sus scrofa</i>		26	139	5	23	1	1			
Medium ungulate	16	314	1,155	35	158	40	51	4	157	53
<i>Equus caballus</i>						1			1	
<i>Lynx pardinus</i>					2				1	4
<i>Felis sylvestris</i>										
<i>Vulpes vulpes</i>			1	1	2					
<i>Oryctolagus cuniculus</i>	17	220	17,209	353	1,313	134	106	2	122	171
<i>Lepus granatensis</i>		1	1		1					
<i>Erinaceus europaeus</i>			5		1					

Table 3.1: Number of Individual Specimens (NIS) for the Late Pleistocene layers of Lapa do Picareiro (Haws n.d.). Layer F/G correlates to the Bølling-Allerød climactic event.

Technological Adaptation and Raw Material Availability

Climatic shifts impacted prehistoric hunter-gatherers in their mobility, subsistence, and settlement patters, however it is not as commonly discussed as to how the effects of climatic events could have influenced raw material availability or stone tool technology (Pereira and Benedetti 2013:20). Foraging Theory suggests hunter gatherers' choices of technological strategies are often determined by the nature of resources available on the landscape (Bousman 1993). When trying to understand the choices made by hunter-gatherer populations, there are two factors that must first be considered: risk and stress.

Risk being the probability of economic loss, where different levels of risk relate to the structure of resources and the predictability of their availability (Bousman 1993). The concept of stress as used here is not only relating to

physical stress, but to the scarcity of resources. For example, during periods of environmental stability in a warm/humid climate with ample access to resources, risk and stress are both relatively low. During periods of full glaciation where climate is cold and arid, both stress (lack of access to ample resources) and risk (the higher probability of failure) are relatively high.

Raw materials necessary for lithic tool production can also be classified in two ways: constant, meaning available in the same place year round, or contingent, referring to seasonal availability (Bousman 1993, Pereira and Benedetti 2013). This correlation between raw material and its availability are related to decisions pertaining to subsistence and tool production strategies, thus bringing us back to Foraging Theory (Pereira and Benedetti 2013).

“All technical systems result from a design process... the designer selects from the available alternatives to create a solution to an identified problem” (Bleed 1986: 738). Thus, as stated in Foraging Theory, tool production is a result of trying to solve a problem, it is the factors surrounding that problem that shape the toolmaker’s choices. As Bleed (1986) describes, a tool should be effective, efficient, and available regardless of the production strategy employed. Meaning that it should be able to do the job it is designed for, do it with minimal ‘cost’ (in terms of material, production time, etc.), and that it should be largely available to do its job (not requiring ample amounts of continuous maintenance).

Technological production strategies can be divided into three main categories: opportunistic, maintainable, and reliable (Bousman 1993).

Opportunistic technological strategies are considered an unplanned technological

response to an unanticipated need (Bousman 1993). The other two tool production strategies are a bit more complex. Maintainable tools are typically light and easily transportable, capable of quickly being repaired or sharpened, made for utility not specificity, and can be repurposed into another tool when broken (Bousman 1993, Pereira and Benedetti 2013). Reliable tools on the other hand are typically larger and more robust, require long maintenance periods, and designed for a specific task requiring subsequent tools for other tasks (Pereira and Benedetti 2013). While these are all technological production strategies geared at effectiveness, efficiency, and availability, the decisions for the selection of one strategy over another is related directly to how the tool is intended to be utilized (Pereira *et al.* 2012a; Pereira *et al.* 2012b; Bicho 2000; Pereira 2010; Gameiro 2012; Aubry and Igreja 2013; Binford 1979). Opportunistic tools seem to correspond to domestic activities, whereas maintainable tools seem to correspond with hunting implements (Pereira and Benedetti 2013; Pereira *et al.* 2012a; Aubry *et al.* 2008; Pereira 2010; Zilhão 1997a). In order to understand technological production strategies, it is also important to understand the natural distribution of raw materials on the landscape.

Raw Material Availability

Pereira and Benedetti (2013) indicate that there are three major geologic regions within the Iberian Peninsula: “chert-poor regions dominated by siliceous Paleozoic rocks, chert-rich regions dominated by limestone, and large sedimentary basins.” With the geography of the land the way it was, water played a crucial role in the region when it came to the erosion, movement, and

deposition of raw materials across the landscape. Due to the mountainous nature of central Portugal, this allowed for a variety of hydrologic settings to exist, ultimately contributing to the fluvial transport of large quantities of raw material (Pereira and Benedetti 2013). Most of the headwaters of the major rivers are located in Central and Eastern Iberia and in their travels to the Atlantic margin, they cross through chert-rich areas before entering chert-poor ones; Thus resulting in large quantities of chert nodules along with other materials good for tool production, such as quartzite, quartz, and greywacke, to be transported across the landscape (Pereira and Benedetti 2013).

The climatic events (described in the previous section) had an impact on the contingency of raw material availability to a certain extent. During the severe cold phases of the Upper Paleolithic, the region would face extreme aridity and thus poor stream flow, resulting in a lack of karst erosion and thus a lack of sediment. Increased aridity also resulted in the carrying capacity of the stream to greatly diminish (Pereira and Benedetti 2013). During warm/humid phases, it would be quite the opposite. There would be an increased stream flow, resulting in increased karst erosion, higher carrying capacity of coarse sediment, and thus a result of a high yield of raw materials in fluvial deposits (Pereira and Benedetti 2013). This fluvial distribution of raw materials across the landscape is due largely to the Tagus River eroding the massive quartzite crests from the Vila Velha do Ródão region since the Miocene (Pereira 2010).

The main conclusion from the reviewed climatic record is that fluctuations in climate were key drivers of changes in prehistoric hunter-gatherer

adaptive strategies. Climate changes would have profoundly influenced hunter-gatherer decision making processes, not only with their subsistence and settlement patterns but also in their technological strategies; thus bringing us back to the concept of Foraging Theory. One of the goals of this thesis is to contextualize the observed patterns found in the late Magdalenian lithic assemblage from layers F/G at Lapa do Picareiro. In doing this, it will also require an understanding of the pressures and processes acting on the hunter-gatherers of the time and the choices, or adaptive responses, they employed to persist through them.

CHAPTER IV:
PREVIOUS ANALYSIS OF LITHIC MATERIALS FROM LAPA DO PICAREIRO

Work by Nuno Bicho

The preliminary analysis of the lithic materials done by Bicho *et al.* (2006) revealed interesting evidence alluding to raw material use and reduction strategy that could ultimately provide insight into the site's function and technological organization during this time. The 2006 publication presented a basic analysis and inventory of the lithic materials that had been recovered from layer F/G up to that point. The assemblage consisted of 1,954 lithic materials and was comprised primarily of the four major raw material sources, presented here as number of artifacts and respective percentage: chert (1,349 = 69.04%), quartz (353 = 18.07%), and quartzite (246 = 12.59%) (Bicho *et al.* 2006). The assemblage was then inventoried based on 10 categories: fragments (chunks), chips, complete flakes, flake fragments, complete blade and bladelets, fragments of blades and bladelets, burin spalls, crests and tablets (preparation and maintenance products), cores, and retouched tools (Bicho *et al.* 2006). From this analysis, Bicho *et al.* called attention to several interesting trends present within this collection. These trends include the high frequency of chert materials within the assemblage. This, as mentioned in the previous section, is a common trend in Late Magdalenian lithic assemblages in the Estremadura region of Portugal,

however it is interesting that trend holds true considering the location of Picareiro. The site's location emphasizes the high procurement cost of this specific raw material; its acquisition and transportation to the site would have required a large commitment of time and energy.

The next trend observed in the analysis is the issue of cores, or rather the near lack thereof. Cores are significantly under represented within the inventoried assemblage (of any raw material type), making up less than 1% of the analyzed materials (Bicho *et al.* 2006). The cores present are stated to be "of small dimensions with the flaking surface less than 2cm long", to this end of the lithic materials analyzed, they proved largely void of core preparation and maintenance products (with only 8 being identified) and cortical flakes, complete or partial, are rare (Bicho *et al.* 2006). This, as stated by Bicho *et al.*, indicates that the cores were being brought to the site nearly exhausted but already prepared for flake blank production. Bicho *et al.* (2006) argue that the representation of chips may make sense of the low representation of cores. Chips, defined as measuring less than 4mm, represent an exceptionally large portion of the assemblage, making up 77% of the analyzed materials (Bicho *et al.* 2006). This quantity and size of the chips is indicated to be typically representative of tool sharpening and retouch than from tool production and core preparation (Bicho *et al.* 2006).

To gain a further understanding of what the 2006 assemblage represented, Bicho *et al.* then looked further at the category of retouched tools. This category, which represents 121 artifacts, was further divided into 8 basic

tool classes: burins, endscrapers, truncations, retouched flakes, notches and denticulates, backed bladelets, microlithic points, and other miscellaneous retouched tools (Bicho *et al.* 2006). Of specific interest was the high number of weaponry tips (backed bladelets and microlithic points) representing over 40% of the retouched tool assemblage (Bicho *et al.* 2006). Of even greater significance was that all but one of these weaponry tips were broken with evidence of impact fractures (Bicho *et al.* 2006). This type of breakage, the researchers believe, was more the result of use during hunting than of post depositional damage (Bicho *et al.* 2006: 497). It is with all of this data and its respective interpretations that Bicho *et al.* conclude that the lithic assemblage at Picareiro was representative of a hunting and carcass processing site.

Work by Telmo Pereira

Pereira (2010) performed an analysis on the quartzite found at many Upper Paleolithic sites in Southwestern Iberia with the ultimate goal of understanding how quartzite was utilized during this time period. He looked at multiple sites across Estremadura, Alentejo, and the Algarve, including Lapa do Picareiro. Pereira's (2010) analysis of the quartzite lithic materials also included identification of any potential refits from layers D, E, F, and G from Lapa do Picareiro. Due to the focus of this thesis, only his results from layers F and G will be presented here.

Pereira (2010) found the quartzite in layer F to be dominantly represented by quartzite of very fine texture, with a low refitting rate (only 3%). The ratio of flakes (proximal and complete)/cores is 8.25/1 and 7/1 (Pereira 2010). The

quartzite cores are identified as having little to no preparation before use, and some of these display extensive exploitation (Pereira 2010). The inventory of tools found in the quartzite of layer F (2010:93) includes: Hammerstones (1), anvil (1), carinated endscraper (1), nucleiform endscraper (1), denticulates (2), notch (1), double convex right scraper (1), simple concave scraper (1), right single scraper (1), and Vale Comprido point (1). Pereira (2010) determines that had the assemblage been based on these quartzite lithic artifacts alone, they could not be definitively attributed to the Upper Paleolithic (92).

Layer G is again dominated by quartzite of very fine texture, with a small percentage of the assemblage being of fine texture (Pereira 2010:93). The ratio of flakes (proximal and complete)/cores is 38/1 and 23/1 (Pereira 2010). The only core recovered was exploited centripetally. The inventory of tools found in the quartzite of layer G (2010:94) includes: right single scraper (1), denticulate (1), and a convex single scraper (1). Pereira (2010) determined that had the assemblage been based on these quartzite lithic artifacts alone, they could not be definitively attributed to the Upper Paleolithic.

These data provided valuable insight into the value quartzite had for hunter-gatherer populations during the late Magdalenian. The raw material was widely available across the landscape and was of good fine grained quality. Hunter-gatherers developed unique strategies for its exploitation transport across the landscape, and in its intended use (Pereira 2010). While many studies focus primarily on the chert lithic artifacts, this study allows for a holistic perspective on the role of raw materials within lithic assemblages.

