ANALYSIS OF THE LITHIC DEBITAGE FROM THE OLDER-THAN-CLOVIS STRATIGRAPHIC LAYERS OF THE GAULT SITE, TEXAS

by

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A thesis submitted to the Graduate Council of
Texas State University in partial fulfillment
of the requirements for the degree of
Master of Arts
with a Major in Anthropology
December 2013

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DEDICATION

To my parents, Edith and Paul Gandy, for all their love and encouragement.

ACKNOWLEDGMENTS

I would like to thank Dr. Michael Collins and Dr. Britt Bousman for always taking time out of their busy schedules to talk with me, and for helping me to think through problems and to see things in a different light. I am grateful for all of their help in teaching me how to run statistical analyses and in how to interpret statistical results. Also, I would like thank Dr. Stephen Black and Dr. Kent Reilly for their kind words of encouragement in all my work and for always making me smile. Thank you all for making my time at Texas State University memorable and enjoyable.

Additionally, I would like to thank everyone at the Gault Project laboratory at Texas State. I am grateful to Nancy Littlefield, Tom Williams, Sergio Ayala, and Dr. Clark Wernecke, who all shared their time, work, and laughter with me. Thank you all for patiently helping me by reading over my numerous drafts and for helping me to gather information and images for my thesis.

Further, I would like to thank my friends and classmates. Thanks go to Robert Lassen and Anastasia Gilmer for their encouragement and for always being willing to listen to me and to help me find resources for my work, even when they were busy with their own dissertation and thesis, respectively. Special thanks go to Jennifer Anderson for always taking time to share thoughts, laughter, and a cup of coffee with me. Her encouragement and understanding truly helped me make it through each step in the process of completing this thesis and in earning my Master's degree.

Finally, I thank my family for all of their support, for always believing in me, and for helping me at every point in my journey. Thank you for your unconditional love and willingness to push me to be the best I can be.

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CHAPTER 1

Introduction

The Gault site is a well-known Clovis site in Central Texas. For the past few years, though, the stratigraphic layers below the Clovis occupations at Area 15 have been investigated due to the discovery of artifacts in 2002 and 2007 from within these stratigraphically older layers. It was discovered that there were approximately 80 cm of cultural layers below the 30 cm of known Clovis layers. These lower cultural layers contained thousands of artifacts, mostly lithic debitage. Thus, it would seem that there were peoples at the Gault site prior to the Clovis occupations. Since these artifacts came from stratigraphic layers dating older than the Clovis, as will be discussed below, the layers and associated artifacts were labeled "older-than-Clovis" (Collins 2013; Collins et al. 2013a). As debitage was the most frequently recovered artifact category, a dedicated debitage analysis might provide the best sample of the older-than-Clovis (OTC) material culture for addressing the primary question for this study: is the debitage, and thus the technology (or technologies), similar to those of Clovis?

Goals of this Study

The primary objectives of this thesis are as follows:

1. To analyze the OTC debitage from Area 15 of the Gault site in order to define that aspect of the cultural materials from the OTC stratigraphic layers. The study focuses on debitage flakes with identifiable striking platforms. Various attributes

and measurements were recorded on each of the flakes meeting this criterion, consisting of a sample of 2,395 specimens.

2. To estimate how similar or dissimilar the Gault OTC debitage is to the Gault Clovis debitage in order to interpret the technology as like or unlike Clovis technology.

Additionally, one of three possible outcomes was expected from the interpretations of the completed study. First, the OTC debitage may be determined to be completely distinct from the Clovis debitage. This would imply that a different technology (or technologies) is represented in the OTC stratigraphic levels. Further, it implies that at least one distinct culture was present in the site area prior to Clovis. Alternatively, the OTC debitage may be found to be indistinguishable from the Clovis debitage. This might imply that the Clovis and OTC technologies are the same, thus possibly implying an older chronological range for Clovis occupations at Gault. Lastly, the OTC debitage may be found to be similar to the Clovis technology, though still with some technological differences. This too would imply a different technology, though possibly with an historical connection to Clovis.

Chapter Outline

Chapter 2 describes in brief the history of the acceptance of the presence of people in the Americas in the Pleistocene. This chapter discusses the earliest finds that defined the Folsom and Clovis technologies leading up to the discovery of OTC sites and the difficulty these sites had in gaining acceptance within the archaeological community. The chapter then describes the Gault site and the archaeological work performed there on cultural stratigraphic layers ranging from the Late Paleoindian to

OTC. Finally, this chapter presents details of Area 15 of the Gault site, from which the debitage analyzed in this study came, and discusses how and why debitage is important for analysis.

Chapter 3 describes the materials used in this study and outlines the methodology used to analyze the Gault OTC debitage. The debitage was examined according to flake and platform attributes, and these data were analyzed using tests such as chi-square tests, scatterplots, and cluster analyses. Chapter 4 presents the results of the analyses, and Chapter 5 presents the discussion and interpretations of these results. Finally, Chapter 6 presents the conclusions drawn from the interpretations presented in the previous chapter.

CHAPTER 2

Background

Acceptance of the Earliest Human Occupations of the Americas

For decades, one of the major topics of inquiry in the American archaeological community has been that of discovering the earliest human occupations of the Americas. How long have humans been present in the Americas? What evidence has been found, and can it reliably be used to support purported early human sites?

It was only after the "Old Testament barrier" had been broken in the mid-nineteenth century in Europe by the Somme River finds that serious thought was given to a geologically ancient human arrival in the Americas (Grayson 1983; Meltzer 2006:24). Later, Ales Hrdlicka (1907:9), who became an authority on the peopling of the Americas, asserted (correctly) that no pre-modern humans had occupied the Americas. Additionally, he argued (again, correctly) that there was no evidence supporting a human occupation before the end of the Pleistocene. Although, at the time, he and many of his colleagues did not believe in a human occupation "earlier that the Indian," Hrdlicka (1907; 1928) allowed that it could be possible, but that such a claim would have to be backed up by substantial evidence. A set of criteria was developed to determine the validity of a proposed early American site (Chamberlin 1903; Hrdlicka 1907; Waters 2000:47-48). An early site would have to possess incontrovertible evidence of a human presence found in undisturbed geologic contexts and with indisputable dating. Such incontrovertible evidence would include, for example, human skeletal remains or tools that could be associated with extinct, prehistoric fauna or with deposits correlated to a Pleistocene age.

In the early twentieth century, numerous sites were purported to be of Pleistocene age, though most of these claims were quickly discounted by Hrdlicka and his colleagues. One such site was Lone Wolf Creek. In late 1923, an artifact collector, Nelson Vaughan, discovered a deposit of bones eroding out of the bank of Lone Wolf Creek in Mitchell County, Texas (Bousman et al. 2004; Meltzer 2006:28-29); and in 1924, he contacted Jesse Figgins, director of the Colorado Museum of Natural History (Figgins 1927). The bones were determined to be the remains of an ancient bison, and Figgins sent H. D. Boyes to excavate the bones for display at the museum. Though the bones were poorly excavated, three projectile points were recovered from among them, only two of which can still be located today. Figgins recognized the importance of this find. If the artifacts were, in fact, associated with the fossil bison bones, then they provided evidence that humans had been in the Americas during the Pleistocene. Harold Cook (1925:460) examined the geology and found no evidence that the artifacts were intrusive, though Hrdlicka and William H. Holmes still dismissed the evidence (Meltzer 2006).

Attention soon shifted to another site. In 1908, George McJunkin discovered a site with fossil bison bones exposed by a recent flood in Folsom, New Mexico. Cook and Figgins inspected the site in March 1926, and excavations were begun in May of the same year (Figgins 1927; Bousman et al. 2004; Meltzer 2006). The distal end of a fluted projectile point was later uncovered amongst the Pleistocene-age bison bones in July 1926, though it was not found *in situ* (Meltzer 2006). However, on August 29, 1927, another point was found *in situ*, embedded between two ribs of one of the *Bison antiquus* skeletons (Figgins 1927). Figgins ordered that the artifact and bones be left in place and then sent out telegrams inviting the scientific community to visit the site to see the find for themselves (Meltzer 2006). Barnum Brown, Frank Roberts, and Alfred V. Kidder were among those who came to see the *in situ* bones and "Folsom" points. They agreed that the Folsom site provided substantial evidence for the early presence of humans in the New World. Hrdlicka eventually accepted this evidence as well (Meltzer 2006), and thus the antiquity of humans in the Americas was pushed back to the late Pleistocene (Haynes 1969). The date range now associated with the Folsom tradition is roughly 10,900 - 10,200 ^{14}C years B.P. (Meltzer 2006:1).

Later discoveries, however, produced evidence suggesting that the human occupation of the Americas extended even further back in time. In the late 1920's, Edgar B. Howard discovered cultural artifacts in a dry cave (now known as Burnet Cave) in the Guadalupe Mountains in New Mexico (Howard 1935; Wormington 1957; Boldurian and Cotter 1999). Five human cremations and associated artifacts were later discovered and attributed to the Christian Era; but, in 1931, a fluted projectile point was found about two and a half feet below the deepest of these cremations (Boldurian and Cotter 1999:72-73). This point was associated with faunal remains such as those of an extinct form of musk ox and a caribou-like animal, which suggested that the point may have been 10,000 years old or older (Wormington 1957). Years later, a radiocarbon date of 7,432 ± 300 ^{14}C years B.P., however, was obtained from charcoal collected three feet below the level in which the point was found, suggesting to researchers at the time that the point was younger than previously thought (Libby 1955; Wormington 1957). Thus, Burnet Cave's significance as an early American site was temporarily overlooked.

Around the same time in 1932, a heavy rainfall uncovered numerous large animal bones at what would become known as the Dent site in Weld County, Colorado (Cassells 1997:58). Union Pacific Railroad employee Frank Gamer discovered the bones and Father Conrad Bilgery from Regis College was informed of the discovery (Cassells 1997:58; Haynes et al. 1998). He began excavations that year and, along with the faunal remains (now identified as mammoth bones), a lanceolate projectile point similar to that found in Burnet Cave was discovered. The points were identified as being similar to Folsom points, though slightly larger in size and with relatively smaller flutes. Due to the association with the mammoth remains, the Dent points also appeared to provide evidence of humans in the Americas prior to the dates associated with Folsom. Father Bilgery, however, was not entirely convinced that the projectile point and mammoth bones were of the same age (Haynes 2002). When Jesse Figgins and his crew began their excavation of Dent later the same year, they found a second point associated with the mammoth bones (Figgins 1933; Haynes et al. 1998). Figgins, unlike Father Bilgery, did believe the age of the artifacts and bones to be the same. Confirming this, a radiocarbon date of 11,200 ± 500 ^{14}C years B.P. on the mammoth remains was obtained during later excavations in 1973 (Haynes 1992:363). However, partially due to some speculation about the integrity of the site stratigraphy, little attention was awarded to the Dent site, and it remained somewhat overlooked until after another discovery was made in New Mexico.