Work by Carolina Mendonça

The chronologic sequence at Picareiro indicates that the depositional layers correlating to the Magdalenian spans layers N through E, with the sub-phase of the Early Magdalenian occupation being represented in levels N-K and the sub-phase of the Late Magdalenian being represented by levels G-E. Level J has dates that are considered too young and therefore could be Middle or Late Magdalenian (Mendonça 2011). Level E dating between 11,980 and 13,119 cal BP, which also corresponds to the Late Magdalenian, was presented in an aggregate analysis done by Carolina Mendonça (2011). In her analysis, she found that quantitatively the assemblage is primarily chips from tool retouch and largely lacks the debitage that would indicate that there was a complete reduction sequence present at the site, thus cores must have been initially worked before being brought to Picareiro speaking to the transportation choices of the prehistoric peoples (Mendonça 2011). Retouched tools represented only 2% of the analyzed lithic assemblage, and that in conjunction with the lack of complete reduction sequence, low representation of cores, and the faunal data recovered from the cave were seen to be indicative of the site being utilized for hunting activities (Mendonça 2011). From the analyzed assemblage it was also noted in the analysis that the tools produced from quartz and quartzite were done so in an expedient manner, whereas tools produced from chert were done more conservatively. While Layer E is not the primary focus of this thesis' analysis, it is important to understand what is going on in the other layers dating to the Magdalenian to determine if there are any diachronic similarities.

CHAPTER V:

METHODOLOGY

The analysis of the assemblage took place over two separate trips to the University of Algarve in Faro, Portugal. The first trip took place in December 2015. The primary goal of this trip was to acquaint myself with the assemblage and establish a preliminary inventory. The second trip took place in June 2016 and produced comprehensive technological, morphological, and typological information. The analysis was conducted utilizing common Western European lithic technological concepts (e.g. Inizan *et al.* 1999). The assemblage, totaling 3,280 artifacts, was initially divided into general morphological artifact categories. These categories are the most common categories utilized when discussing the Portuguese Upper Paleolithic (Zilhão 1997a; Bicho 2000; Gameiro 2012; Pereira 2010). These categories were used to maintain consistency and comparability with the region so that the analysis done on this assemblage could be utilized in future comparative analyses for other regionally contemporaneous assemblages.

For this analysis, only complete artifacts and fragments possessing an intact platform were subjected to further study beyond their initial general categorization, as is consistent practice among other researchers such as Zilhão (1997a, 1997b), Bicho (2000), and Gameiro (2012).

Due to the large amount of chips (see definition below) recovered, their high percentage distorts the representation of the other artifacts within the assemblage. Consequently, in order to gain a better understanding of what is present in the assemblage, two methodological decisions were made:

- 1.) Weight for chips were not taken
- 2.) Calculations combining effective and relative quantities of artifacts were based upon the total assemblage minus chips.

TECHNOLOGICAL ANALYTIC PROCEDURE

General Analysis

All artifacts were classified by raw material and weight in grams. Exception was weight for chips as they are so light that it was not possible to make this measure with certain accuracy. All artifacts were measured in millimeters, except in the case of fragments where the dimension where the fracture occurred was not taken; for example proximal, mesial, and distal blanks where width and thickness were measured, but not length since this is the dimension where the fracture occurred.

TECHNOLOGICAL DEFINITIONS

Nodule, cobble, and pebble: nodules of raw material that are unused, meaning that they have no presence of stippling or removals.

Core: chunk of raw material that has identifiable flake scars due to its use as a source of flake blanks. Cores also possess identifiable platforms.

Cores were analyzed as so:

- Length: taken on the morphological axis;

- Width: perpendicular to the maximum length at midpoint;
- Thickness: the cross section where length and width intersect;
- Core Type: chopper, bipolar, chipped stone, multidirectional, prismatic, tested pebble/nodule, core fragment.
- Platform Type: cortical, faceted, flat, bipolar, or indeterminate (if there was no discernable platform).
- Cortex: present or absent. It was then documented in a representative percentage: None, less than 25%, 26%-50%, 51%-75%, 76%-99%, Completely Cortical.
- Dominant Flake Scar Pattern: unidirectional, bi-directional, multi-directional, or convergent.
- Dominant Scar Type: elongated, expanding, or intermediate.

Blanks: These include flakes, blades, and bladelets

- Flake: a piece of a core that has been removed and possesses a platform and complete termination. The term flake is not indicative of a specific shape or size, but merely a term used to describe a removed piece of raw material that can be used as a tool with or without being retouched.
- Flake fragment: classified as proximal, mesial, or distal. Proximal fragments lack an intact termination, but possess an intact platform and/or bulb of percussion. Distal fragments lack an intact platform,

but possess and intact termination. Mesial fragments lack both an intact platform and an intact termination.

- Blade: flake with parallel edges whose length is equal or more to twice its width but larger than 12mm wide and/or 50mm long.
- Bladelet: smaller version of a blade with its length being at least twice its width, but smaller than 12mm wide and/or 50mm long.
- Blade/bladelet fragments: classified as proximal, mesial, or distal.

Proximal fragments lack an intact termination, but possess an intact platform and/or bulb of percussion. Distal fragments lack an intact platform, but possess and intact termination. Mesial fragments lack both an intact platform and an intact termination.

Blanks were analyzed as so:

- Length: taken according to the technological axis;
- Width: taken perpendicular to length at midpoint
- Thickness: the cross section where length and width intersect.
- Platform type: plain, faceted, indeterminate, cortical, or pointed.
- Platform width
- Platform thickness
- Blank shape: circular, semi-circular, rectangular, *dejeete*, rectangular, expanding, convergent
- Blank profile: flat, curved, twisted

- Transversal cross section: triangular, trapezoidal, flat.
- Dominant flake scar pattern: unidirectional, bi-directional, multi-directional, convergent, or cortical.
- Blank termination: feather, step, hinge, or plunge.
- Cortex: present or absent. It was then documented in a representative percentage: None, less than 25%, 26%-50%, 51%-75%, 76%-99%, Completely Cortical.
- Retouch: presence or absence; it was then documented in a relative percentage: none, less than 25%, 26%-50%, 51%-75%, 76%-99%, completely retouched.
- Typology: see typological section for various types.

Debris/Possible blanks

- Burin spalls: reminiscent of bladelets however they possess a thick, often triangular, cross section. This is a result of the production strategy utilized to produce them, the burin blow reduction technique, as opposed to prismatic core reduction which produces blades and bladelets. These were analyzed following the blank criteria (see above).
- Chips: smaller than 1cm² and not possessing the previously defined traits of proximal or distal blade/bladelet fragments. While the chips in this assemblage were not analyzed beyond counting their presence within each raw material group, they are

important indicators of the reliability of the integrity of the assemblage (Zilhão 1997).

- Preparatory and maintenance products: any flake produced as a means to prepare a core for blank production or to remove flaws on a core so that it can be further utilized for blank production. These were analyzed following the blank criteria (listed above).
- Chunks: fragment of raw material that has no identifiable blank removals or presence of retouch.
- Firecrack: fragment of raw material that has no identifiable blank removals or presence of retouch but possesses the characteristics of being heat treated.

TYPOLOGICAL DEFINITIONS

The identification and defining of the specific typologies was done utilizing Sonnevile-Bordes and Perrot (1954-1956) adapted by Zilhão 1997. Definitions and interpretation were also developed through the utilization and adaptation of Andrefsky 2005, Inizan *et al* 1999, and Bicho 2000.

Domestic Utensils:

- Notch: tools that possess a delineated edge with a sharp concave indentation, sometimes v-shaped, with a small curvature radius that is created by various forms of retouch (Inizan *et al* 1999: 147).
- Denticulate: possesses at least one delineated edge that displays multiple sharp, concave indentations, sometimes v-shaped, with a

small curvature radius, in succession of one another (Inizan *et al* 1999: 138).

- Side scraper: possess at least one steeply retouched lateral edge. Typological differences are attributed to the shape and position of the retouch.
- Thin endscrapers: possess at least one retouched edge, typically along their distal end, and the retouch would be acute.
- Perforator: a type of delineation that refer to a projection outlined by two adjacent notches (Inizan *et al* 1999: 156).

Hunting Utensils:

- Backed bladelets: bladelets that possess steep retouch along at least one lateral edge. Typological differences are based upon subtle variation in retouch.

Functionally Ambiguous Utensils:

- Composite tools: possess at least two morphologically distinct retouched edges resulting in at least two distinct tool types on the artifact. They typically consist of a pairing of scrapers, burins, perforators, and/or truncations.
- Truncation: possess a line of continuous abrupt retouch along either the proximal, distal, or lateral edge of a blank. Typological differences are based upon the shape and position of the retouch.
- Burins: a French term that means engraving tool; typologically distinguished based on their overall shape, number and orientation

of burin spall scars. These scars are at least 5mm long and aligned more or less parallel to the long axis of the tool and are the result of the burin blow technique. While the burin itself can be used as a tool, they can also be categorized as cores for bladelet blank production.

Bladelet Cores:

- Thick endscrapers: possess at least one retouched edge, typically along their distal end. These endscrapers have steeply convergent retouch with laminar flake scars. They can be carinated.

CHAPTER VI:
NEW DATA ON LITHIC TECHNOLOGICAL ORGANIZATION AT LAPA DO
PICAREIRO

The primary focus of this thesis project is the Late Magdalenian layers of F/G (Figure 6.1). Excavation of this layer began in 1994 and was completed for the current excavated units within the cave in 2016. Thus, over the course of roughly 22 years, 8,205 artifacts have been piece plotted, recovered, analyzed, and curated all from Layer F/G.

In the case of this assemblage, the site's integrity is 63.9% (See Appendix II for equation). This is indicative of the integrity of four things:

- 1.) Human behavior at the cave encompassed in situ knapping;
- 2.) Site formation processes allowed the preservation of the smallest implements;
- 3.) The excavation was careful and recovery methods allowed for the collection of these small implements.

Thus, the layer F/G lithic assemblage is reliable for an accurate interpretation of the technological and typological patterns, and more importantly, of the human behavior carried out at the cave. The presentation of the summary of the analysis of this assemblage will be broken up into four sections: raw

material use, reduction sequence, productivity by raw material, and retouched tools.

Figure 6.1: Stratigraphic Sequence of the Late Magdalenian layers of Lapa do Picareiro

Layer F/G: Archaeological Context

Layer F/G dates between 13,772 and 14,011 cal BP (Haws 2003; See APPENDIX I: Site Chronology). This layer was identified in the stratigraphy as possessing loose clasts with very little sediment present (Haws 2003). The most significant feature identified in this layer was a large hearth, nicknamed ‘the bunny pit’ due to the immense amount of rabbit bone recovered, that contained a large quantity of sediment, charcoal, fragmentary and burned bones, and lithic material (Haws 2003).

From Layer F/G 3,280 lithic artifacts were recovered (See Table 6.1). The predominant raw materials are chert (69.56%), quartz (20.65%), and quartzite

(8.68%). Technologically, it is dominated by chips (#2,096 = 64.15%), flakes/flake fragments (#512 = 15.67%), elongated blanks (#444 = 13.59%), cores (#67 = 2.05%), preparatory and maintenance products (#63 = 1.92%), and hammerstones (#2 = 0.06%) that comprise the *in situ* knapping. The large amount of chips, chunks, hammerstones, anvils, and preparatory and maintenance products are indicative of *in situ* knapping and core maintenance and the pebbles/nodules indicate raw material selection.

Technological Type	Count by Raw Material				Total
	Chert	Quartz	Quartzite	Misc.	
Flakes	193	24	81	2	300
Flake fragments	143	23	48	0	214
Blades	8	0	2	0	10
Bladelets	142	4	3	0	149
Blade/bladelet fragments	192	18	7	0	217
Burin spalls	53	6	9	0	68
Prep. & maintenance	38	1	24	0	63
Cores	27	17	23	1	68
Hammerstones	0	0	2	1	3
Anvils	0	0	1	0	1
Pebbles/nodules	0	0	5	0	5
Firecracks	0	0	8	0	8
Chunks	29	10	32	7	78
Chips	1,301	535	258	2	2,096
Total	2,126	638	503	13	3,280

Table 6.1: Layer F/G assemblage inventory by raw materials

Figure 6.2: António Carvalho in 1994 exposing the large hearth nicknamed 'the bunny pit' in Layer F/G

Figure 6.3: Top of the large hearth nicknamed 'the bunny pit' in Layer F/G

Artifact Density

The artifacts recovered from Layer F/G are plotted on a plan layout of the cave (Figures 6.4 and 6.5); from these, there are interesting trends in general artifact density that can be identified, specifically in the E5, E6, and F5 units.

These three units represent the location of the large hearth nicknamed ‘the bunny pit’. It is apparent from these densities that the recovered lithic materials were all being reduced, used, and discarded within the same areas.