The Blackwater No. 1 Locality (or Blackwater Draw) near Clovis, New Mexico was a gravel pit quarry that was first recognized as an archaeological site by Ridgely Whiteman in 1929 and later investigated by Edgar B. Howard and John L. Cotter (Howard 1935; Sellards 1952). The construction company quarrying the site had removed numerous large bones which were determined to be mammoth and bison remains. In 1932, Howard and his crew began excavations at the site along an exposed face of the gravel pit (Howard 1935). A Folsom cultural layer was identified, and stratified below this layer and in association with the mammoth bones were points similar to those previously found at Dent and Burnet Cave (Cotter 1937; Cotter 1938). These points, even though they were first discovered at the two previously mentioned sites, were christened Clovis points (Cotter 1937; Cotter 1938). The timeframe generally associated with these and other Clovis sites is often considered to be between 11,500 and 10,900 ^{14}C years B.P. (or between about 13,500 and 12,900 cal B.P.) (Haynes 1992; Collins et al. 2013b); though, Waters and Stafford (2007) have argued for a narrower range between about 11,050 and 10,800 ^{14}C years B.P.

These and other Clovis sites, for a long time, were considered to represent the oldest occupations in the Americas. This line of thought developed into the "Clovis First Model" in which the peoples who would create the sites recognized today as Clovis were the first peoples to enter the Americas, spreading rapidly across the land as they followed large game animals (Haynes 1964; Martin 1973; Haynes 1980a, 1982; Kilby et al. 2004). However, claims for earlier sites persisted.

In 1964, for example, Alex Krieger published a paper in which he discussed a number of sites, such as Friesenhahn Cave and the Lewisville site in Texas, which he believed had evidence of older occupations (Krieger 1964). Krieger (1964:42) claimed that these sites were a part of a "Pre-Projectile Point Stage" in which the stone tools that were manufactured were not as complex, resembling the technology of the Lower Paleolithic tools in the Old World. However, the greater antiquity of many of these sites, a number of which had been investigated for years, was quickly dismissed (Josephy 1968:42-43); and today none of the sites Krieger listed are accepted as having produced substantial evidence of an occupation earlier than Clovis (Meltzer 2009). Other claims for early sites, though, could not be so easily dismissed, particularly evidence from early sites in South America. Due to the archaeological evidence discovered at these sites and newly discovered early sites in North America, the validity of the Clovis First Model itself began to be questioned (Bryan 1991; Dillehay 1997; Haynes 2002; Kilby et al. 2004).

Today, it is generally accepted that a number of sites across the Americas have, in fact, produced cultural materials in stratigraphic horizons below Clovis. These sites have been termed 'pre-Clovis' or 'older-than-Clovis.' Since the term 'pre-Clovis' could be interpreted as implying that there is a direct relationship between Clovis and the older technologies, which may or may not be true, the neutral term 'older-than-Clovis' (OTC) will be used herein. Though numerous sites had been proposed and rejected over the years as being OTC, one site that brought much attention to the "Clovis First - pre-Clovis (OTC)" debate was Meadowcroft Rockshelter in Pennsylvania.

In 1973, James Adovasio was contacted to investigate a rockshelter in Pennsylvania (Adovasio 2002). Excavations at Meadowcroft Rockshelter by Adovasio and his team began on June 15, 1973, mostly revealing modern artifacts such as oldfashioned beer bottles (Adovasio 2002). As the excavation continued, however, the team realized that the site dated back even farther than the initial European contact, and the following year, the team returned to continue digging into the older stratigraphic layers. Each stratigraphic layer was meticulously documented and tagged by Adovasio and his team.

Eventually, below layers determined to be Archaic, a layer of rocks from the rockshelter's roof was encountered. This layer (later dated at ca. 10,000 B.P.) effectively sealed off the sediments and artifacts below it (Adovasio et al. 1978; Adovasio 2002). Adovasio and his team broke through this layer and continued the excavation, uncovering unfamiliar artifacts, including what would become known as the Miller lanceolate point, a point that differed distinctively from Clovis points (Adovasio 2002). Eleven radiocarbon dates were run by the laboratory at the Smithsonian Institution for five of the stratigraphic levels; and on July 13, 1974, when the results were sent back to Adovasio, the crew was shocked to find that two of the dates pre-dated Clovis: 12,900 ± 650 B.P. and 13,170 ± 165 B.P. (Adovasio 2002). These dates had come from charcoal samples taken from hearths in the older stratigraphic layers.

These OTC dates and artifacts eventually led to the site and the excavators being dragged into what Adovasio (2002:164) termed the "Clovis/pre-Clovis wars." The excavations at Meadowcroft had been done with as much precision as possible, such as sieving everything through a series of tiny meshes, using water floatation, using hydrogen peroxide to process any charred material, and even excavating microstrata with razor blades, in an attempt to stave off some of the criticisms Adovasio and his team knew they would receive after the publication of the OTC dates (Adovasio et al.

1977; Adovasio 2002:171). Despite this, harsh criticisms were repeatedly made against the site's great antiquity and the implications of such old dates. For instance, criticisms were made concerning the type of floral and faunal remains recovered from the site. It was believed by some that the radiocarbon dates indicated that the site was occupied during the time the Wisconsinan glacier was near the area, and it was argued that the Meadowcroft flora and fauna did not match the same types of floral and faunal fossils of Wisconsinan-age (Mead 1980).

Additionally, C. Vance Haynes (1980b) and Dena Dincauze (1981) argued that contamination was likely the cause of the older dates. Contamination, they suggested, could have come from nearby outcrops of coal that mixed with the samples taken for dating, or that vitrified wood may have mixed with the samples (Haynes 1980b; Dincauze 1981; Adovasio 2002). In other words, some contaminants may have drifted down into the lower strata, or could have been moved by the fluctuating water table (Adovasio 2002). Adovasio (2002:180-181) noted, though, that while the dates of the older strata were questioned, the post-Clovis dates of the younger strata were accepted by these same critics without consideration of contamination for those upper levels.

The Meadowcroft team addressed these criticisms, finding no evidence to suggest that their initial results were incorrect (Adovasio et al. 1980; Adovasio et al. 1990). No coal or vitrified wood was found to have been near enough to the site to have affected the samples, but additional samples were taken and meticulously searched for coal or vitrified particles, none of which were identified within the samples (Adovasio 2002). Likewise, there was no evidence of groundwater saturation causing the movement of any contaminants through the sediments (Goldberg and Arpin 1999).

Continued research also showed that the Wisconsinan glacier was more than a hundred miles from the site during the time the cultural deposits would have been left at the site, and the countryside around the site would have been a mosaic of different ecosystems, thereby explaining the differences in the flora and fauna recovered at Meadowcroft from those recovered at other sites (Volman 1981; Guilday and Parmalee 1982; Adovasio et al. 1985; Adovasio 2002). Further, to eliminate any doubts that the OTC dates may have been caused due to laboratory errors, samples were sent to four different radiocarbon laboratories with the results being the same (Adovasio 2002).

Even after addressing the primary criticisms, though, doubt was still cast on the reliability of the Meadowcroft OTC dates for years, particularly since the critics (most of whom were well-looked-upon by the scientific community) refused to accept the evidence. Meadowcroft Rockshelter would not be generally accepted as an OTC site until after the discoveries made at Monte Verde in Chile. Adovasio (2002:171), however, wrote: "[o]ne of the most important aspects of all we accomplished at Meadowcroft is the often overlooked fact that it provided a nearly unique sequence of human habitation over a period of some 16,000 years." In this sense, the discoveries at Meadowcroft aided in the recognition and eventual acceptance of other OTC sites in the Americas.

Following the discovery of Meadowcroft, a gomphothere tooth and other bones were discovered at the site of Monte Verde in Chile in late 1975 and early 1976 after locals had cut into the Chinchihuapi Creek bank while clearing a path for their oxcarts (Dillehay 1997). Wood and stone artifacts were found in apparent association with the ancient faunal remains. In 1977, Tom Dillehay and his crew began excavations, uncovering bones with butchery marks, more stone tools, and clay-lined hearths, as well as perishable artifacts such as worked wood, cordage, and seaweed chews with human tooth impressions, all of which were preserved under peat-moss (Dillehay 1997). Additionally, buried under the boggy ground, they uncovered the remains of ancient residential structures and a human footprint (Dillehay 1997). Radiocarbon dates of 12,500 ^{14}C years B.P. and 33,000 ^{14}C years B.P. were obtained for the MV-II (upper) and MV-I (lower) OTC levels, respectively (Dillehay and Collins 1988; Dillehay 1997). As with Meadowcroft, strong criticisms were made of this discovery, particularly due to the OTC radiocarbon dates associated with the site.

An event that aided in breaking through the "Clovis barrier" was the organized site visit in 1997 of prominent archaeologists and Paleoindian researchers to Monte Verde (Meltzer et al. 1997). A forum on Paleoindian studies was first organized and held in Lexington, Kentucky, during which some of the Monte Verde materials that dated earlier than Clovis were examined and discussed (Meltzer et al. 1997). The site visit following the Kentucky forum was meant to allow the prominent researchers to view and evaluate the stratigraphy and artifacts from the MV-II and MV-I levels of the site, as well as to examine the site for any possible signs of disturbance or contamination that may have affected the results of the radiocarbon dating (Meltzer et al. 1997). After examining the site and the artifacts, the majority of the Paleoindian researchers agreed that Monte Verde did appear to be an OTC site, though the date associated with the MV-I layer was still considered suspect (Meltzer et al. 1997). This consensus agreed that humans had occupied South America prior to the dates associated with Clovis.

There was also another significant find reported in 1997 – Cactus Hill in Virginia (McAvoy and McAvoy 1997). At this site, the first good stratigraphic sequence of a Clovis component overlying an OTC component was found (McAvoy and McAvoy 1997). The find, however, was mostly ignored at the time.

Two years later in 1999, the *Clovis and Beyond Conference* held in Santa Fe, New Mexico further aided in breaking through the Clovis barrier. This conference again brought together some of the leading researchers of the peopling of the Americas to discuss new finds and theories (Lepper and Bonnichsen 2004; Bonnichsen et al. 2005). The conference was instrumental in eliciting more excitement on the subject of the first Americans, though it also brought to light more debates, especially from those who still held onto the belief that Clovis was representative of the earliest American occupations (Fiedel 1999).

Following the conference and with the escalating interest in first Americans studies, other disciplines such as Quaternary geology, linguistics, physical anthropology, oceanography, and glaciology began their own examinations of the riddle of the first Americans (Haynes 2002; Collins 2013). Combined with the archaeological studies, these multidisciplined investigations led to the wider acceptance of many other proposed OTC sites. Other sites now widely accepted as being OTC include, for example, Cactus Hill in Virginia (McAvoy and McAvoy 1997), Page-Ladson in Florida (Dunbar 2006), the Paisley Caves in Oregon (Gilbert et al. 2008), and the Gault (Collins and Bradley 2008; Collins et al. 2013b) site in Texas. These and other sites are now recognized as having yielded artifacts that date older than Clovis, some dating even greater than 12,500 ^{14}C years B.P. (about 14,000 – 15,000 cal B.P.), thus providing evidence that earlier cultures occupied the Americas prior to Clovis (Collins 2013; Collins et al. 2013b).

The Gault Site

For two decades now, the Gault site (41BL323) has been one of the major Clovis cultural sites in Texas and North America, and there is now evidence of deposits that date older than Clovis. The site is located in Bell County within the Balcones Ecotone (Fig. 1) and is about 250 meters upstream along Buttermilk Creek from the Debra L. Friedkin site (Collins 2002). The site itself is approximately 800 m long and 200 m across (Collins 2002). As evidenced by the copious amounts of archaeological materials recovered from the site dating from OTC up to the Late Prehistoric, the setting was especially appealing for early peoples (Collins 2002). Also, see Fig. 2 below for a topographic map showing the location of Gault.

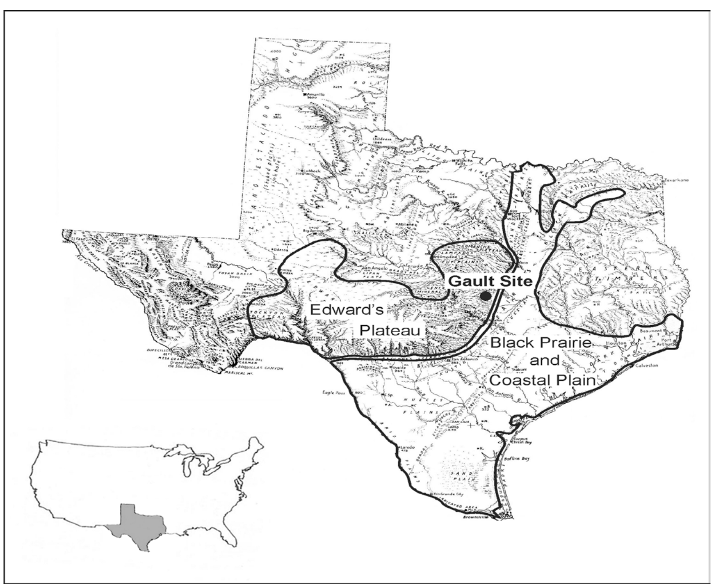


Figure 1. Map showing the location of the Gault site (41BL323), Central Texas. (Graphic courtesy of the Gault School of Archaeological Research.)

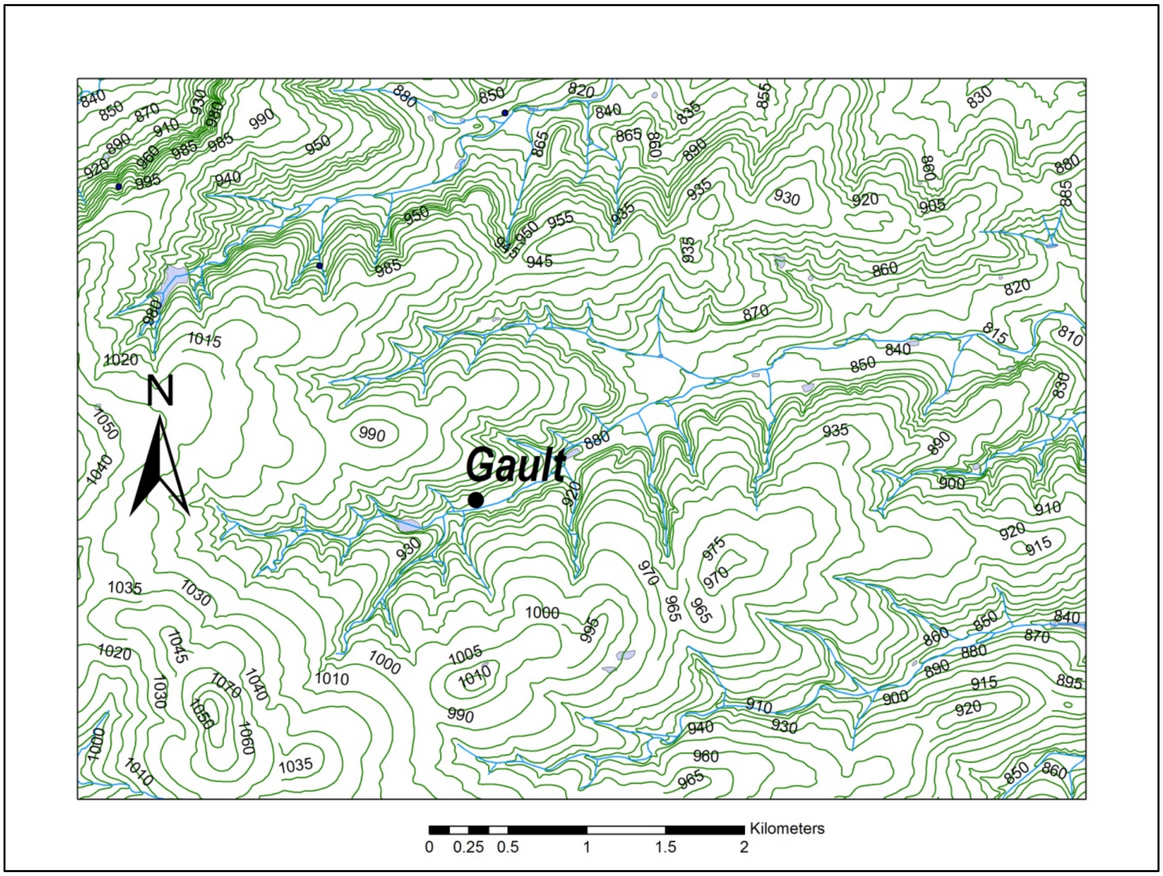


Figure 2. Topographic map of the Gault site and surrounding area. (Graphic courtesy of C. Britt Bousman.)

Occupants of the site had access to rich resources. The springs at the site provided reliable sources of water. Various forms of flora and fauna (such as horses, bison, mammoths, turtles, frogs, rodents, and birds) could be found at the site; and still other varieties could be found within about a day's walking distance due to how the numerous environment types (ranging from mesic to xeric) were linked within the Balcones Ecotone (Collins 2002). Adding to the appeal of the site, Gault also offered outcrops of high-quality chert for knapping. About 99% of the lithic artifacts found at the site, including lithic tools, whole and broken points, and the debitage from tool manufacture, appear to be made from the local chert (Collins and Brown 2000; Collins

2002; Collins 2007:67; Williams and Crook 2013). The Gault site was therefore an ideal occupation location for prehistoric hunter-gatherers, providing for many of their needs.

The early history of the site has been described in brief in Collins and Brown (2000) and Collins (2002). The Gault site was first discovered by artifact collectors and looters who were attracted by the abundance of artifacts found on or just below the surface of the ground. It first became known to the scientific community when collectors and looters brought the site to the attention of J. E. Pearce, a professor from the University of Texas, who dug at the site in 1929-1930. As digging continued at the site, it was discovered that there were archaeological deposits buried deeply and spread over a vast area. Later, probably beginning in the late 1960s and lasting until 1998, the landowners set the site up as a pay-to-dig site, allowing people to dig for artifacts for a fee. These paid diggings and continued looting destroyed much of the stratigraphically younger archaeological context of the site, particularly that of the Archaic deposits.

In 1990, David Olmstead, while digging at the site, discovered Clovis artifacts in deep deposits, including stones with elaborate engravings. He alerted professional archaeologists, including Tom Hester and Michael Collins, from the University of Texas at Austin who began brief testing at the site in 1991 (Collins et al. 1991; Collins et al. 1992). Their excavations uncovered more of these engraved stones, and they recognized that the looting and unprofessional digging had not disturbed the entire archaeological context of the site, particularly the deep Paleoindian strata (GSAR 2011a). Since 1998, ongoing investigations of the site, mostly focusing on the Paleoindian strata, have continued under the direction of Collins and with combined aid and effort from other organizations. Clovis artifacts were the most numerous artifacts found across Gault, making the site possibly the most extensive and dense Clovis site known thus far (Collins 2002; GSAR 2011a; Turner et al. 2011:75).

Discoveries at the site also added to the growing knowledge about the peoples occupying the site during the Clovis time-frame. For example, aside from some mammoth, horse, and bison bones, burned and unburned faunal remains from numerous species of small animals were associated with Clovis finds, suggesting that the peoples who occupied the site during that period were not solely specialized big game hunters, but had a broad spectrum diet (Collins 2002; 2007). Additionally, use-wear analyses have shown that many of the tools, such as the Clovis blades, were used for cutting grass which may have been used for bedding or thatching (Shoberg 2010). These discoveries, along with the fact that most of the lithic tools were made from chert found at or near the site, suggest a more sedentary pattern of living than the mobile lifeway once attributed to Clovis.

These were not the only discoveries at the site, however, that contributed to the growing knowledge of early peoples in the Americas. A few artifacts were also being recovered from beneath well-defined Clovis strata, and in 2002, a small test unit was dug to investigate the stratigraphic layers below Clovis (Collins 2002; Collins and Bradley 2008). Excavations temporarily ceased after this.

The Gault School of Archaeological Research (GSAR) was founded in 2006, and the members of the organization set out to continue research on the early Paleoindian levels of the Gault site (GSAR 2011a). A year later, the Gault site was bought and donated to the Texas Archaeological Conservancy (TAC), and excavations began again shortly afterward (GSAR 2011a). Since then, an abundance of artifacts, mostly lithic debitage, has been recovered from the levels below Clovis. Additionally, a feature interpreted as a stone pavement with two distinct toss zones (one of bones and another of lithic debitage) was unearthed in Area 12 of the Gault site and has been preliminarily dated by optically stimulated luminescence (OSL) as earlier than Clovis (Collins et al. 2013b). The preliminary OSL dates now associated with the older-than-Clovis levels in general fall between 13,500 and 15,000 cal yr B.P. (Collins et al. 2013b). Research on the artifacts collected from the OTC levels of Area 15 of the site, particularly the OTC debitage, is still ongoing and is the focus of this thesis.