Figure 6.4: Relative density of raw materials in Layer F/G. Each marker is roughly equal to 10 artifacts.

Figure 6.5: Relative density of raw materials in Layer F/G. Each marker roughly represents 10 artifacts.

Layer F/G: Cores

	Chert	Quartz	Quartzite	Sandstone	Total
Count	27	17	23	1	68
%	39.70	25.00	33.82	1.47	99.99%
Weight (g)	513.54	448.75	6,543.69	285.50	7,791.48

Table 6.2: Inventory of cores by raw material

Chert

Core Type	Count	% of those in chert
Bipolar	3	11.11
Prismatic	14	51.85
Multi-directional	8	29.62
Core fragments	2	7.4
Total	27	99.98%

Table 6.3: Inventory of core types in chert

The chert cores produced bladelets mostly through prismatic reduction. This is shown by the predominance of prismatic cores with bladelet detachments (#14 = 51.85%) and corroborated by the bladelet to core production ratio [MNI of bladelets (213): cores (14)], meaning there is an average production of 15.21 bladelets per prismatic core. Chert cores were also used however to produce flakes; shown by 10 cores with expanding and/or intermediate flake scar detachments and corroborated by the flake to core production ratio [MNI of flakes (240): cores (11)], meaning there is an average production of 21.81 flakes per core with expanding and/or intermediate flake scars. The ratio between prismatic cores to those producing flakes is 1.27, meaning that for every flake there is 1.27 bladelets being produced. Nevertheless, at least some of these, along with bipolar and chunks might have represented prismatic cores that, as they reached an exhausted stage of exploitation, experienced a shift in production strategy towards flake blanks production, for a more opportunistic and expedient means producing useable cutting edges. This seems to be corroborated by the 46.11% of flakes of small size being less than 20mm in length. This is also corroborated by the low amount of cortex on the cores, as all cores have less than 50% cortex.

Quartz

Core Type	Count	% of those in quartz
Bipolar	10	58.82
Prismatic	2	11.76
Multi-directional	2	11.76
Core fragments	2	11.76
Tested pebble	1	5.88
Total	17	99.98%

Table 6.4: Inventory of core types in quartz

The quartz cores produced flakes mostly through bipolar reduction. This is shown by the predominance of bipolar cores with flake detachments (#10 = 58.82%). These cores, much like those in chert, reached a stage of exploitation that required a shift in production strategy, from bladelet production, [(MNI of bladelets (7): cores (2)] meaning there is an average production of 3.5 bladelets per prismatic core, to flake blank production, [MNI of flakes (#36): cores (#10)], meaning that there is an average production of 3.6 flakes per core, due to the need to produce cutting edges from these small cores. This seems to be corroborated by the 45.08% of small sized flakes with less than 20mm in length. This is also corroborated by the low amount of cortex, as 88.23% of the cores have less than 50% cortex.

Quartzite

Core Type	Count	% of those in quartz
Prismatic	3	13.04
Multi-directional	1	4.34
Core fragments	5	21.73
Chopper	14	60.86
Total	23	99.97%

Table 6.5: Inventory of core types in quartzite

The quartzite cores were largely used to produce flakes. These cores were reduced by the direct knapping of a water worn pebble without any

preparation; the nodules were selected based upon the possession of a naturally flat platform. These types of artifacts are traditionally called choppers. This is shown by the predominance of choppers with flake detachments (#14 = 60.86%). [MNI of flakes (#93)/cores (#14)] gives an average ratio of 6 flakes by core. Of these cores, 65.21% of them possess more than 50% cortex and 85.18% of the flakes being over 20mm in length. Bladelets were not intensively produced in this material, corroborated to the low bladelet to core ratio [MNI of bladelets (5): cores (14)].

Figure 6.6: Average core size by raw material with standard deviation

Figure 6.7: Core volume to cortical presence comparison

Figure 6.6 shows the distribution of the average size of primary raw materials cores. From this, it is shown that quartzite cores possess larger dimensions while chert and quartz are small in size. Figure 6.7 represented the volume of the cores versus their cortical representation. Looking at these two figures together, it is evident that chert and quartz were exploited in a similar manner or at the time of procurement were of similar size. The chert and quartz cores were reduced to very small dimensions with little to no cortex present, while the quartzite cores remained largely cortical, this could be due to the utility of the core itself as a tool. The variation in core size has an influence on blank size production (See Figure 6.8); quartzite flakes, much like quartzite cores, have larger dimensions than that of chert and quartz.

Figure 6.8: Average flake blank size by raw material with standard deviation

Layer F/G: Blanks

The MNI for blanks (flakes, blades, and bladelets) that make up Layer F/G represent 604 artifacts. Figure 6.9 demonstrates the relative distribution of blank types by raw material. Flakes represent the highest production rate, being present in all three raw materials.

Figure 6.9: Relative distribution of blank types

However, there is a larger relative frequency in quartz and quartzite than in chert, this is because chert was also used for intensive bladelet production. Bladelets, while being the second most produced blank type, are produced most predominantly in chert, with a small amount being produced in quartz. Blades, being the least represented blank type were produced relatively equally between chert and quartzite, but not in quartz. Thus, chert was producing bladelets and flake blanks relatively equally; quartz was producing flake blanks and some bladelets, while quartzite was used almost exclusively for flake production. Figure 6.10 displays the distribution of average flake blank size by raw material.

Figure 6.10: Distribution of average flake blank size by raw material

Looking back at figure 6.7 and then at 6.10, based upon production of blank type, volume, and representation of cortex it is discernable that quartz was treated similarly to chert. Thus, from these two figures, and from the information gathered from the cores, blanks were produced through intensive reduction on chert and quartz, and less intensively on quartzite.

Figure 6.11: Average blade and bladelet size distribution by raw material with standard deviation

Figure 6.11 demonstrates the variation in average size variation between blades and bladelets. This type of variation is indicative of two different categories of elongated blanks, thus reaffirming that there is indeed blade and bladelets being produced at the site.

Looking at the dimensions of the elongated blanks (Figures 6.12, 6.13, and 6.14), it can be determined if there is one or more production strategies employed in their production. First (Figure 6.12), is that of quartzite. The histogram demonstrates a elongate unimodal curve, indicating that there is only one group of elongated quartzite blanks being produced. Second, (Figure 6.13) is quartz blanks. The histogram clearly demonstrates a pronounced unimodal curve, again indicating that there is only one group of elongated blank types being produced. Finally (Figure 6.14) represents chert elongated blanks. This histogram, demonstrates an elongated unimodal curve with a significant peak that suggests there may be two production groups of elongated blanks, one larger than the other, but still within the standard bladelet threshold of 12mm.

Figure 6.12: Frequency of elongated quartzite blanks

Figure 6.13: Frequency of elongated quartz blanks

Figure 6.14: Frequency of elongated chert blanks

Layer F/G: Burin Spalls

		Chert	Quartz	Quartzite	Total
Platform Type	Pointed	1	0	0	1
	Plain	27	2	3	32
	Faceted	21	4	6	31
	Indeterminate	4	0	0	4
Dorsal Scar Pattern	Unidirectional	53	6	9	68
Termination	Feather	38	1	8	47
	Hinge	1	0	0	1
	Step	14	5	1	20
Total		53	6	9	

Table 6.6: Inventory of burin spalls by raw material

The 68 burin spalls were produced on chert (#53 = 77.94% = 20.82g), quartz (#6 = 8.82% = 0.89g), and quartzite (#9 = 13.23% = 3.69g). None of the burin spalls have cortex. Taking their average dimensions in each raw material and comparing them to the same average measurements in bladelets, then end result is Figure 6.15.

Figure 6.15: Average bladelet and burin spall size distribution by raw material with standard deviation

Length and width, while being variable across the various classes, are relatively proportionate in all raw materials by artifact type. Thickness however is where they are less proportionate. Despite being smaller in length and width, the thicknesses of the burin spalls are proportionate to their longer and wider counterparts in chert. Thus, instead of being elongated and thin like the bladelets, the burin spalls are short and thick. These short, thick, multi- edged implements were ideal for use as hunting barbs (Zilhão 1997a:157). Further analysis will need to be conducted to determine if the burin spalls recovered were used via residue analysis and/or identification of impact fractures.

Layer F/G: Retouched Tools

	Chert	Quartz	Quartzite	Total by typological assignment
Backed Bladelets	76	11	0	87
Burins	48	1	0	49
Composite Tool	5	0	0	5
Denticulate	4	0	1	5
Notch	16	4	1	21
Perforator	1	1	0	2
Side Scraper	7	0	0	7
Thick Endscraper	7	1	0	8
Thin Endscraper	14	0	0	14
Truncation	11	1	1	13
Total by Raw Material	189	19	3	211

Table 6.7: Retouched tool inventory

The 211 retouched tools were produced on chert (#189 = 89.57% = 820.21g), quartz (#19 = 9.00% = 70.52g), and quartzite (#3 = 1.42% = 28.1g). The retouched tool types identified consist of backed bladelets (#87 = 41.23%), burins (#49 = 23.22%), notches (#21 = 9.95%), thin endscrapers (#13 = 6.16%), truncations (#13 = 6.16%), thick endscrapers (#8 = 3.79%), side scrapers (#7 = 3.31%), composite tools (#5 = 2.36%), denticulates (#5 = 2.36%), and a perforator (#2 = 0.94%).

Backed Bladelets

		Chert	Quartz	Quartzite	Total
Blank Type	Bladelet	40	1	0	41
	Blade/bladelet fragment	29	10	0	39
	Burin Spall	7	0	0	7
Platform Type	Pointed	4	0	0	4
	Plain	24	1	0	25
	Faceted	23	0	0	23
	Indeterminate	3	0	0	3
	Unknown	22	10	0	32
Dorsal Scar Pattern	Unidirectional	41	1	0	42
	Bidirectional	7	0	0	7
	Unknown	28	10	0	38
Termination	Feather	48	8	0	56
	Hinge	0	0	0	0
	Plunge	1	0	0	1
	Step	7	0	0	7
	Unknown	20	3	0	23
Total		76	11	0	

Table 6.8: Inventory of backed bladelets by raw material

The backed bladelet assemblage is composed 87.35% by chert and 12.64% by quartz. There were no backed bladelets found in quartzite (see Table 6.8). Of these, 47.12% are on bladelets, 8.04% on burin spalls, and 44.82% on blade/bladelet fragments. The high percentage of fragmentary implements could be the result of use and discard; however this would have to be investigated through further analysis. None of these possessed any cortex, thus these tools were detached when the core was already in an advanced stage of reduction but before being exhausted. These backed bladelets are often interpreted as hunting tips and barbs (see Table 6.9; Zilhão 1997a:157), thus it can be inferred that the site had some connection to hunting activities.

		Chert	Quartz	Quartzite	Total
Typological Designation	Microgravette (51a)	2	0	0	2
	Rectilinear Backed Bladelet (85a)	17	1	0	18
	Double backed bladelet (85d)	2	0	0	2
	Fragment of backed bladelet (85f)	25	9	0	34
	Truncated backed bladelet (86a)	8	0	0	8
	Denticulated backed bladelet (88)	1	0	0	1
	Backed bladelet w/ Notch (89)	7	1	0	7
	Dufor bladelet (90a)	3	0	0	3
	Fusifforme point (91d)	11	0	0	11
Total		76	11	0	

Table 6.9: Inventory of backed bladelet typologies

Burins

		Chert	Quartz	Quartzite	Total
Blank Type	Blade	2	0	0	2
	Blade/bladelet fragment	7	0	0	7
	Bladelet	4	0	0	4
	Burin spall	3	0	0	3
	Flake	13	1	0	14
	Flake fragment	16	0	0	16
	Prep. & maint. product	2	0	0	2
	Chunk	1	0	0	1
Platform Type	Cortical	4	0	0	4
	Plain	13	0	0	13
	Faceted	12	1	0	13
	Indeterminate	18	0	0	18
	Unknown	1	0	0	1
Dorsal Scar Pattern	Unidirectional	15	0	0	15
	Multidirectional	1	1	0	2
	Cortical	2	0	0	2
	Bidirectional	7	0	0	7
	Unknown	23	0	0	23
Termination	Feather	10	1	0	11
	Hinge	2	0	0	2
	Step	2	0	0	2
	Unknown	34	0	0	34
Total		48	1	0	

Table 6.10: Inventory of burins

The burin assemblage is composed 97.95% of chert and 2.04% by quartz. There were no burins found on quartzite (see Table 6.10), this could be due to burins being the result of barb (burin spall) production for use as hunting implements, or could be seen as evidence of those in quartzite being taken away from the site. Table 6.6 shows that there are quartzite burin spalls that were recovered from the site (none with retouch; Table 6.8), thus either the quartzite burin spalls were brought to the site, or the burins from which they were produced were removed (or yet to be recovered) from the site; this would require

further research and analysis. The burins were produced on a wide variety of debitage types, but most commonly on flake and flake fragments. 89.79% of the burins possessed no cortex, thus their blanks were likely produced when the core was in an advanced stage of reduction, but before being exhausted. These burins represent both domestic tools and cores for barb production (see Table 6.11; Zilhão 1997a:157), thus it can be inferred that the site had some connection to hunting and domestic activities.

		Chert	Quartz	Quartzite	Total
Typological designation	Burin on Truncation (19)	1	0	0	1
	Dihedral straight burin (27)	4	0	0	4
	Dihedral diverted burin (28)	4	0	0	4
	Angled dihedral burin (29)	9	0	0	9
	Angled burin on fracture (30a)	11	0	0	11
	Burin on straight truncation (34)	3	1	0	4
	Burin on oblique truncation (35)	4	0	0	4
	Burin on concave truncation (36)	1	0	0	1
	Burin on convex truncation (37)	3	0	0	3
	Transversal burin on lateral truncation (38)	3	0	0	3
	Transversal burin on notch (39)	3	0	0	3
	Multiple burins on truncation (40)	1	0	0	1
	Bassaler burin (44b)	1	0	0	1
Total		48	1	0	

Table 6.11: Inventory of burin typologies

Composite tools

		Chert	Quartz	Quartzite	Total
Blank Type	Blade	1	0	0	1
	Blade/bladelet fragment	1	0	0	1
	Flake	2	0	0	2
	Flake fragment	1	0	0	1
Platform Type	Cortical	1	0	0	1
	Faceted	1	0	0	1
	Indeterminate	1	0	0	1
	Unknown	2	0	0	2
Dorsal Scar Pattern	Unidirectional	1	0	0	1
	Bidirectional	2	0	0	2
	Unknown	2	0	0	2
Termination	Unknown	5	0	0	5
Total		5	0	0	

Table 6.12: Inventory of composite tools

The composite tools are all endscraper-burins made on chert. This combination could be the result of three scenarios: 1.) that they were both utilized for their capabilities as domestic tools, 2.) that both tool types were the result of barb production for hunting implements, or 3.) that while they could have produced barbs for hunting implements, they were also utilized for domestic activities. 80% of these tools were found to have no cortex, indicating that their blanks were produced when the core was in an advanced stage of reduction, but before being exhausted (see figure 6.13; Zilhão 1997a:157).

		Chert	Quartz	Quartzite	Total
Typological designation	Burin and endscraper (17)	5	0	0	5
Total		5	0	0	

Table 6.13: Inventory of composite tool typologies

Denticulates

		Chert	Quartz	Quartzite	Total
Blank Type	Bladelet	1	0	0	1
	Flake	3	0	0	3
	Flake fragment	0	0	1	1
Platform Type	Cortical	1	0	0	1
	Faceted	1	0	0	1
	Plain	2	0	0	2
	Unknown	0	0	1	1
Dorsal Scar Pattern	Multidirectional	1	0	0	1
	Bidirectional	1	0	0	1
	Unknown	2	0	1	3
Termination	Unknown	2	0	1	3
	Plunge	1	0	0	1
	Hinge	1	0	0	1
Total		4	0	1	

Table 6.14: Inventory of denticulates

The denticulate class is comprised 80% of chert artifacts and 20% of quartzite artifacts. There were no quartz denticulates identified within the assemblage (see Table 6.14). All of these artifacts possess less than 50% cortical coverage indicating that they are at an advanced stage of reduction. These tools were primarily produced on complete blanks indicating that they were either the intended initial product or the result of modification on an otherwise exhausted blank. These tools are typically associated with domestic activities (see Table 6.15; Zilhão 1997a:157).

		Chert	Quartz	Quartzite	Total
Typological designation	Denticulate (75)	4	0	1	5
Total		4	0	1	

Table 6.15: Inventory of denticulate typology

Notches

		Chert	Quartz	Quartzite	Total
Blank Type	Blade/bladelet fragment	1	0	0	1
	Bladelet	2	0	0	2
	Flake	4	1	1	6
	Flake fragment	6	3	0	9
	Prep. & maint. Product	3	0	0	3
Platform Type	Cortical	0	0	1	1
	Faceted	1	2	0	3
	Plain	9	1	0	10
	Unknown	6	1	0	7
Dorsal Scar Pattern	Multidirectional	4	1	0	5
	Bidirectional	3	0	0	3
	Unknown	6	0	0	6
	Unidirectional	2	1	1	5
	Cortical	1	0	0	1
Termination	Unknown	7	3	0	10
	Feather	7	1	1	9
	Plunge	1	0	0	1
	Step	1	0	0	1
Total		16	4	1	

Table 6.16: Inventory of notches

The notches are 76.19% chert, 19.04% quartz, and 4.76% quartzite (see Table 6.16). 76.19% were found to possess no cortex, meaning that the majority of their blanks were reduced when the core was in an advanced stage of reduction, but before being exhausted. This is corroborated by 47.61% of these tools being produced on fragments of blanks, indicating that these tools were modified from previously broken/exhausted blanks. These tools are associated with domestic activities (see Table 6.17; Zilhão 1997a:157).

		Chert	Quartz	Quartzite	Total
Typological designation	Notch (74)	16	4	1	21
Total		16	4	1	

Table 6.17: Inventory of notch typology

Perforators

		Chert	Quartz	Quartzite	Total
Blank Type	Blade/bladelet fragment	1	0	0	1
	Flake	0	1	0	1
Platform Type	Cortical	0	1	0	1
	Faceted	1	0	0	1
Dorsal Scar Pattern	Bidirectional	1	0	0	1
	Cortical	0	1	0	1
Termination	Unknown	0	1	0	1
	Feather	1	0	0	1
Total		1	1	0	

Table 6.18: Inventory of perforators

The perforators are made from chert and quartz. They both possess less than 50% cortical coverage indicating that their blanks were produced when the core was in an advanced stage of reduction, but before being exhausted. These tools are associated with domestic activities (see Table 6.19; Zilhão 1997a:157).

		Chert	Quartz	Quartzite	Total
Typological designation	Perforator (73)	1	1	0	2
Total		1	1	0	

Table 6.19: Inventory of perforator typology

Side Scrapers

		Chert	Quartz	Quartzite	Total
Blank Type	Blade/bladelet fragment	1	0	0	1
	Flake	3	0	0	3
	Flake fragment	2	0	0	2
	Burin spall	1	0	0	1
Platform Type	Cortical	1	0	0	1
	Unknown	1	0	0	1
	Plain	1	0	0	1
	Faceted	3	0	0	3
Dorsal Scar Pattern	Unidirectional	3	0	0	3
	Cortical	1	0	0	1
	Unknown	3	0	0	3
Termination	Unknown	6	0	0	6
	Feather	1	0	0	1
Total		7	0	0	

Table 6.20: Inventory of side scrapers

All of the side scrapers were produced from chert. 85.71% of these artifacts possessed less than 50% cortex, indicating their blanks were produced when the core was in an advanced stage of reduction, but before being exhausted. These tools are associated with domestic activities (see Table 6.21; Zilhão 1997a:157).

		Chert	Quartz	Quartzite	Total
Typological designation	Side Scraper (77)	7	0	0	7
Total		7	0	0	

Table 6.21: Inventory of side scraper typology

End Scrapers

Endscrapers are divided between thick and thin; thick can be associated with being cores to produce bladelets, often with twisted profiles, and thin being associated with domestic tasks (Zilhão 1997a:157).

		Chert	Quartz	Quartzite	Total
Blank Type	Bladelet	2	0	0	2
	Flake	3	0	0	3
	Flake fragment	1	1	0	2
	Prep. & maint. Product	1	0	0	1
Platform Type	Faceted	2	0	0	2
	Unknown	1	1	0	2
	Plain	4	0	0	4
Dorsal Scar Pattern	Unidirectional	1	0	0	1
	Bidirectional	3	0	0	3
	Cortical	1	0	0	1
	Convergent	1	0	0	1
	Unknown	1	1	0	2
Termination	Unknown	4	1	0	5
	Feather	2	0	0	2
	Hinge	1	0	0	1
Total		7	1	0	

Table 6.22: Inventory of thick endscrapers

The thick endscrapers are 87.5% chert and 12.5% quartz; none were found to be produced on quartzite (see Table 6.22). Thick endscrapers were found to be used as bladelet cores in the Portuguese Upper Paleolithic; this production results in bladelets with twisted profiles (Zilhão 1997; Almeida 2000). In the assemblage, we have 25 bladelets (chert =#24, quartz = #1) that possess twisted profiles that are indicative of being produced from utilizing thick endscrapers as cores. As there were no quartzite thick endscrapers, there were also no bladelets with twisted profiles in quartzite. This demonstrated that these tools were utilized in one of two potential manners: 1.) purely as cores for

bladelets or 2.) as cores for bladelets and as domestic tools themselves (see Table 6.23; Zilhão 1997a:157). However, this would require further investigation through refitting and usewear analysis.

		Chert	Quartz	Quartzite	Total
Typological designation	Scraper on blade (8)	1	0	0	1
	Carinated Endscraper (11)	3	0	0	3
	Atypical carinated endscraper (12)	1	0	0	1
	Thick scraper (13)	1	1	0	2
	Nucleiform scraper (15)	1	0	0	1
Total		7	1	0	

Table 6.23: Inventory of thick endscraper typologies

		Chert	Quartz	Quartzite	Total
Blank Type	Bladelet	4	0	0	4
	Blade/bladelet fragment	3	0	0	3
	Flake	4	0	0	4
	Flake fragment	3	0	0	3
Platform Type	Faceted	3	0	0	3
	Unknown	9	0	0	9
	Plain	2	0	0	2
Dorsal Scar Pattern	Unidirectional	6	0	0	6
	Bidirectional	1	0	0	1
	Unknown	7	0	0	7
Termination	Unknown	14	0	0	14
Total		14	0	0	

Table 6.24: Inventory of thin endscrapers

All of the thin endscrapers are produced from chert. 78.57% possess no cortex, indicating that they are at an advanced stage of reduction; this is further corroborated by 42.85% of these being represented on fragments of blanks indicating that these tools were produced from previously broken/exhausted

blanks. These tools are associated with domestic activities (see Table 6.25; Zilhão 1997a:157).

		Chert	Quartz	Quartzite	Total
Typological designation	Simple scraper on end of bladelet (1a)	4	0	0	4
	Simple scraper on end of flake (1b)	1	0	0	1
	Atypical scraper on end of flake (2b)	4	0	0	4
	Scraper on end of retouched bladelet (5a)	2	0	0	2
	Scraper on flake (8)	1	0	0	1
	Unguiforme scraper (10)	2	0	0	2
Total		14	0	0	

Table 6.25: Inventory of thin endscraper typologies

Truncations

		Chert	Quartz	Quartzite	Total
Blank Type	Bladelet	5	0	0	5
	Blade/bladelet fragment	3	0	0	3
	Flake	3	0	1	3
	Flake fragment	0	1	0	1
Platform Type	Faceted	5	0	0	5
	Unknown	2	0	0	2
	Indeterminate	2	1	0	3
	Plain	2	0	1	3
Dorsal Scar Pattern	Unidirectional	5	0	0	5
	Cortical	0	0	1	1
	Bidirectional	4	0	0	4
	Unknown	2	1	0	3
Termination	Unknown	11	1	1	13
Total		11	1	1	

Table 6.26: Inventory of truncations

The truncations are 84.61% chert, 7.69% quartz, and 7.69% quartzite (see Table 6.26). 92.30% were found to possess no cortex, thus the majority of these artifacts were their blanks were produced when the core was in an advanced

stage of reduction, but before being exhausted. 30.76% of these tools are produced on fragments of blanks, indicating that these tools were modified from previously broken/exhausted blanks. These tools are associated with hunting activities (see Table 6.27; Zilhão 1997a:157).