Area 15 and the Stratigraphic Integrity of the Gault Site

At Gault, a number of excavation blocks were dug, each block area numbered according to the order in which the excavations in the blocks began. The excavation block known as Area 15 (Fig. 3) has been the main focus of excavation and research at the Gault site since 2007, due to the remarkable amount of cultural materials recovered from this area. The depositional processes of the area have also been of importance in deciphering the occupational history of the Gault site and the stratigraphic integrity of the cultural materials that were recovered. In her analysis of the site stratigraphy and deposition, Anastasia Gilmer (2013:80) found that Area 15 is made up of eight soil-stratigraphic horizons, which include two paleosols, and ten stratigraphic zones. OSL dates taken from the zones and horizons were also found to be in the expected stratigraphic order, suggesting that little or no disturbance may have occurred between the zones and horizons (Gilmer 2013).

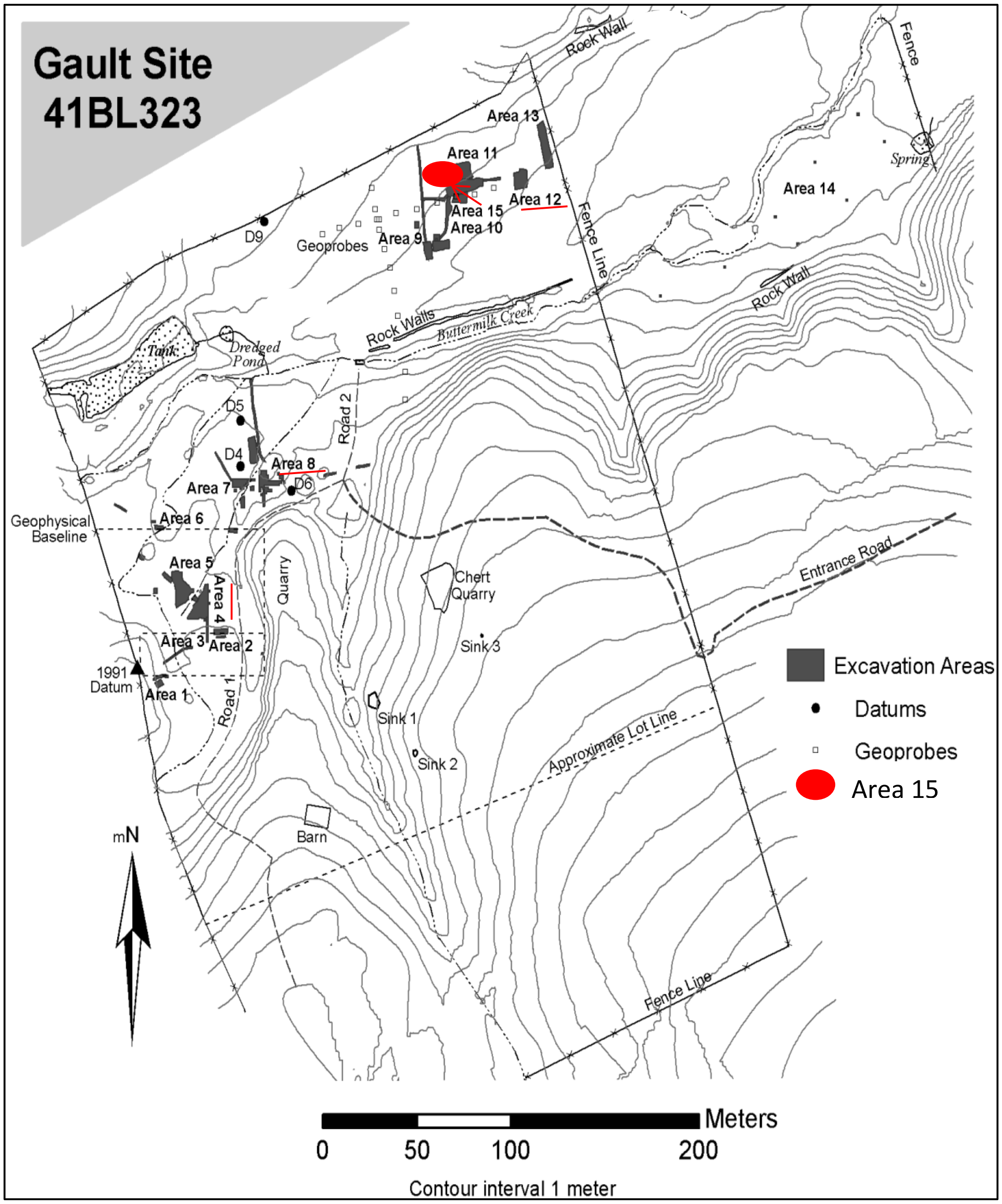


Figure 3. Gault site map showing the excavation areas. Area 15 is circled in red. Some areas discussed in the text are underlined in red. (Graphic courtesy of the Gault School of Archaeological Research and modified from Gilmer 2013:5, her Figure 2).

The Area 15 block rests on Lower Cretaceous limestone bedrock (Barnes 1974). The bedrock is overlain with fluvial, colluvial, and aeolian sediment deposits, many of which contain cultural materials (Gilmer 2013:26-30). See Fig. 4 below for a visual of part of the Area 15 stratigraphy. The uppermost archaeology-bearing deposit is associated with Late Prehistoric materials and the lowermost is associated with OTC materials. Like much of the site, Area 15 had little in the way of cultural materials from Late Prehistoric deposits (1,200 - 250 cal B.P.), mostly materials missed by looters (Collins 2002). Situated below the Late Prehistoric deposits are Archaic deposits (8,900 – 1,200 cal B.P.), some of which are about 2.5 m thick. Though many of the Archaic deposits across the site have been heavily disturbed by looting, part of these deposits appear to be intact in Area 15, and diagnostic points recovered from this area appear to span the Archaic period (Collins 2002; GSAR 2011b).

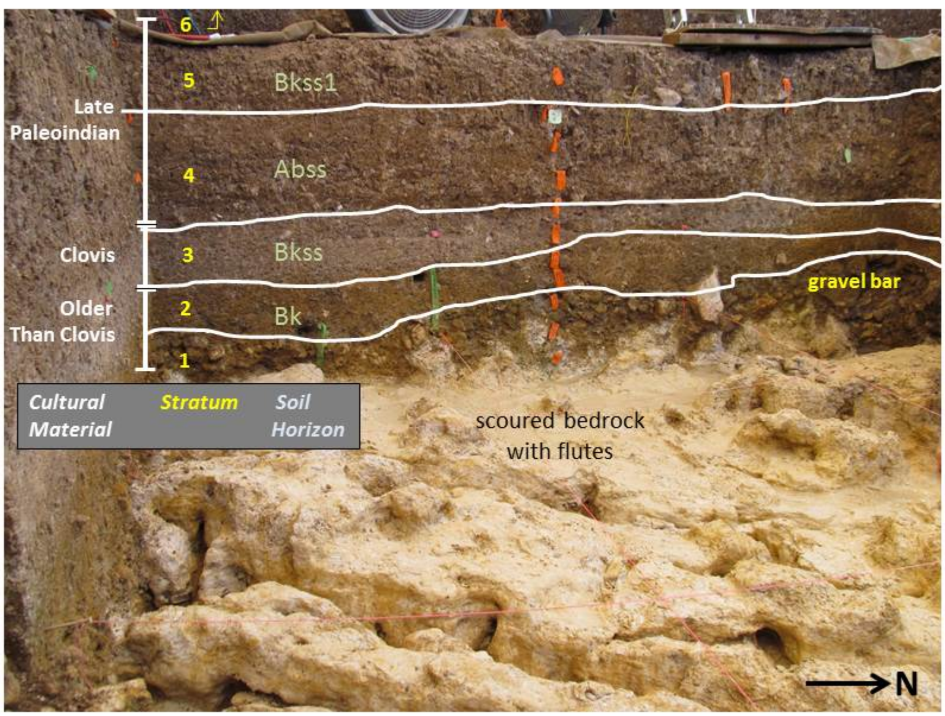


Figure 4. West wall profile from Area 15 showing the soil and cultural horizons from Late Paleoindian to OTC and bedrock. (Image courtesy of Anastasia Gilmer and Sergio Ayala.)

The deposits of Paleoindian age (>12,000 – 8,900 cal B.P.) at Area 15 appear to be intact, though the Late Paleoindian cultural materials are more sparse than the Early

Paleoindian cultural materials. The Early Paleoindian period is exemplified by the presence of Folsom, Clovis, and OTC components. While the Folsom component of Area 15 is represented by a somewhat meager lithic scatter and few diagnostic artifacts, the Clovis component is much more pronounced (Collins 2002). Diagnostic Clovis cultural materials have been recovered from a dark silty clay stratum infused with soft carbonate nodules between the approximate elevations of 92.75 - 92.65 m (Collins and Bradley 2008; Gilmer 2013:128).

Below this, at about 92.65 - 92.50 m, the amount of pedogenic calcium carbonate begins to increase and there is a significant reduction in the amount of cultural material per unit (Gilmer 2013). No clearly-identifiable, diagnostic Clovis artifacts were recovered from within these 15 cm (Michael Collins, personal communication 2013). This could represent a possible break or reduction in occupation at the site (Collins and Bradley 2008; Michael Collins, personal communication 2013; Gilmer 2013).

Below 92.50 m, there was an increase in the amount of cultural materials recovered (Collins and Bradley 2008). Preliminary observations of bifaces and some debitage recovered from below 92.50 m were made by Collins (personal communication 2013). He determined that the bifaces were morphologically and technologically different from bifaces made using Clovis production techniques, and most of the debitage flakes appeared in general to be smaller in flake size but slightly larger in platform size. Cultural materials recovered from below 92.50 m were therefore not thought to be technologically Clovis, and thus were believed to represent a different lithic assemblage or technology, an idea further investigated by the present study. OSL dates for the OTC layers, now known to be approximately 80 cm thick, range from about

13,300 - 13,800 B.P. (Collins and Bradley 2008; Michael Collins, personal communication 2013).

There has been some controversy over whether or not the nearby Friedkin site has stratigraphic integrity, and whether the artifacts found below noted Clovis horizons are “older-than-Clovis” or if they are Clovis artifacts that were just displaced. Morrow et al. (2012) argue that the published data on the Friedkin site (Waters et al. 2011) presents a number of problems. First of all, they noted that there was problematic dating in the published Friedkin article, possibly meaning that some of the ages for the cultural layers had been overestimated. Also, Morrow et al. point out that the Friedkin site area has a vertisol, and thus the shrink-swell processes of the vertisol may have resulted in the downward movement of cultural artifacts into lower layers (Schaetzl and Anderson 2005; Graham 2006; Hildebrand et al. 2007). They note that Waters et al.’s data show signs of size-sorting, with the smaller pieces of lithic debitage being stratified in lower layers, likely caused by the displacement of smaller artifacts that fell down the vertisol cracks. Additionally, there was evidence of bioturbation, such as the discovery of an Early Archaic Martindale point in a krotovina within the Clovis horizon. Thus it is possible that the proposed OTC artifacts were Clovis artifacts that had been translocated into lower strata due to bioturbation and natural processes, particularly since the debitage recovered from below the known Clovis layers had undisputed Clovis traits (Waters et al. 2011; Morrow et al. 2012).