		Chert	Quartz	Quartzite	Total
Typological designation	Truncation on bladelet (60)	6	0	0	6
	Oblique truncation on bladelet (61)	4	0	0	4
	Bi-truncated bladelet (64a)	1	0	0	1
	Concave truncation on bladelet or flake (62)	0	1	1	2
Total		11	1	1	

Table 6.27: Inventory of truncation typologies

CHAPTER VII:
DISCUSSION, CONCLUSIONS, AND FUTURE RESEARCH OPPORTUNITIES

Analysis Interpretation

This analysis of the lithic assemblage from Layer F/G at Lapa do Picareiro presented in the previous chapter will be utilized to interpret raw material economy, lithic economy, and site function during the late Magdalenian. Lapa do Picareiro's lithic data will then be compared with other regionally contemporaneous collections to determine similarities and differences between the sites.

Raw Material and Lithic Economy

	Number of artifacts	Weight (g)	% of assemblage
Chert	2,126	2,625.97	64.81
Quartz	638	782.03	19.45
Quartzite	503	13,664.74	15.33
Miscellaneous	13	987.26	0.39
Total	3,280	18,060g	99.98%

Table 7.1: Assemblage represented by number, weight, and percent representation

The Layer F/G assemblage weighs 18,060g ($\approx$ 39.82 lbs.); excluding chips (See Chapter IV, this volume). Of that, chert makes up 2,625.97g (5.79 lbs.) representing 14.54% of the assemblage; quartz represents 782.03g ($\approx$ 1.72 lbs.) or 4.33% of the assemblage; quartzite represents 13,664.74g ($\approx$ 30.13 lbs.) or 75.66% of the assemblage; While the remainder of the raw materials make up

987.26g ($\approx$ 2.18 lbs.) or 5.46% of the assemblage and is composed of limestone (#7 = 667g), sandstone (#1 = 287.50g), schist (#1 = 27.70g), basalt (#1 = 3.70g), and rock crystal (#3 = 1.36g). Chert far out numbers quartz and quartzite in terms of number of artifacts, however quartzite far out weights chert, quartz, and the miscellaneous raw materials (See Figure 7.1 and Figure 7.2).

Figure 7.1: Raw material distribution by number less chips

Figure 7.2: Raw material distribution by weight less chips

	# of Artifacts	# of retouched tools
Chert	825	189
Quartz	103	19
Quartzite	245	3
Total	1184	211

Table 7.2: Raw material representation by number of artifacts (less chips) and number of retouched tools

These raw materials were brought to the site with preliminary testing and/or preparation, as 92.98% (#1,101) of the assemblage has less than 50% cortex present. Further corroborating this is the size of the artifacts recovered from the site. The assemblage (less chips) consists of small sized artifacts, 91.65% smaller than 40mm long, and 18.9% less than 20mm long; the largest artifact (not including cores) is a quartzite flake measuring 91.34mm long. Preliminary preparation of the cores before being brought to Picareiro could have

played a role in the size of the artifacts being produced. Taking the data gathered from the previous analysis of Picareiro's lithic assemblage (see Chapter IV), it is agreed that core preparation (except in the case of quartzite) occurred prior to the cores being transported to the site (Bicho *et al.* 2006; Pereira 2010; Mendonça 2011). The role of chips, due to their size and quantity, are interpreted as resulting from tool resharpening and retouch (Bicho *et al.* 2006; Mendonça 2011); however, the analysis presented here besides confirming this it also points for the possibility of an intentional production of very small implements with cutting edges to be used as barbs, thus the need for further investigation.

Once at the site, the raw materials were subjected to different intensities of reduction. Table 7.2 show the number of artifacts for each raw material (less chips) and the number of those which are retouched. From this, 22.9% chert, 18.44% quartz, and 1.22% quartzite artifacts were retouched. The traditional functional attribution for each retouch tool indicates that, from complete artifacts to fragments, the quartzite retouched artifacts are primarily domestic tools, the quartz ones are majority fragments of hunting implements, and those on chert are hunting implements and domestic tools.

The unretouched blanks can be interpreted primarily in three ways: 1.) as blanks produced for use as tools; 2.) as blanks produced with the intent to retouch and use as tools; 3.) as blanks produced as debris from another tools production. These conjectures however would need further investigation through refitting and use wear analysis.

Discerning Site Function from the Assemblage Analysis

One of the primary objectives of this thesis is to identify site function and patterns in human behavior during the Late Magdalenian occupation of Layer F/G at Lapa do Picareiro. Zilhão (1997a: 156-157, 161; 167) provides several indices designed to evaluate the contents of a lithic assemblage to determine site function based upon identified site types in the region. Zilhão states that “the various archaeological contexts currently known in the [Portuguese] Paleolithic can be grouped into five categories” (1997a: 167). These five categories, or groups, are meant to assist in the identification of site function based upon variation within a sites lithic assemblage (1997a: 164-165, 168) (see Appendix III, this volume for detailed quantitative analysis).

The Production Index (PI) established by Zilhão (1997a:157) is meant to discern the proportion of domestic tools being produced at the site. This is calculated by taking the number of cores and comparing it to the number of retouched tools considered to be for domestic use (this is not including burins, thick endscrapers, or functionally ambiguous typological groups such as composites and truncations, nor hunting implements). For the Layer F/G assemblage, this ratio is 68 cores: 49 domestic tools. This ration demonstrates that while there are a significant amount of cores, there is also a significant amount of domestic tools (nearly ¼ the retouched tool assemblage). Thus, the site has more than just logistical activities being carried out.

The Barb Production Index (CPI) (Zilhão 1997a: 161) is a means to discern if the assemblage possesses reduction geared towards production of

logistical tools. This is done by taking the percentage of total retouched tools that are also identified as being bladelet cores (i.e. burins and thick endscrapers). There are 57 of these artifacts identified, and when compared to the total number of retouched tools (211), they represent 27.01% of the retouched tool assemblage. However, backed bladelets are removed from the equation, these core types representing 45.96% of the retouched tool assemblage. This index demonstrates the focus on bladelet production at Picareiro.

The Export Indices (IE) that Zilhão (1997a) established are utilized to help discern what was being produced and then transported from the site. IE1 is calculated by establishing a ratio between the number of prismatic cores and the minimum number of bladelets (including complete and proximal fragments of bladelets). For Layer F/G, this ratio is 19:225. The high ratio of bladelets to the small ratio of cores is indicative of intensive bladelet production. IE2 is the percentage of blades with no cortex and a trapezoidal cross section present in the retouched tool assemblage. For Layer F/G this is 1.89%. This is representative of a very low incidence of blades at the site, thus bladelets were the intended product, the cores were of small volume resulting in bladelets, or the blades were exported from the site. The cores, as discussed in Chapter VI, were brought to the site in a stage of preliminary reduction, thus lending to the possibility that core size could have played a role, but since the other contemporaneous sites also possess such a low representation of blades, it could be inferred that it was an intended (cultural) choice to produce bladelets instead of blades.

The Logistical Activity Indices (IAL) looks at the ratio of retouched tools associated with hunting (backed bladelets) to those raw materials associated with domestic activities (not including composites and truncations due to their ambiguous use, or burins and thick endscrapers due to their use as bladelet cores). Of the two indices, ILA2 is utilized because it applies to the typology of the Magdalenian. For Layer F/G this ratio is 87 backed bladelets: 49 domestic tools. Despite being of relatively high value, this ratio demonstrates that there is not a monopoly one way or another towards production being logistically or residentially focused.

How will applying these indices allude to as to the function of Lapa do Picareiro during the late Magdalenian? The Indices produce a means by which to take the data that was just produced and then equate them to a certain site type. As stated previously, Zilhão (1997a: 164-165, 168) established five identifiable site types in the Portuguese Upper Paleolithic; which are: Group 1: Quarries, Group 2: Residential camps, Group 3: Temporary hunting camps, Group 4: Cache, and Group 5: Episodic specialized hunting camps. After evaluating the requirements for attributing a site to one of the groups, it was determined that Lapa do Picareiro fits the attributes of Group 3: Temporary hunting camp and Group 5: Episodic specialized hunting camp.

Group 3 is defined as being a temporary hunting camp, with both logistical and domestic tools present. The raw materials utilized to produce the majority of the retouched tools would have been brought to the site, while those of largely domestic nature would have been procured from relatively local raw materials

(quartz and quartzite). This group is differentiated from Group 2, residential/base camps, by possessing a high value in the Logistical Activities Index (IAL2; see above).

Group 5 is defined as having many of the same characteristics as Group 3, however the tools attributed to hunting activities are not predominantly made from imported raw materials (chert) but also from locally available raw materials (quartz and quartzite). Group 5 also possesses a characteristic often assigned to Group 4, that being a high CPI index. Which, as stated above, Lapa do Picareiro possesses a relatively high CPI percentage.

So what does this mean as far as site function? Following these indexes and groups that are traditionally considered in the paleoethnographic of the Portuguese Paleolithic, it means that Lapa do Picareiro seems to have been utilized during the late Magdalenian as a temporary hunting camp, but also for specialized hunting expeditions. They could be one in the same, or they could represent different events. The tools recovered from the assemblage are indicative of hunting and processing of game animals. The domestic tools are those traditionally associated with animal processing. When we look at the faunal data from Lapa do Picareiro (Haws n.d.; see Table 3.1), it is evident that the primary game being hunted were red deer (*Cervus elaphus*), wild boar (*Sus scrofa*), and rabbit (*Oryctolagus cuniculus*). Further investigation and analysis of the distribution of the lithic assemblage, faunal assemblage, and features identified within the site would provide a unique insight into whether there is any distribution synchrony.

Almeida (2004) hypothesizes that Lapa dos Coelhos and Lapa do Picareiro could potentially be sites occupied by individuals associated with the same nomadic group. The climatic changes that occurred during the YD and the resulting fluctuation in animal migrations across the landscape could have potentially resulted in the oscillation between the sites being habituated (Foraging Theory). However, to establish this hypothesis, further research beyond the scope of this Master's thesis would need to be done.

Regional Site Comparisons

There has been an influx of new information over the past several years, and it has led to a better understanding of hunter-gatherer raw material use and lithic technological adaptation during the latter half of the Upper Paleolithic in the Portuguese Estremadura (Gameiro 2012, Pereira 2010, Bicho 2000). There are now 12 sites with layers radiometrically dated to the Magdalenian (roughly 20 to 10 ka cal BP). Most of these dates were obtained from the sites of Cabeço do Porto Marinho (CPM) (Marks *et al.* 1994), Lapa do Picareiro (Bicho *et al.* 2000; See Appendix I this volume), Lapa do Suão (Zilhão 1997a; Haws 2003), and Lapa dos Coelhos (Almeida *et al.* 2004); All of which have had at least preliminary analysis of their lithic materials dating to this period analyzed. Now with the data acquired from the analysis of the late Magdalenian layer of F/G from Lapa do Picareiro, it too can be introduced into the discussion about regional human behavior and ecodynamics at the end of the Pleistocene. This can be done by comparing assemblages that are contemporaneous with one another. In the case of Estremadura, the majority of the data on Magdalenian

lithic technology is derived from CPM and Lapa dos Coelhos (Zilhão 1997a, Bicho 2000). Thus, these two sites make for good comparative collections with Picareiro because they possess similar occupational time scales, CPM and Coelhos have both under gone thorough analysis and thus have been well situated within the chronologically defined Magdalenian in central Portugal, and they are all in located within the same region (See Figures 7.3, 7.4, and 7.5).

Figure 7.3: Location of CPM in relation to Coelhos and Picareiro. Elevation indicated in bottom of image.

Figure 7.4: Location of Coelho's in relation to CPM and Picareiro. Elevation indicated in bottom of image.

Figure 7.5: Location of Picareiro in relation to Coelho's and CPM. Elevation indicated in bottom of image.

Figure 7.6 and Table 7.6 provide a general comparison of blank type, core, and retouched tool representations from each of the sites. Looking at the ratios displayed in Table 7.6 several trends can be identified. For example, there was very little emphasis on blade production at all of the sites, which is typical in the Portuguese Magdalenian. Another example is that Picareiro and Coelhos possess very similar bladelet to retouched tool ratios, whereas CPM possesses far more retouched tools than bladelets indicated by the same bladelet to retouched tool ratio.

Figure 7.6: Inter-site comparison between Lapa do Picareiro, Cabeço de Porto Marinho (CPM) I Upper, CPM II Upper, and Lapa dos Coelhos (Zilhão 1997b; Bicho 1992; Almeida 2004)

Ratios	Picareiro	CPM I	CMP II	CPM III	Coelhos
Bladelet: Retouched Tools	0.70	0.09	0.33	0.20	0.96
Flake: Retouched Tools	1.40	0.38	2.11	1.40	5.82
Blades: Retouched Tools	0.05	0.04	0.13	0.12	0.22
Bladelet+Blades+Flakes: Retouched Tools	2.16	0.51	2.58	1.79	7.00
Bladelet:Flake	0.50	0.26	0.16	0.13	0.17
Bladelet+Blades+Flakes+Retouched Tools: Cores	10.74	10.52	19.74	8.31	40.81

Table 7.6: Inter-site comparison ratios.

Differential representation of artifacts, such as that shown in these diagrams, is ultimately conducive to discerning what a site was utilized for. Utilizing Zilhão's (1997a) definition of site types, CPM is representative of residential base camp, while Picareiro and Coelhos are hunting encampments. Thus, seeing the contrast in artifact type representation is interesting in that it highlights the differences in site types or function. For example, the large quantity of retouched tools and lower representation of bladelets at CPM are characteristic in this region and during this time period of residential sites, while the high occurrence of bladelets and lower representation of retouched tools found at Picareiro and Coelhos is similarly indicative to hunting camps (Zilhão 1997a). An in depth morphological and typological comparison of the blank types and retouched tools present at each site needs to be done to provide a complete picture of the variations in sites. From this general comparison however, it is still possible to identify an apparent trend in site function using artifact types. It is, after all, these subtle variations in lithic economy that can be the defining trait in discerning one site type from another.

Figure 7.7: Cluster analysis of similarities between sites based upon blank type, core, and retouched tool representation at each site

Figure 7.7 is a cluster analysis for these sites based upon representative quantities of blank types, core presence, and retouched tool presence at each site; they do not represent specific tool or core types. As it has been shown, these sites possess several differences, while also sharing apparent similarities. CPM IU, CPM IIU, CPM IIIU, and Coelhos' assemblages possess similarities to Picareiro's Late Magdalenian assemblage in terms of raw material representation, use, and reduction. All of these sites possess chert, quartz, and quartzite as their primary raw materials selected and they are similar in that they all exercised preferential raw material reduction, for example, quartzite was the least represented in all five sites in the retouched tool assemblages (Zilhão 1997a, Bicho 2000; Marks *et al.* 1994). With that in mind and looking at Figure 7.7, it offers a visual representation that Lapa do Picareiro's Late Magdalenian lithic assemblage fits in with other regionally contemporaneous sites when considering just numeric quantities alone.

It is important however to keep in mind that location could have also played a role in site function (See Images 7.1, 7.2, and 7.3). CPM is located on a terrace that possesses ample access to high quality raw material gravels sitting at only 83m above sea level; Coelhos is located on the Eastern face of the Sierra d'Aire mountain range, at 119m above sea level, with the nearby Tagus river providing the site with access to water, aquatic species, and transported raw material cobbles; Then there is Picareiro, towering at 570m above sea level on the Western face of the Sierra d'Aire mountains. These sites are all located in different areas possessing different elevations and access to resources, thus site location could have played a role in site function. As previously stated however, a more comprehensive comparison and in depth analysis of these assemblages would need to occur to better understand these variations in site types.

Another site that would be interesting to add to this comparative analysis would be Lapa do Suão. The site is regionally contemporaneous to the others and possesses similar depositional chronology. Unfortunately however, the data recovery methods employed resulted in the production of data sets that are difficult to compare with such a specific time range as is being utilized in this analysis (i.e. Late Magdalenian). An in depth analysis of the assemblage done by Cláudia Manso (2015) could potentially be utilized for future data comparison encompassing a wider time frame or in bulk analysis.

Conclusion and Future Research Opportunities

Much work is still left to be done to further evaluate Picareiro's role during the Late Magdalenian, not only within its own assemblage, but within the

region. The Layer F/G assemblage should undergo further investigation in some of the following manners: 1.) Analysis of the core negatives and those artifacts classified as chips; were these chips produced intentionally or were they just debris as a product of knapping? 2.) Investigation of the role of cores for bladelets (i.e. burins, thick endscrapers); were these simply domestic tools? Were they cores for bladelets? Or were they tools and cores for bladelets? Use wear analysis and refitting could potentially shed some light on this. 3.) Analysis of burin spalls to determine if their production was the result of producing a useable burin or for the use of the burin spalls as hunting tools; Use wear analysis and investigation as to the presence or absence of impact fractures would be needed. 4.) Investigation into where the quartzite burin spalls came from; where are the associated burins? 5.) Analysis of the backed bladelets, including those that are fragmentary, to establish use; were they cutting tools or were they inset as barb hunting tips? Use wear analysis and investigation as to the presence or absence of impact fractures would be needed. 6.) An in depth analysis of the role of unretouched blanks. Were these used as tools without further modification or were they produced with intent to eventually retouch into specific tools? This would require use wear analysis. 7.) Analyzing the complete Magdalenian sequence from Picareiro; the analysis presented in this thesis only represents one layer associated within the Magdalenian occupations of the cave, could analysis of the other layers influence the interpretation of site function during the Magdalenian? Would it affect how the site is perceived when compared with the other regionally contemporaneous sites? 8.) Identification and

attribution of raw materials to specific sources to allow for a better understanding of material transport and provide more information about the amount of cortical presence identified on the materials at the site (i.e. were they getting the raw material from a quarry or gravels). 9.) Refitting of artifacts would be pertinent to understanding spatial distribution within the cave which would allow for paleoethnographic interpretations of the artifact, fauna, and charcoal concentrations. Refitting would also be pertinent to understanding the reduction sequence at the cave. Pereira (2010) demonstrated that refittings exist in quartzite within the assemblage, thus it can be expected to find refits in other raw materials as well. Refittings can also provide insight into the importation and exportation of blanks and tools by potentially showing the presence or absence of some specific elements.

This thesis demonstrates the value of utilizing a lithic analytic approach to answering important questions about prehistoric cultural ecology. Having presented an in-depth analysis of the lithic materials recovered from the Late Magdalenian occupation Layer F/G has allowed for information pertaining to raw material use, reduction phase representation, and identification of specific typologies indicative of site functionality to be discerned and utilized to contextualize Lapa do Picareiro within the broader context of the Late Magdalenian in Estremadura. The data presented here allows for the introduction of the Late Magdalenian lithic assemblage from Layer F/G at Lapa do Picareiro to enter the regional discussion about human behavior and ecodynamics during the end of the Pleistocene.

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APPENDIX I: SITE CHRONOLOGY

This table presents the current absolute dates for Lapa do Picareiro (provided by Haws 2017). Layer F/G is highlighted.

Level	Sample ID	Depth (cm)	Cultural affiliation	Lab number	Sample material	¹⁴ C age	cal BP range ^a (2-sigma)	δ ¹³ C (‰)	%C	C:N
A										
B	LP.C5.B	-85	Epipaleolithic	UGAMS-9098	charcoal	8,500±30	9,535-9,475	-25.0		
	LP.I5.top	-75	Epipaleolithic	UGAMS-9099	charcoal	8,700±30	9,735-9,550	-24.5		
C (outside)	LP.K13.2B		Neolithic	Wk-7439	charcoal	6,580 ±90		-25.9		
Ca (outside)	LP.K13.3		Neolithic	Wk-7440	charcoal	6,970 ±80		-27.7		
C (inside)	LP.E12.C1	-110-115		Wk-41388	bone	10,716 ±42	12,727-12,589	n/a		n/a
D	LP.G4.D1	-115-125	Epipaleolithic	Wk-6676	charcoal	8,310 ±130	9,528-9,014	-25.2		
E upper	LP.D6.E5	-145-150	Magdalenian	Wk-4217	charcoal	10,070 ±80	11,980-11,307	-24.2		
E middle	LP.D6.E8	-160-165	Magdalenian	Wk-5431	charcoal	11,700 ±120	13,764-13,296	-24.7		
E lower	LP.D6.E10	-170-175	Magdalenian	Wk-4218	charcoal	11,550 ±120	13,605-13,119	-24.3		
	LP.D8.E14	-185-190		Wk-10434	charcoal	12,498 ±159	15,228-14,110	-23.1		
F	LP.D6.F3	-190-195	Magdalenian	Wk-4219	charcoal	11,780 ±90	13,772-13,442	-24.7		
	LP.F5.F10	-215-220		Wk-6677	charcoal	12,210 ±100	14,607-13,778	-24.3		
G	LP.D5		Magdalenian	OxA-5527	charcoal	12,320 ±90	14,824 - 14,011	-23.7		
H			n/a							
I (SB surface)	LP.ZZ9.1271	-240	Magdalenian	Wk-41257	bone	12,260 ±33	14,323-14,028	-20.8	37.67	3.47
I (SB surface)	LP.ZZ10.1279	-229	Magdalenian	UGAMS-20480	charcoal	11,760±30	13,719-13,467	-25.2		
J	LP.D5.J6	-290-295	Magdalenian	Wk-10433	charcoal	10,486 ±110	12,678-12,052	-24.3		
	LP.D5.J10.49	-310		Wk-12129	bone	12,121 ± 65	14,150-13,777	-20.8		2.97
	LP.D7.J2	-240-245		Wk-6678	charcoal	11,877 ±81	13,950-13,485	-24.1		
K	LP.F6.K5.5	-271 cm	Magdalenian	Wk-31354	bone	15,035±87	18,512-18,006	-20.7	41.99	3.38
L	LP.E9.L	-282 cm	Magdalenian	UGAMS-17664	charcoal	15,680 ±40	19,035-18,800	-23.7		
M										
N	LP.D5.N1.9	-332 cm		Wk-16417	bone	16,389±111	20,070-19,511	-19.5	13.7	3.52
O	LP.G9.O	-300 cm	Solutrean?	Beta-247965	charcoal	17,480±100	21,450-20,805	-24.4		
	LP.YY11.115	-340 cm		UGAMS-23724	charcoal	16,280±40	19,854-19,497	-24.3		
	LP.YY10.327	-368 cm		UGAMS-24606	charcoal	17,570±45	21,451-21,002	-22.8		
P										
Q			Solutrean							
R	LP.E6.R1.5	-383 cm	Solutrean	Beta-234370	charcoal	8,670±40		-25.0		
	LP.E7.R	-385 cm		UGAMS-03415	charcoal	19,100±70	23,335-22,758	-24.3		
	LP.B7.337	-412 cm		UGAMS-23719	charcoal	19,090±50	23,272-22,772	-25.1		
S	LP.E6.S1.31	-406 cm	Solutrean	Beta-234371	charcoal	19,290±80	23,510-22,965	-24.4		
	LP.B7.344	-420 cm		UGAMS-23720	charcoal	18,930±50	23,001-22,569	-24.4		