In the Gault area, the soil has also been classified as a vertisol. However, the problems associated with the Friedkin site do not appear to apply equally to the Gault site. If the downward movement occurred, it may be evidenced through the size-sorting of cultural materials. This does not seem to be the case at Gault (Ayala 2013; Gilmer 2013). At the Gault site, the widest of the vertisol cracks were at the surface, with the crack sizes decreasing with depth (Gilmer 2013). Additionally, Sergio Ayala's (2013) on-going research on Andice points and notching flakes has demonstrated that the cultural materials within the strata of Area 15 appear to have only moved slightly or not at all through the soil matrix. The distinctive notching flakes produced from Andice point manufacture are very small, easily small enough to fall into cracks in the soil, dispersing them along a greater range than the points themselves. However, the notching flakes found at the Gault site appear to be tightly clustered between 94.30 and 94.40 m with thinner scatters slightly above and below these elevations, which would not be expected if the tiny notching flakes were being displaced by the vertisol cracks (Ayala 2013; Collins et al. 2013a). Rather than flakes and other artifacts falling down the cracks, it appears that they are actually gripped and held in place by the sticky clay in the cracks' walls (Ayala 2013; Collins et al. 2013a). Therefore, this demonstrates that it is unlikely that the shrink-swell processes of the Gault vertisols have had much effect on the distribution of cultural materials within or between the stratigraphic horizons.

Aside from the shrink-swell processes of vertisols, this type of soil has also been shown to be self-mulching, meaning that the soil tends to move and mix its contents, in some cases translocating material from deep strata to the surface (Wilding and Tessier 1988). In this case, cultural materials could be mixed and moved from one stratum to another with older materials being moved up toward the surface and younger materials being moved down into older strata. In the case of the Gault site, a gravel bar is present near the base of the OTC profile (Gilmer 2013). Since these gravels do not appear to have been disturbed or vertically moved within the profile, it does not appear that the Gault vertisol is actively self-mulching (Gilmer 2013).

In addition to the analyses of the Gault vertisol, another important avenue of investigation has been the examination of the formation and distribution of calcium carbonate nodules (Luchsinger 2002; Gilmer 2013). Calcium carbonate can form both pedogenically and from carbonate-rich groundwater (Luchsinger 2002; C. Britt Bousman, personal communication 2013; Michael Collins, personal communication 2013). According to Luchsinger (2002:104-107) and Collins, the calcium carbonate nodules from above 92.35 m in Area 8 were pedogenically formed, and the increase in the amount of calcium carbonate with depth reflects the age of the deposits. In other words, older strata are expected to have more calcium carbonate present than younger strata, and artifacts recovered from older strata are expected to have more calcium carbonate covering them than those recovered from younger strata. At Gault, the percentage of calcium carbonate was found to steadily increase with depth, with the materials in the OTC strata having the highest percentage (Luchsinger 2002; Gilmer 2013). This also demonstrates that little to no self-mulching was occurring in Area 8, at least down to the elevation of 92.35, as no materials with a heavy coating of calcium carbonate were found translocated into higher, younger strata. The strata below 92.35 m, however, were located approximately below the general water-table level and thus were found by Gault Project excavations to be generally under water (Michael Collins, personal communication 2013). Below this elevation at Area 8, there is some evidence of the formation of calcium carbonate due to the carbonate-rich groundwater. At Area 15, though, much of the OTC components lie below the levels of pedogenic carbonate and in an area affected by ground water carbonate (Michael Collins, personal communication 2013).

Furthermore, Alexander (2008) looked at artifact orientation and Clovis refits (recovered from the ~35 cm Clovis deposits) from another part of the site (Area 8, slightly southwest of Area 15). Her goal was to determine the extent to which the cultural materials collected on the valley wall from Area 8 may have been influenced temporally and spatially by natural agencies (Alexander 2008). In other words, she was attempting to determine if secondary displacement of cultural materials had occurred at Gault. She recorded artifacts larger than 2.5 cm in situ during the excavations of the area, noting the long axis relative to magnetic north and the degree of dip of each of the cultural materials. Her study found no evidence of non-random orientations resulting from stream action or other natural processes, meaning that there was little to no evidence that natural agents were causing artifacts to be displaced. Further, Alexander analyzed the vertical and horizontal relationships of the artifacts that refit. Thirty-three groups of refitting artifacts (n=73 total individual pieces) were identified, and twenty-two of the groups (67 percent) were found to have a vertical difference of 5 cm or less between the pieces (Alexander 2008). This means that only a small degree of vertical displacement was occurring. Therefore, natural processes such as bioturbation and stream alteration only had a minimal effect on the movement of cultural materials through the Area 8 strata. The orientations and stratigraphic positions of the artifacts, then, were primarily the result of cultural activities with only minimal movement due to natural agents (Alexander 2008). Since there seems to be very little artifact movement due to natural agents, Alexander's results suggest stratigraphic integrity at the site.

Moreover, even if processes such as bioturbation were active within the Gault soils at Area 15, the 15 cm-thick stratum at 92.50-92.65 m, which contained much fewer cultural materials per unit than the strata above and below it, separates the Clovis from the OTC strata (Collins 2013). This stratum is thick enough to have acted as a stratigraphic buffer under conditions of low to moderate bioturbation. There is very little notable evidence of bioturbation, or even micro-bioturbation, within or between the Area 15 stratigraphic layers due to the thickness of the stratum (Gilmer 2013; Nancy Littlefield, personal communication 2013). The downward drift of artifacts due to bioturbation from the Clovis layers through the 15 cm buffer stratum and into the OTC layers, therefore, does not appear to have occurred.

Finally, Gilmer (2013:122) analyzed the overall depositional and post-depositional integrity of the sediments and cultural materials at Area 15 with a special focus on the Clovis and OTC stratigraphic layers. She conducted analyses on bulk soil samples (taken mostly in 5 cm increments) from Area 15, including standard sediment and soil analyses to examine and interpret sedimentary processes, pedogenic qualities of the soil, and the effects of post-depositional processes on the sediments and stratigraphy (Gilmer 2013). Field descriptions and profile illustrations were also used to determine the attributes of the stratigraphic units and soil horizons, such as soil structure, texture, and color (Gilmer 2013). Additionally, Gilmer performed particle size analyses and looked at calcium carbonate content of the stratigraphic layers. From these analyses, she was able to map out some of the depositional and post-depositional processes at Area 15. She found that the Clovis and OTC layers were separated into distinct stratigraphic layers and soil horizons; and her analyses supported the claim of the presence of a 15 cm "buffer zone" separating the two cultural layers, particularly by finding (with the help of Nick Rodriquez) a decrease in the amount of cultural materials noted as being recovered from this 15 cm layer (Gilmer 2013). Through her combined analyses of the field descriptions, studies of the soil and sediment deposition, and post-depositional processes, Gilmer determined that the context of the Paleoindian stratigraphy, including the OTC strata, appeared to be preserved.

Thus, according to the findings of Luchsinger (2002), Alexander (2008), and Gilmer (2013), the Paleoindian stratigraphy of the Gault site appears to have good integrity. To sum up their works, Luchsinger (2002) found that there is not much movement of items caused by the vertisols since the artifacts with the most calcium carbonate were found in the lower deposits instead of transposed to the upper deposits. Alexander (2008) determined that cultural materials appeared to move no more than about 5 cm vertically in the Gault soils. Finally, Gilmer's (2013) analysis also supported the presence of a 15 cm "buffer zone" at Area 15 which had fewer cultural materials per unit, separating the Clovis and OTC strata. Taken together, then, these analyses imply preserved stratigraphic contexts for the cultural components at Gault.

Debitage Analysis: What is debitage, how is it analyzed, and why?

As the above implies, the artifacts from the OTC stratigraphic layers do not appear to have drifted down (at least no more than 5 cm) to their current elevations from the Clovis layers, and thus a different cultural component is represented by the presence of this cultural material. Is the cultural material similar to or a precursor of Clovis? How does the material differ from Clovis materials? Since the most abundant type of artifact collected from Area 15 of the Gault site is lithic debitage, this material is used herein to investigate and define OTC technology in comparison with Clovis technology.

Debitage, in the French sense of the term, means the intentional action or actions used in fracturing a block of raw material in order to either use the resultant fragments (or blanks) or to further fashion other products from the core material (Inizan et al. 1999:59). In the American or English use of the term, as it is used here, debitage is the "residual lithic material resulting from tool manufacture" (Crabtree 1972:58). This includes lithic flakes and flake fragments, angular chert, and shatter. Debitage is created through direct percussion (which includes soft and hard hammer percussion), indirect percussion (which may involve the use of other tools such as punches and anvils), and pressure flaking.

Debitage can be used by researchers to learn about human behaviors since it is one of the most numerous artifacts that portray or are the result of human actions and behaviors (Michael Collins, personal communication 2013). Much, therefore, can be learned from the analysis of debitage (Andrefsky 2001; Odell 2003; Andrefsky 2005). One of the most simple things that can be learned from looking at the debitage of a site is what kinds of materials were chosen for knapping and whether or not those materials are found locally or brought to the site from elsewhere. Also, debitage can show if heating (whether intentional or unintentional) occurred by the presence or absence of pot-lidding and crazing or by demonstrating a color change (often to a pink or red color in cherts) or luster. Additionally, scatter zones of debitage can be used by researchers to interpret how areas of a site may have been used, such as a lithic workshop. Further, refitting debitage can aid researchers in determining the steps and processes of tool manufacture and what types of tools were being made. Finally, certain forms of debitage can be useful in determining what type of cultural technology was being used at a site at a certain time.

Andrefsky (2001) notes that there are three main types of debitage analysis: mass (or aggregate) analysis, typological analysis, and attribute analysis. Each of these types of analyses become somewhat more specific in their focus, beginning at the least specific, the aggregate or population level, moving to the individual types, and finally to the attributes of each of the types (Andrefsky 2001:3). Mass or aggregate analysis is actually one of the most popular types of debitage analysis. As Andrefsky explains, in this type of analysis, the entire assemblage of debitage is stratified by some uniform criteria, such as size. Then the relative proportions of debitage in each of the strata are compared. Different assemblages can also be compared to find similarities and differences in the populations when they are each stratified. The size of the debitage is the most often used uniform criteria in this form of analysis, though weight and length may also be used (Andrefsky 2001). Size is often obtained by pouring debitage through a series of nested screens. Size grades are considered useful because they are standardized by the screen mesh sizes, and thus make the analysis replicable. The debitage size is also used because it is generally believed that it is directly related to the size of the objective piece. This is because artifact production is a reductive process with the debitage becoming progressively smaller as the artifact is nearly completed (Andrefsky 2001). It is often assumed that this type of analysis can be used, therefore, to determine production stages. However, when using this method, the different kinds of tools or cores that were made cannot generally be identified from the lithic assemblage, along with other limitations.