T	LP.F8.T5.1032	-421 cm		Wk-37655	bone	18,957±79	23,069-22,551	-20.3	43.67	3.22
	LP.B7.505	-466 cm		UGAMS-23721	charcoal	20,710±55	25,248-24,615	-22.6		
	LP.B7.788	-488 cm		UGAMS-23722	charcoal	20,630±55	25,146-24,530	-23.3		
	LP.B9.92	-449 cm		UGAMS-23718	charcoal	20,240±50	24,508-24,104	-23.7		
	LP.YY11.436	-446 cm		UGAMS-23725	charcoal	20,320±50	24,586-24,177	-25.0		
	LP.YY11.666	-451 cm		UGAMS-23726	charcoal	20,530±50	24,999-24,437	-22.9		
	LP.XX12.21	-456 cm		UGAMS-23727	charcoal	19,530±50	23,761-23,276	-26.0		
(T4)	E5.T4	-455-460	Solutrean?	Beta-208221	charcoal	20,240±110	24,615-23,984	-23.6		
	E5.T4	-455-460		Beta-229781	bone	20,700±100	25,276-24,545	-21.0		
(T8)	LP.E7.T8.46	-486 cm	Gravettian?	Wk- 37656	charcoal	23,097±131	27,641-27,146	-23.8		
U	LP.E6.U	-490-495	Gravettian?	Beta-208222	charcoal	22,660±240	27,461-26,395	-26.1		
	LP.F6.U1	-488 cm		Beta-234373	charcoal	22,560±110	27,220-26,525	-23.1		
	LP.F6.U3	-505 cm		Beta-234374	charcoal	22,590±110	27,246-26,550	-23.8		
V	LP.F6.V1.2071	-525 cm		Wk-31353	bone	25,579±173	30,320-29,254	-20.2	44.27	3.31
W	LP.F8.W1.1105	-516 cm	Gravettian	Wk-30539	bone	26,505±270	31,164-30,184	-19.4	42.3	3.2
X	LP.D10.27	-516 cm		UGAMS-23723	charcoal	27,230±80	31,331-30,996	-24.2		
Y	LP.E9.Y.89	-563 cm		Wk-41389	bone	28,430±210	33,041-31,633	-19.0	41.04	3.29
Z	LP.F7.Z1	-560-565	Gravettian?	UGAMS-03417	bone	22,190±80		-20.3		
	LP.F7.Z2.1117 + F6.Z1.2081	-572 cm -573 cm		Wk-30538	bone	28,161±329	32,984-31,307	-19.6	43.5	3.3
	LP.G6.Z1.10	-564 cm		Wk-32280	bone	29,054±224	33,769-32,690	-19.4	43.48	3.24
AA										
BB	LP.E7.BB.2000	-592 cm		Wk-32281	bone	30,027±207	34,512-33,745	-19.4	42.93	3.24
CC										
DD										
EE										
FF	LP.F7.FF	-625-635	Middle P	Beta-247964	charcoal	28,610±300	33,485-31,705	-22.3		
	LP.F7.FF.1140	-644 cm		Wk-28843	bone	27,721 ±260	32,291-31,087	n/a		n/a
	LP.F7.FF.1132	-640 cm		Wk-32219	bone	32,997±263	38,086-36,355	-19.3	43.02	3.25
	LP.E9.FF	~625 cm		Wk-41259	charcoal	33,238 ±419	38,524-36,381	n/a		
	LP.F9.FF	~610 cm		UGAMS-20479	charcoal	32,200± 90	36,355-35,800	-24.0	57.04	
GG	LP.G6.GG.1090	-633 cm		Wk-41258	bone	32,063 ±336	36,726-35,173	-19.0	38.74	3.44
HH										
II										
JJ	LP.F7.JJ1	-690-700	Middle P	UGAMS-03416	bone	24,160±100		-19.6		
(JJ4)	LP.F7.JJ4.3003	-744 cm		Wk-28844	bone	40,078±1239	46,381-42,094	-19.9	39.53	3.4
(JJ4)	LP.F7.JJ4	-750 cm		UGAMS-07769	charcoal	41,480±220	45,420-44,451	-25.1	55.54	
KK										
LL										
MM										
NN										

^aPaula J Reimer, Edouard Bard, Alex Bayliss, J Warren Beck, Paul G Blackwell, Christopher Bronk Ramsey, Pieter M Grootes, Thomas P Guilderson, Hafliði Hafliðason, Irka Hajdas, Christine Hatté, Timothy J Heaton, Dirk L Hoffmann, Alan G Hogg, Konrad A Hughen, K Felix Kaiser, Bernd Kromer, Sturt W Manning, Mu Niu, Ron W Reimer, David A Richards, E Marian Scott, John R Southon, Richard A Staff, Christian S M Turney, Johannes van der Plicht. 2013. IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50,000 Years cal BP. *Radiocarbon* 55(4): 1869-1887.

APPENDIX II: ANALYTIC INDEXES

- **Assemblage Integrity:**
 - $(\text{Chips}/\text{All assemblage}) * 100$
 - $(2,023/3,207) * 100 = \mathbf{63.08\%}$

3.1 QUANTITATIVE ANALYSIS

- **Raw Material Use:**
 - **Acquisition:** Nodules/Pebbles/Cobbles + Tested nodules + Blanks
(complete and proximal) with more than 50% of cortex.
 - **Acquisition for all material types:**
 - $5 + (47+1) = 53$
 - $(53/3,207) * 100 = 1.65\%$
 - Less Chips: $(53/1,184) * 100 = 4.48\%$
 - **Acquisition for Chert:**
 - $0 + (20+1) = 20$
 - $(20/3,207) * 100 = 0.62\%$
 - Less Chips: $(20/1,184) * 100 = 1.70\%$
 - **Acquisition for Quartzite:**
 - $5 + (21 + 0) = 26$
 - $(26/3,207) * 100 = 0.81\%$
 - Less Chips: $(26/1,184) * 100 = 2.20\%$

- **Acquisition for Quartz:**
 - $0 + (4 + 0) = 4$
 - $(4/3,207)*100 = 0.12\%$
 - Less Chips: $(4/1,184)*100 = 0.34\%$
- **Production:** Blanks (complete and proximal) + Cores
- **Production for Complete Assemblage:**
 - $(300+62) + 69 = 431$
 - $(431/3,207)*100 = 13.44\%$
 - Less Chips: $(431/1,184)*100 = 36.40\%$
- **Production for Chert:**
 - $(193 + 40) + 27 = 260$
 - $(260/3,207)*100 = 8.11\%$
 - Less Chips: $(260/1,184)*100 = 21.94\%$
- **Production for Quartzite:**
 - $(81 + 12) + 23 = 116$
 - $(116/3,207)*100 = 3.62\%$
 - Less Chips: $(116/1,184)*100 = 9.80\%$
- **Production for Quartz:**
 - $(24 + 10) + 18 = 52$
 - $(52/3,207)*100 = 1.62\%$
 - Less Chips: $(52/1,184)*100 = 4.39\%$

- **Retouch:** Retouched tools
- **Retouch for Complete Assemblage:**
 - 211
 - $(211/3,207)*100 = 6.60\%$
 - Less Chips: $(211/1,184)*100 = 17.82\%$
- **Retouch for Chert:**
 - 189
 - $(189/3,207)*100 = 5.89\%$
 - Less Chips: $(189/1,184)*100 = 15.96\%$
- **Retouch for Quartzite:**
 - 3
 - $(3/3,207)*100 = 0.09\%$
 - Less Chips: $(3/1,184)*100 = 0.25\%$
- **Retouch for Quartz:**
 - 19
 - $(19/3,207)*100 = 0.59\%$
 - Less Chips: $(19/1,184)*100 = 1.60\%$

- **Representation of the Phases of Reduction Sequence:**
 - Acquisition/Production and Retouch/Production
 - **All Material Types:**
 - Acquisition/Production:
$$[(53/3,207) / (431/3,207)] * 100 = 12.29\%$$
 - Less Chips: $[(53/1,184) / (431/1,184)] * 100 = 12.29\%$
 - Retouch/Production:
 - $[(211/3,207) / (431/3,207)] * 100 = 48.96\%$
 - Less Chips: $[(211/1,184) / (431/1,184)] * 100 = 48.96\%$
 - **Chert:**
 - Acquisition/Production:
$$[(20/3,207) / (431/3,207)] * 100 = 4.64\%$$
 - Less Chips: $[(20/1,184) / (431/1,184)] * 100 = 4.64\%$
 - Retouch/Production:
$$[(189/3,207) / (431/3,207)] * 100 = 43.85\%$$
 - Less Chips: $[(189/1,184) / (431/1,184)] * 100 = 43.85\%$
 - **Quartzite:**
 - Acquisition/Production:
$$[(26/3,207) / (431/3,207)] * 100 = 6.03\%$$
 - Less Chips: $[(26/1,184) / (431/1,184)] * 100 = 6.03\%$
 - Retouch/Production:
$$[(3/3,207) / (431/3,207)] * 100 = 0.69\%$$
 - Less Chips: $[(3/1,184) / (431/1,184)] * 100 = 0.69\%$

- **Quartz:**
 - Acquisition/Production:
 - $[(4/3,207) / (431/3,207)] * 100 = 0.93\%$
 - Less Chips: $[(4/1,184) / (431/1,184)] * 100 = 0.93\%$
 - Retouch/Production:
 - $[(19/3,207) / (431/3,207)] * 100 = 4.41\%$
 - Less Chips: $[(19/1,184) / (431/1,184)] * 100 = 4.41\%$
- **Productivity by Raw Material**
 - Blanks (Complete and Proximal) / Cores
 - **All Material Types:**
 - $(300+62) / 69 = 5.24$
 - **Chert:**
 - $(193 + 40) / 27 = 8.62$
 - **Quartzite:**
 - $(81 + 12) / 23 = 4.04$
 - **Quartz:**
 - $(24 + 10) / 18 = 1.89$

- **Debitage Preference**

- Complete + Proximal (for each blank type by raw material); Percentage of assemblage with and without chips

- **Chert:**

- Flake: $193 + 40 = 233$
 - $(233/3,207)*100 = 7.26\%$
 - Less Chips : $(233/1,184)*100 = 19.67\%$
- Blade: 8
 - $(8/3,207)*100 = 0.24\%$
 - Less Chips: $(8/1,184)*100 = 0.67\%$
- Bladelet: $142 + 72 = 214$
 - $(214/3,207)*100 = 6.67\%$
 - Less Chips: $(214/1,184)*100 = 18.07\%$
- Burin Spall: 53
 - $(53/3,207)*100 = 1.65\%$
 - Less Chips: $(53/1,184)*100 = 4.48\%$

- **Quartzite:**

- Flake: $81 + 12 = 93$
 - $(93/3,207)*100 = 2.89\%$
 - Less Chips: $(93/1,184)*100 = 7.85\%$
- Blade: 2
 - $(2/3,207)*100 = 0.06\%$
 - Less Chips: $(2/1,184)*100 = 0.17\%$

- Bladelet: $3 + 2 = 5$
 - $(5/3,207)*100 = 0.15\%$
 - Less Chips: $(5/1,184)*100 = 0.42\%$
- Burin Spall: 9
 - $(9/3,207)*100 = 0.28\%$
 - Less Chips: $(9/1,184)*100 = 0.76\%$
- **Quartz:**
 - Flake: $24 + 10 = 34$
 - $(34/3,207)*100 = 1.06\%$
 - Less Chips: $(34/1,184)*100 = 2.87\%$
 - Blade: 0
 - $(0/3,207)*100 = 0\%$
 - Less Chips: $(0/1,184)*100 = 0\%$
 - Bladelet: $4 + 3 = 7$
 - $(7/3,207)*100 = 0.22\%$
 - Less Chips: $(7/1,184)*100 = 0.59\%$
 - Burin Spall: 6
 - $(6/3,207)*100 = 0.18\%$
 - Less Chips: $(6/1,184)*100 = 0.51\%$

- **Debitage Technology**

- Frequency of core types by raw material; total cores in assemblage: 69

- **Chert:**

- Bipolar: 1

- $(1/69) * 100 = 1.45\%$

- Chopper: 0

- $(0/69) * 100 = 0\%$

- Chipped Stone: 2

- $(2/69) * 100 = 2.89\%$

- Multidirectional: 8

- $(8/69) * 100 = 11.59\%$

- Prismatic: 14

- $(14/69) * 100 = 20.29\%$

- Pebble/Nodule: 0

- $(0/69) * 100 = 0\%$

- **Quartzite:**

- Bipolar: 0

- $(0/69) * 100 = 0\%$

- Chopper: 13

- $(13/69) * 100 = 18.84\%$

- Chipped Stone: 0

- $(0/69) * 100 = 0\%$

- Multidirectional: 1
 - $(1/69)*100 = 1.45\%$
- Prismatic: 2
 - $(2/69)*100 = 2.89\%$
- Pebble/Nodule: 0
 - $(0/69)*100 = 0\%$