Typological analysis, conversely, does not have this drawback. This form of analysis focuses on individual debitage specimens, most often flakes, and these artifacts are classified into types. These types are generally used to provide some kind of technological or functional meaning. In typological analysis, one advantage is that behavioral inferences may be immediately gained by recognizing a single, specific piece of debitage; for example, finding a notching flake in an assemblage might lead to the hypothesis that notched tools or points were produced at the site (Andrefsky 2001). The main problem with this type of analysis, however, is that there may be a lack of consistent and replicable definitions for debitage typologies. Despite this problem, typological analysis remains a popular form of debitage analysis.

Further, Andrefsky (2001:6-9) identified four different kinds of typological analysis: application load typologies, technological typologies, cortex typologies, and free-standing debitage typologies. Application load typologies focus on classifying flakes according to the kind of force (i.e. hard or soft hammer percussion or pressure flaking) used to detach a flake. When using technological typologies, analysts separate debitage into groups based on the reductive technology employed to detach flakes from a core. For cortex typologies, the amount of cortex on the debitage pieces is used as a proxy for reduction stages, in which flakes may be classified as primary, secondary, or tertiary. Finally, free-standing debitage typologies use objective replicable criteria to build the typology and may be used to compare technological assemblages (Andrefsky 2001). For example, Sullivan and Rozen (1985) note their use of technological attribute keys to define four debitage categories: complete flake, broken flake, flake fragment, and debris.

The final main type of debitage analysis is attribute analysis. This type of analysis involves selecting and recording debitage characteristics or attributes, generally looking at patterns at the population level. This is in contrast to the typological analysis which examines debitage attributes on each individual specimen (Andrefsky 2001). This type of analysis has been used to interpret technology, artifact type, and reduction stages according to some combinations of attributes. For example, the characteristics of striking platforms are commonly recorded attributes since they can indicate the kind of technology that was used at a site according to the debitage (Andrefsky 2001:9-10). However, problems with this form of debitage analysis include reliability and replicable measurement since many of the attributes or ways in which the debitage is measured can be subjective. Additionally, this form of debitage analysis is time consuming.

These different forms of debitage analysis are not mutually exclusive. Combinations of the analyses can be used in studies and can complement each other. Within this thesis, as will be discussed in the following chapter, the debitage from the OTC levels of the Gault site will be examined. Typological and attribute analyses of the debitage will be used in the interpretation of the technology used during the OTC occupation(s).

CHAPTER 3

Methods

Materials and Preparations for Analysis

At Area 15 of the Gault site, as was previously discussed, the most numerous type of artifact recovered was lithic debitage. Since debitage is so common and can readily be used to interpret and define the technology used during cultural occupations, this type of artifact was chosen for analysis. Of the twelve 1-x-1 m units dug (mostly in 5 cm levels) down to OTC levels, six units were selected for this study (Fig. 5).

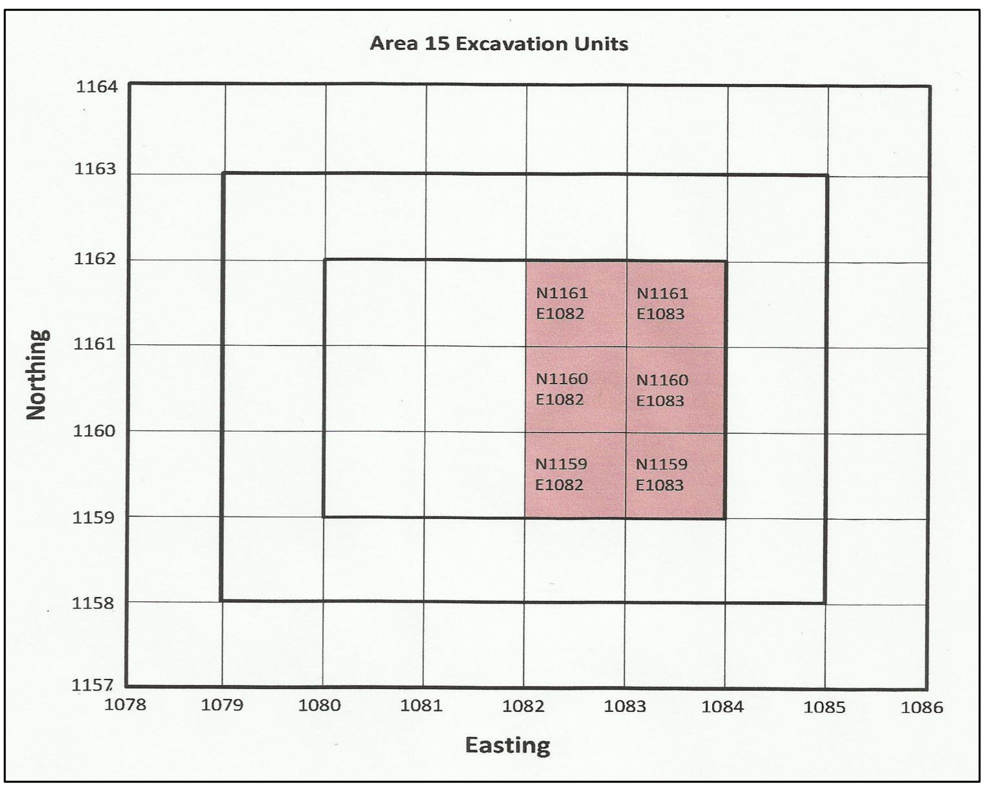


Figure 5. Layout of the excavation units at Area 15. The lithic debitage analyzed in this study was recovered from the six colored units. (Image courtesy of the Gault School of Archaeological Research.)

From these units, about 152 lot bags of cultural materials were collected. (Six lot bags, however, could not be located, and so were not included in this study.) Processing one lot bag at a time, the individually bagged and provenienced lithic artifacts and the bags of general ¼ inch materials were separated from the other cultural materials. Many of these artifacts were covered in damp, sticky clay, and so, in preparation for analysis, the provenienced artifacts were laid out to be air-dried. These provenienced artifacts were not washed since a number of them might be used in other analyses, such as starch grain analyses. The general ¼ inch debitage was rinsed off with warm water by gently agitating the artifacts in a non-metallic sieve and then laid out to be air-dried. These forms of light cleaning allowed the characteristics or attributes of the lithic debitage to be more observable.

After the provenienced and general lithic artifacts were dried, the lithic flakes were separated from the angular chert and shatter. Of the lithic flakes, only the flakes with identifiable striking platforms or platform remnants from which the attributes described below could still be discerned were selected for analysis. A total of 2,395 flakes with identifiable platforms or platform remnants (a 100% sample) were selected and given unique numbers for this analysis, ranging from OTC-1 to OTC-2395. For each of these flakes, a group of attributes and metric data were recorded for interpretation.

Attributes and Measurements

A number of attributes and flake measurements were chosen to get the most information for defining the OTC materials. (See Appendix A for detailed definitions of each of the attributes and flake measurements.) The attributes included in this study were: flake condition, type of termination, flake type, dorsal cortex, size of the bulb of percussion, and platform traits such as type of platform, platform lipping, and evidence of platform preparation. Each of these attributes was recorded for each specimen in a Microsoft Access 2010 database. Flake condition, for instance, was recorded to note whether flakes were whole or broken. A flake was categorized as "whole" if there was very little or no evidence of breaking on the flake (Table A-1a); "transversely broken" if part of the distal end of the flake was broken off (Table A-1c); or "longitudinally broken" if there was a vertical break from or near the striking platform to the distal end along the longitudinal axis (Table A-1b).

For whole flakes and longitudinally broken flakes which retained enough of an identifiable distal end, the recognizable terminations were identified as feather (Table A-2a), hinge (Table A-2b), or overshot (Table A-2c). Step terminations (Table A-2e) are also a common type of flake termination. However, since they are often difficult to distinguish from the distal end of a flake that has been broken transversely after removal from a core, step terminations are considered synonymous here with broken terminations. Therefore, the terminations of transversely broken flakes were all identified as step terminations. A plunging termination (Table A-2d) category was later added to the termination categories as a distinction from overshot terminations. Overshot terminations occur when a flake is struck from one edge of a biface, travels across the midline, and stops at and removes part of the opposite edge; whereas, a plunging termination occurs when a flake, often a blade or channel flake, is struck and the distal end, instead of terminating at the end or edge of a core, plunges or swoops under it and up a short distance on the opposite side (Michael Collins and Tom Williams, personal communications 2013).

Next, some of the flake type designations used in this study were biface thinning flakes (Table A-3a) and sequent flakes (Tables A-3e-h), which refer to flakes identified by specific morphological characteristics. Blades (Table A-3b), though they may also be considered tools, were considered a flake type category here since blades are flakes that are twice as long as they are wide. Flakes which did not fall into any of the abovementioned categories were designated as either "normal flakes" or "other." Normal (i.e. "plain" or "generic") flakes (Table A-3c) have the general characteristics of a flake, such as a platform and recognizable dorsal and ventral sides, but have no other differentiating or defining characteristics. Flakes labeled as "other" (Table A-3d) are abnormal flakes which do not fall into the aforementioned types, but which have some distinct characteristic or characteristics that set them apart. Notes were taken on what kinds of flakes were placed in the "other" category.

The patterns of flake conditions, terminations, and types of flakes most common to the OTC levels at Gault were useful in interpreting the probable techniques and tools employed in lithic tool manufacture and which resulted in the production of the flakes examined in this study. These patterns further allowed for the interpretation of the types of tools that were being produced. This in turn provided insight into some of the behaviors of the ancient peoples present at the site.

Following the recording of the abovementioned data, the amount of dorsal cortex (the natural, weathered, outer surface or covering of a stone piece or core) was estimated. The presence of dorsal cortex was documented similarly to the technique demonstrated in Andrefsky (2005:104-107), ranking the amount of cortex on a scale of 1 to 4 (1 = no cortex or 0% (Table A-4a); 2 = ≤50% (Table A-4b); 3 = >50% (Table A-4c); and 4 = 100% (Table A-4d) dorsal cortex present). The ranking of cortex on each of the flakes was determined by sight, estimating the approximate percent of cortex by how much of the dorsal surface of a flake appeared to be covered. The amount of cortex present on a flake was useful because it can tentatively be correlated with the stages of reduction (Andrefsky 2001). For instance, if a flake's dorsal surface was completely covered in cortex (100-percent), it could be interpreted as a flake that was removed early in the reduction sequence. If no cortex was present on the dorsal surface of a flake, the flake could be interpreted as being removed later in the reduction sequence. Thus, the cortex was used to look for possible patterns of reduction sequences.