○ **Quartz:**

- Bipolar: 3
 - $(3/69)*100 = 4.34\%$
- Chopper: 1
 - $(1/69)*100 = 1.45\%$
- Chipped Stone: 7
 - $(7/69)*100 = 10.14\%$
- Multidirectional: 2
 - $(2/69)*100 = 2.89\%$
- Prismatic: 2
 - $(2/69)*100 = 2.89\%$
- Pebble/Nodule: 1
 - $(1/69)*100 = 1.45\%$

APPENDIX II: ASSEMBLAGE ANALYSIS

6.1: STATISTICAL BREAKDOWN

Layer F/G: Cores

Layer F/G Chert Cores					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	28.34	Mean	23.81	Mean	16.77
Median	24.76	Median	21.33	Median	15.49
Mode	#N/A	Mode	#N/A	Mode	25.38
Standard Deviation	11.02	Standard Deviation	8.42	Standard Deviation	6.87

Table 6.1: Statistical breakdown of chert cores

Layer F/G Quartz Cores					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	30.70	Mean	27.16	Mean	14.67
Median	25.63	Median	23.47	Median	12.35
Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	16.44	Standard Deviation	11.20	Standard Deviation	8.19

Table 6.2: Statistical breakdown of quartz cores

Layer F/G Quartzite Cores					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	68.11	Mean	66.31	Mean	46.58
Median	58.5	Median	66.02	Median	47.1
Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	38.54	Standard Deviation	15.87	Standard Deviation	14.99

Table 6.3: Statistical breakdown of quartzite cores

Layer F/G: Flakes

Layer F/G Chert Flakes					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	23.44	Mean	20.54	Mean	5.95
Median	21.43	Median	18.96	Median	4.88
Mode	36.83	Mode	26.43	Mode	2.78
Standard Deviation	11.30	Standard Deviation	9.427	Standard Deviation	3.94

Table 6.4: Statistical breakdown of chert flakes

Layer F/G Quartz Flakes					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	23.57	Mean	20.19	Mean	7.26
Median	21.54	Median	16.77	Median	6.79
Mode	14.69	Mode	21.01	Mode	#N/A
Standard Deviation	13.1	Standard Deviation	11.67	Standard Deviation	3.57

Table 6.5: Statistical breakdown of quartz flakes

Layer F/G Quartzite Flakes					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	35.96	Mean	31.62	Mean	9.88
Median	32.55	Median	29.38	Median	8.44
Mode	#N/A	Mode	#N/A	Mode	16.9
Standard Deviation	16.91	Standard Deviation	14.46	Standard Deviation	5.32

Table 6.6: Statistical breakdown of quartzite flakes

Layer F/G: Blades

Layer F/G Chert Blades					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	39.16	Mean	16.09	Mean	5.48
Median	40.19	Median	17.64	Median	5.24
Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	16.61	Standard Deviation	5.64	Standard Deviation	2.64

Table 6.7: Statistical breakdown of chert blades

Layer F/G: Quartzite Blades					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	38.96	Mean	19.27	Mean	7.86
Median	38.96	Median	19.27	Median	7.86
Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	12.52	Standard Deviation	5.607	Standard Deviation	0.54

Table 6.8: Statistical breakdown of quartzite blades

Layer F/G: Bladelets

Layer F/G Chert Bladelets					
<i>Length</i>		<i>Width</i>		<i>Thickness</i>	
Mean	24.89	Mean	8.41	Mean	3.35
Median	22.41	Median	7.84	Median	2.81
Mode	15.4	Mode	16.9	Mode	1.57
Standard Deviation	12.22	Standard Deviation	4.7	Standard Deviation	1.9

Table 6.9: Statistical breakdown of chert bladelets

Layer F/G: Quartz Bladelets					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	15.9	Mean	6.66	Mean	3.36
Median	16.6	Median	7.02	Median	3.19
Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	3.23	Standard Deviation	1.67	Standard Deviation	1.22

Table 6.10: Statistical breakdown of quartz bladelets

Layer F/G: Quartzite Bladelets					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	30.45	Mean	12.47	Mean	6.82
Median	29.96	Median	11.3	Median	5.36
Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	10.87	Standard Deviation	4.05	Standard Deviation	4.13

Table 6.11: Statistical breakdown of quartzite bladelets

Layer F/G Burin Spalls:

Layer F/G Chert Burin Spalls					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	14.72	Mean	4.34	Mean	3.1
Median	14.01	Median	4	Median	2.56
Mode	#N/A	Mode	4	Mode	1.91
Standard Deviation	6.804	Standard Deviation	2.23	Standard Deviation	1.53

Table 6.12: Statistical breakdown of chert burin spalls

Layer F/G Quartz Burin Spalls					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	9.69	Mean	4.22	Mean	3.04
Median	9.6	Median	4.03	Median	2.38
Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	3.48	Standard Deviation	1.87	Standard Deviation	1.58

Table 6.13: Statistical breakdown of quartz burin spalls

Layer F/G: Quartzite Burin Spalls					
<i>Length (mm)</i>		<i>Width (mm)</i>		<i>Thickness (mm)</i>	
Mean	13.2	Mean	4.45	Mean	3.86
Median	10.78	Median	4.04	Median	3.125
Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	7.57	Standard Deviation	1.27	Standard Deviation	2.49

Table 6.14: Statistical breakdown of quartzite burin spall

6.2: IMAGERY APPENDIX

Cores

Chert; Prismatic Core

Chert; Prismatic Core

Chert; Prismatic Core

Chert; Multidirectional Core

Quartzite; Prismatic Core

Quartz; Bipolar Core

Quartz; Prismatic Core

Quartz; Core Fragment

Unretouched Blanks

Chert; Blade/bladelet Fragment

Chert; Bladelet

Chert; Bladelet

Chert; Bladelet

Chert; Blade

Chert; Blade

Preparatory and Maintenance Products

Chert; Crest

Retouched Tools

Chert; Burin

Chert; Burin

Chert; Burin

Chert; Truncation

Chert; Burin

Chert; Truncation

Chert; Side Scraper

Chert (#4) and Quartz (#1); Backed Bladelet

Quartzite; Denticulate

Chert; Backed Bladelet

Chert; Notch

Chert; Backed Bladelet

Chert; Thin Endscraper

Chert; Thick Endscraper

Chips

Mixed Materials; Chips

Refits

Chert; Refit

CURRICULUM VITAE

MELISSA J. HOLST

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Higher Education Experience

Master of Arts in Anthropology

GPA: 4.0

University of Louisville, Louisville, Kentucky

May 2017

Bachelor of Arts in Anthropology

GPA: 3.2

University of Louisville, Louisville, Kentucky

May 2013

Research and Teaching Experience

Graduate Research Assistant

University of Louisville Archaeology Laboratory

Philip DiBlasi

August 2016-May 2017

Conducted independent research

- Assisted students with research projects and laboratory exercises
- Assisted in the preservation and management of cultural resources stored at the laboratory

Graduate Teaching Assistant

Ceramics

University of Louisville Archaeology Laboratory

Dr. Anna Browne Ribeiro

January 2017-May 2017

- Assisted in instructing class lectures and demonstrations
- Coached students in laboratory identification and analysis techniques
- Instructed independent study sessions

Graduate Teaching Assistant

Lithics

University of Louisville Archaeology Laboratory

Dr. Amanuel Beyin

August 2016-December 2016

- Assisted in instructing class lectures and demonstrations
- Coached students in hands-on knapping experiments
- Instructed independent study sessions

Archaeological Excavation

Lapa do Picareiro, Central Portugal

Dr. Jonathan Haws

July 2012-August 2016

This project is titled *Neanderthal and Modern Human Response to Environmental Change at the Middle-Upper Paleolithic Transition, Lapa do Picareiro, Portugal*. The site has been under excavation by Dr. Jonathan Haws since 2005 and it contains roughly 10 meters of sediments spanning about 50,000 years. Excavation of the site is continuing to produce high resolution data sets pertaining to site function, lithic technological organization, and subsistence practices. This project has been funded by the National Science Foundation, the Wenner-Gren Foundation for Anthropological Research, the Archaeological Institute of America, the National Geographic Society, and the University of Louisville. During this project I assisted in excavation, manual screening of sediment, laboratory processing of recovered materials, faunal and lithic analysis, and total station set-up and data recording.

Archaeological Survey

June 2013-July 2013

Southwestern Coast of Portugal

Dr. Jonathan Haws

This project was titled *Human responses to late Pleistocene environmental change in the coastal zone of Portuguese Estremadura*. The project involved geoarchaeological survey of the coastal region between São Pedro de Muel and Peniche, with the goal of finding evidence of coastal settlements during the Paleolithic. This project was funded by the National Science Foundation. During this project I assisted in systematic pedestrian survey, artifact identification, excavation of test pits, and laboratory processing of recovered artifacts.

Laboratory Research and Analysis

University of Algarve Archaeology Laboratory, Faro, Portugal

Dr. Telmo Pereira

December 2015, June 2016

This study was conducted as part of an ongoing independent Master's thesis research project. It involved the macroscopic and microscopic analysis of a previously unstudied late Magdalenian lithic assemblage recovered from the cave site of Lapa do Picareiro in Portugal. This project was funded by the University of Louisville Anthropology Department Research Fund, University of Louisville Portuguese Studies Fund, Graduate Student Council Research and Travel Fund Grants, and the Graduate Network in the Arts and Sciences Graduate Research Grant. During this study I was responsible for the analysis and identification and curation of each artifact within the assemblage. After analysis, each artifact was then coded and put into a database that I created for the study.

Completed/Presented Works

"New Data on Late Magdalenian Lithic Technological Organization at Lapa do Picareiro" with Dr. Jonathan Haws, poster presented at the Society for American Anthropology Annual Meeting in Orlando, Florida, April 2016.

"Late Magdalenian Lithic Technological Organization: New Data from Lapa do Picareiro, Portugal" with Dr. Jonathan Haws, poster presented at the Graduate Student Regional Research Conference in Louisville, Kentucky, April 2016.

"Late Magdalenian Lithic Technology at Lapa do Picareiro, Central Portugal" with Dr. Jonathan Haws, poster to be presented at the Graduate Student Regional Research Conference in Louisville, Kentucky, March 2017.

"Late Magdalenian Lithic Technology at Lapa do Picareiro, Central Portugal" with Dr. Jonathan Haws, poster to be presented at the Society for American Anthropology Annual Meeting in Vancouver, B.C., Canada, March 2017.

"Late Magdalenian Lithic Technological Organization at Lapa do Picareiro, Central Portugal." Thesis submitted to the Faculty of the College of Arts and Sciences of the University of Louisville in Partial Fulfillment of the Requirements for the Degree of Master of Arts. April 2017.

Honors and Awards

Graduate Research Assistantship	2016-2017
Graduate Student Council Travel Fund Grant	2016, 2017
Portuguese Studies Program Travel Grant	2012, 2013, 2015, 2016
Graduate Student Council Research Fund Grant	2015
Anthropology Departmental Research Grant	2015
Graduate Network in Arts and Sciences Graduate Student Research Grant	2015

Professional Development Experience

School of Arts and Sciences Research Spotlight	2017
Kentucky Academy of Science 102 nd Annual Meeting Volunteer	2016
Paleoanthropology Society Annual Meeting Attendee	2017
Society of American Archaeology Annual Conference Attendee	2016, 2017
Kentucky Heritage Council Archaeology Annual Conference Attendee	2017
Graduate Student Regional Research Conference Attendee	2016, 2017
Anthropology Graduate Student Association Secretary	2016-2017
Grant Writing Academy Member	2015
Publishing Academy Member	2016
Graduate Teaching Assistantship Academy	2017

Professional Society Memberships

(From – Until)

Kentucky Academy of Science	2017 – Current
Paleoanthropology Society	2017 – Current
Archaeological Institute of America	2012 - Current
Society for American Archaeology	2015 – Current
Lambda Alpha Anthropological Honors Society	2012 – Lifetime
Sigma Alpha Lambda Leadership Honors Society	2012 – Lifetime
Golden Key International Honors Society	2012 – Lifetime
Tau Sigma Honor Society for Transfer Students	2012 – Lifetime