The bulb of percussion was also examined and labeled as "flat," "normal," or "exuberant," using the states outlined in Collins (1974). Flat bulbs (Table A-5a), as their name implies, are considered relatively flat and may or may not have a lip protruding above them. Normal bulbs (Table A-5b) denote bulbs that are visibly present, but which are not very pronounced. Exuberant bulbs (Table A-5c) are strongly pronounced. The size of the bulb of percussion was recorded to aid in interpreting what kinds of tools where used to produce the OTC debitage, such as hard-hammer and soft-hammer percussors. For instance, Collins (1974:165-167) notes that flat bulbs, whether having a visible lip or not, have been shown experimentally to be produced by soft-hammer percussion during the thinning of bifaces. Therefore, these data were useful for inferring potential knapping behaviors of the ancient culture(s) represented at Gault.

The type of platform of each specimen was described, as well. Platform type categories in this study were: cortical (Table A-6a), single-faceted (Table A-6b), dihedral (Table A-6c), multi-faceted (Table A-6d), and ground (Table A-6e). These platform types were distinguished by either being covered by cortex, by being completely ground, or by the number of facets present. The category "crushed" (Table A-6f) was also added to include those flakes which have platforms that have been partially crushed off, leaving a remnant from which the other attributes may still be discerned. The type of platform, along with other platform attributes discussed below, also represent human behavior. For instance, these attributes may represent the amount of time and effort the knappers chose to spend on preparing the platform in order to remove a flake in a predictable way.

Further, the type of lipping was identified on each flake. For this study, the types of lipping on the flakes were recognized as "lipped," "prominently lipped," or "no lipping." "Lipped" (Table A-7b) denotes a flake that has a lip, or protrusion from the striking platform, that can be seen or felt when a finger is run across where the ventral flake surface and the platform meet. A designation of "prominently lipped" (Table A-7c), however, denotes a flake with a large, or heavy, visible lip. If lipping was not observed on the flake or could not be felt with a finger, a designation of "no lipping" (Table A-7a) was given. Lipping was also a useful attribute for interpreting the possible types of tools using in the flaking process.

Additionally, evidence of platform preparation for flake removal was recorded. These attributes were noted as being present or absent on or near the flake platform. The platform preparation attributes include reduction, releasing, platform isolation, platform abrasion, and dorsal surface abrasion near the flake platform. Flake platforms were considered reduced if there was evidence of small flakes taken off the dorsal side of the flake near the platform to raise the margin (Table A-8a). Flakes were labeled as "released" if there was evidence of small flakes or notches made near the platform that ran from the dorsal to the ventral surface, "releasing" the platform from the core or biface and helping to guide the removal of the flake (Table A-8b). Platform isolation was used to note whether or not the platform appears to have been intentionally isolated by the removal of smaller flakes around the platform area on the distal surface. Flake platforms were designated as "isolated" (meaning the platform appeared to be intentionally isolated or freed from the core mass) (Table A-8c) or "not isolated." Similarly, platform abrasion (Table A-8d) and dorsal surface abrasion near the flake platform (Table A-8e) were identified as being present or absent on each flake. These were observed as intentional abrasion (or grinding) that could be seen with or without a microscope or that could be felt with the finger in some cases. As mentioned above, these attributes were used in interpreting human behaviors such as predicting and preparing flake removals.

Furthermore, the presence of thermal damage on the flakes was recorded. Thermal damage results from changes in temperature, most often heat, being applied to the flakes after they are removed from the core or tool. Chert, the most common type of flaking material at Gault, has water trapped within it (occupying interstices among the cryptocrystals making up the chert), and as it is heated, the water vaporizes into steam (Leudtke 1992:99-101). If heated too quickly or at too high a temperature depending on the chert's chemical make-up and moisture content, the steam builds up pressure and, as a means of escaping the material, it causes fractures (crazing) (Table A-9a) to form and some fractures may result in pot-lids (small, circular convex fragments of chert) (Table A-9b) to pop off the chert core or tool (Leudtke 1992:106). As it is used here, a flake was considered to have thermal damage if it exhibited crazing or pot-lidding. This attribute was recorded in order to see if there were any patterns indicating areas of heating within the deposits that might be where fires had been built in the past.

In addition to the flake and platform attributes, the weight of each flake was recorded in grams using a Scout Pro Digital Scale, and metrics were recorded in millimeters using Hawk 4" Carbon Fiber Composites Electronic Digital Calipers. Two sets of flake lengths and widths were measured on each flake. First, the trajectory flake length (Table A-10a) was measured from the point of impact on the platform, straight down the trajectory axis to the distal end of the flake. The trajectory flake width (Table A-10b) was measured from the widest section of the flake perpendicular to the trajectory length. Second, the morphological flake length (Table A-10c) was measured from the point of impact, following the ripples to the endpoint, or distal-most point, of the flake. While it was used to measure the greatest flake length following the concoidal ripples, the morphological length did not always follow the trajectory axis. The morphological flake width (Table A-10d) was measured from the widest section of the flake perpendicular to the morphological flake length. Flake thickness (Table A-10e) was also recorded by measuring the thickest part of the flake.

Aside from these basic measurements of each flake, measurements of depth and width were also taken on the striking platforms. Platform depth (Table A-10f) was measured from the point of impact on the edge of the platform on the ventral side of the flake, straight back to the dorsal side of the flake platform. Platform width (Table A-10g) was measured from one end of the platform or platform remnant to the other, perpendicular to the line of measurement of the platform depth.

Together, all of these forms of data (attributes and metrics) were used to discern patterns within the debitage sample. The interpretation of these patterns was used to define characteristics of the OTC debitage, and thus part of the production technology used at Area 15. This provided a base for a tentative comparison with Clovis technology in order to determine how similar or dissimilar the two technologies appear to be.

Statistical Analyses

Basic statistics, mostly bivariate analyses, such as linear regression, were run and recorded in order to look for significant patterns in the data. These also included calculating basic sums and percentages of the occurrence of each of the individual attributes, as well as the mean, median, mode, standard deviation, and range of the measures. (See Appendix B.) Two sets of chi- square tests were run in SPSS Statistics 21.0 (IBM Corp. 2012) and were used in order to compare the observed data and the data expected to be observed according to certain hypotheses. The first set of chi-square tests looked at the attributes according to flake type. The second set of chi-square tests split the sample by flake type, and then looked at the attributes according to the amount of dorsal cortex in order to see if patterns of flake reduction could be interpreted from the data. Additionally, cluster analyses were run in SPSS and JMP Pro 9 (SAS Institute Inc. 2010). The patterns identified through these statistical analyses aided in the OTC debitage from the Gault site, and thus in interpreting what kind of technology or technologies were being used at the site.

CHAPTER 4

Results

Entire Sample

Of the sample of 2,395 flakes analyzed in this study, about 65 percent (n=1,562) were considered to be whole flakes, 34 percent (n=820) were broken transversely, and only 1 percent (n=13) was broken longitudinally (Table 1). Concerning the average sizes of these flakes, the mean average trajectory flake length for the entire sample was 17.0 mm with a standard deviation of 10.1 mm, and the mean average morphological flake length was 17.7 mm with a standard deviation of 10.5 mm. Both forms of length measurements were on average greater for whole flakes and for longitudinally broken flake, while the lengths were shorter for transversely broken flakes, as would be expected. On average, concerning the total sample and when broken down by flake condition, there was not a significant difference between the trajectory and morphological lengths, with the morphological flake lengths only being slightly longer. (See Tables 2-6 for lists of means, medians, modes, standard deviations, and ranges, some of which will be discussed below.)

Table 1. Flake counts and percentages of flake condition.

	Flake Condition			
	Whole	Transversely Broken	Longitudinally Broken	Total
Count	1562	820	13	2395
Percent (%)	65	34	1	

Table 2. Metrics of the entire sample.

Total Flakes Metrics (n=2395)								
	Trajectory Flake Length (mm)	Morphological Flake Length (mm)	Trajectory Flake Width (mm)	Morphological Flake Width (mm)	Flake Thickness (mm)	Platform Depth (mm)	Platform Width (mm)	Flake Weight (g)
Mean	17.0	17.7	16.2	15.7	3.2	2.1	8.0	1.7
Median	14.2	14.6	13.8	13.5	2.5	1.6	6.5	0.5
Mode	9.3	11.8	13.0	8.7	1.7	1.0	6.3	0.2
Standard Deviation	10.1	10.5	8.3	7.9	2.3	1.5	5.1	4.7
Maximum	105.3	105.3	75.4	69.4	21.0	18.1	62.7	75.2
Minimum	4.2	4.2	4.2	4.2	0.4	0.3	0.9	0.1
Range (Max. – Min.)	101.1	101.1	71.2	65.2	20.6	17.8	61.8	75.1

Table 3. Metrics of the whole flakes.

Whole Flakes Metrics (n=1562)								
	Trajectory Flake Length (mm)	Morphologica l Flake Length (mm)	Trajectory Flake Width (mm)	Morphologica l Flake Width (mm)	Flake Thickness (mm)	Platform Depth (mm)	Platform Width (mm)	Flake Weight (g)
Mean	17.3	18.2	15.9	15.3	3.1	2.1	8.0	1.7
Median	14.3	14.7	13.2	12.8	2.4	1.6	6.4	0.4
Mode	9.6	11.8	13.0	8.7	2.0	1.0	6.3	0.2
Standard Deviation	10.5	11.1	8.8	8.2	2.4	1.6	5.4	5.0
Maximum	105.3	105.3	75.4	69.4	21.0	18.1	62.7	75.2
Minimum	4.4	4.4	5.3	5.3	0.6	0.4	0.9	0.1
Range (Max. – Min.)	100.9	100.9	70.1	64.1	20.4	17.7	61.8	75.1

Table 4. Metrics of the total broken flakes.

Total Broken Flakes Metrics (n=833)								
	Trajectory Flake Length (mm)	Morphological Flake Length (mm)	Trajectory Flake Width (mm)	Morphological Flake Width (mm)	Flake Thickness (mm)	Platform Depth (mm)	Platform Width (mm)	Flake Weight (g)
Mean	16.5	16.8	16.6	16.5	3.3	2.1	7.9	1.7
Median	14.1	14.3	15.0	14.8	2.6	1.7	6.8	0.6
Mode	10.3	10.3	13.0	13.0	2.2	1.3	5.0	0.2
Standard Deviation	9.2	9.4	7.3	7.2	2.1	1.4	4.5	4.0
Maximum	97.1	97.1	54.4	54.4	16.7	12.4	29.1	53.3
Minimum	4.2	4.2	4.2	4.2	0.4	0.3	1.6	0.1
Range (Max. – Min.)	92.9	92.9	50.2	50.2	16.3	12.1	27.5	53.2

Table 5. Metrics of only the transversely broken flakes.

Transversely Broken Flakes Metrics (n=820)								
	Trajectory Flake Length (mm)	Morphological Flake Length (mm)	Trajectory Flake Width (mm)	Morphological Flake Width (mm)	Flake Thickness (mm)	Platform Depth (mm)	Platform Width (mm)	Flake Weight (g)
Mean	16.4	16.7	16.7	16.5	3.2	2.0	7.9	1.7
Median	14.05	14.2	15.0	14.8	2.6	1.65	6.8	0.6
Mode	10.3	10.3	13.0	13.0	2.2	1.3	5.0	0.2
Standard Deviation	9.2	9.4	7.3	7.2	2.1	1.3	4.4	4.0
Maximum	97.1	97.1	54.4	54.4	16.7	10.8	29.1	53.3
Minimum	4.2	4.2	4.2	4.2	0.4	0.3	1.6	0.1
Range (Max. – Min.)	92.9	92.9	50.2	50.2	16.3	10.5	27.5	53.2

Table 6. Metrics of only the longitudinally broken flakes.

Longitudinally Broken Flakes Metrics (n=13)								
	Trajectory Flake Length (mm)	Morphological Flake Length (mm)	Trajectory Flake Width (mm)	Morphological Flake Width (mm)	Flake Thickness (mm)	Platform Depth (mm)	Platform Width (mm)	Flake Weight (g)
Mean	24.2	25.1	15.7	15.6	4.4	3.8	8.8	2.4
Median	23.0	23.0	12.5	12.5	3.1	2.5	7.5	1.2
Mode	n/a	n/a	n/a	n/a	2.8	n/a	5.0	0.5
Standard Deviation	9.6	8.7	6.6	6.6	3.1	3.3	5.5	3.4
Maximum	38.6	38.6	27.7	27.7	12.4	12.4	21.8	12.3
Minimum	9.2	9.2	8.6	8.6	1.5	0.7	3.4	0.1
Range (Max. – Min.)	29.4	29.4	19.1	19.1	10.9	11.7	18.4	12.2

For the entire sample, the mean average trajectory flake width was 16.2 mm with a standard deviation of 8.3 mm, and the mean average morphological flake width was 15.7 mm with a standard deviation of 7.9 mm. Whole flakes and longitudinally broken flakes had similar lengths on average, though transversely broken flakes appeared to be slightly wider. As with the two types of length measures, neither of the width measures were significantly different, whether for whole or broken flakes or for the entire sample. Trajectory flake widths, though, appeared to be just slightly wider than morphological flake widths.

The mean average flake thickness for the overall sample was 3.2 mm with a standard deviation of 2.5 mm. The mean average flake thicknesses and standard deviations for the whole flakes and transversely broken flakes were nearly the same as those for the overall sample. The longitudinally broken flakes were slightly thicker, having a mean average thickness of 4.4 mm with a standard deviation of 3.1 mm.

Concerning platform size, the mean average platform depth for the overall sample was 2.1 mm with a standard deviation of 1.5 mm, and the mean average platform width was 8.0 mm with a standard deviation of 5.1 mm. Again, the mean measures for the whole flakes and the transversely broken flakes of platform depth and width were very similar to those of the overall sample. These measures for the longitudinally broken flakes were slightly greater with the mean average platform depth being 3.8 mm with a standard deviation of 3.3 mm and a mean average platform width of 8.8 mm with a standard deviation of 5.5 mm.

Finally, concerning the last measurement, flake weight, the mean average flake weight for the entire sample was 1.7 g with a standard deviation of 4.7 g. As with the mean average thicknesses and platform measurements, the whole and transversely broken flakes had very similar measurements to those of the entire sample. The mean average flake weight for the longitudinally broken flakes was slightly greater at 2.4 g with a standard deviation of 3.4 g.

Additionally, some overall patterns were also identified while analyzing the flake attributes of the entire sample. Over half of the lithic flakes had feather terminations (n=1,257, 52.5 percent), followed by step terminations (n=821, 34.3 percent) and hinge terminations (n=314, 13.1 percent), with only two flakes having overshot terminations (0.1 percent) and only one flake (about 0.04 percent) having a plunging termination. Also, most flakes were found to have normal bulbs of percussion (n=1,734, 72.4 percent) and flat bulbs of percussion (n=527, 22.0 percent). Few overall had exuberant bulbs (n=134, 5.6 percent). The majority of flakes had normal lipping (n=1,925, 80.4 percent), as well, with fewer having no lipping (n=398, 16.6 percent) and very few having prominent lipping (n=72, 3.0 percent). Further, in regards to the amount of dorsal cortex, the majority of flakes had no dorsal cortex (n=1,614, 67.4 percent). About 19.1 percent (457 flakes) had ≤50-percent cortex, and 9.2 percent (221 flakes) had >50-percent dorsal cortex present. The dorsal surface of the fewest flakes (n=103, 4.3 percent) was completely covered in cortex. Moreover, most flakes (n=1,973, 82.0 percent) showed no signs of thermal damage such as pot-lidding or crazing; and, of those 422 flakes that were thermally damaged, the majority had no cortex (n=342, 14.3 percent of the total flakes, or 81.0 percent of the total thermally damaged flakes).

In addition, upon focusing on the flake striking platforms, it was found that over half of the flakes had multi-faceted platforms (n=1,406, 58.7 percent), while the least number had dihedral platforms (n=19, 0.8 percent). Of the other platform types, 473 flakes (19.6 percent) had single-faceted platforms, 292 flakes (12.2 percent) had cortical platforms, 180 flakes (7.5 percent) had crushed platforms, and 25 flakes (about 1.0 percent) had completely ground platforms. The flake platforms, in general, were not reduced (n=2,012, 84.0 percent), not released (n=2,059, 86 percent), and had no dorsal surface abrasion (n=2,204, 92.0 percent). Slightly more of the platforms were abraded (n=1,290, 54.0 percent) and isolated (n=1,215, 51.0 percent) than not. Therefore, the average flake pattern (of flakes that would meet the criteria discussed in Chapter 3) can be described as follows: a general flake from Area 15 of the Gault site is typically whole; has about a 17.0 mm trajectory length and about a 17.7 mm morphological length; has a ~16.2 mm trajectory width and approximately a 15.7 mm morphological width; is about 3.2 mm thick; has a platform depth of about 2.1 mm and a platform width of about 8.0 mm; weighs about 1.7 g; has no dorsal cortex; has a feather termination; exhibits a normal bulb of percussion and normal lipping; has a platform that is multifaceted, isolated, and abraded; and is not thermally damaged.

Flake Types

The total flake sample was also broken down into flake types: normal, biface thinning, sequent, blade, and other. (See Appendix A for flake type definitions.) Most of the analyses run, such as chi-square analyses, were split according to flake type. (See Appendix B for charts showing the results of the analyses that were run.) The results for these analyses will be presented below according to flake type (Table 7).

Table 7. Flake counts and percentages by flake types. (*denotes flakes included in the "Other" flake type category)

All Flake Types											
	Normal	Biface Thinning	Sequent	Blade	Channel*	End Thinning*	Edge-collapse*	Ridge-Removal*	Scraper-Retouch*	Double Bulb*	Total
Count	1849	352	153	9	1	1	24	1	1	4	2395
Percent (%)	77.20	14.70	6.39	0.38	0.04	0.04	1.00	0.04	0.04	0.17	

Normal Flakes. The total count of flakes determined to fall into the category of normal was 1,849. Chi-square tests were run to check for patterns within and between this flake type and the other flake types, all of which, except for the one testing thermal damage, were shown to be significant to the 0.05 level. For normal flakes, it was shown that most flakes had feather terminations, though a lack of overshot terminations was found to be significant (Table B-1). Most of the normal flakes had normal bulbs of percussion (Table B-2), and the majority were normally lipped (Table B-3). However, the chi-square test showed that there was a significantly larger amount than expected of normal flakes without lipping and a significantly smaller amount than expected of normal flakes with prominent lipping. Additionally, the greatest number of normal flakes had no dorsal surface cortex; but the chi-square test showed that the number with no dorsal cortex was significantly lower than expected and the number of flakes with 100-percent dorsal cortex was significantly higher than expected (Table B-4). Only 327 of these flakes showed signs of thermal damage, though the first set of chi-square tests showed that there was no statistical significance (Table B-5).

Concerning the striking platforms, the chi-squared tests showed that the greatest number of normal flakes had multi-faceted platforms, though the number with multi-faceted platforms was significantly lower than expected (Table B-6). The number of normal flakes with ground platforms was also significantly lower than expected, while the number of flakes with cortical and single-faceted platforms was greater than statistically expected (Table B-6). Further, the platforms were shown to generally not be reduced (Table B-7), released (Table B-8), or isolated (Table B-9), and significantly fewer normal flakes showed signs of platform or dorsal surface abrasion (Tables B-10 and B-11, respectively).

Furthermore, a second set of chi-square tests were run in order to check for patterns within the attributes of the flake types according to the amount of dorsal cortex. These tests showed that flakes with 100-percent dorsal cortex had more feather terminations than expected, and flakes which had no dorsal cortex had fewer hinge terminations and a greater number of step terminations than expected (Table B-12). No overshot or plunging terminations were present. Also, greater than expected numbers of flakes within the 100-percent dorsal cortex and >50-percent dorsal cortex categories had exuberant bulbs (Table B-13). A greater number of flakes than expected within the 0-percent dorsal cortex category had normal bulbs, and there were less than expected numbers of flakes with exuberant bulbs. Further, there were no prominently lipped normal flakes, but there were significantly more flakes than expected with no lipping in the ≤50-percent to 100-percent dorsal cortex categories (Table B-14). Conversely, there were more lipped normal flakes than expected in the 0-percent dorsal cortex category and less than expected flakes with no lipping.

The tests showed that greater than expected numbers of normal flakes had cortical platforms in the ≤50-percent to 100-percent dorsal cortex categories, and much fewer than expected cortical platforms in the 0-percent dorsal cortex category (Table B-15). The opposite is true for multi-faceted platforms. Fewer flakes than expected had multi-faceted platforms in the ≤50-percent to 100-percent dorsal cortex categories, and more than expected flakes had multi-faceted platforms in the 0-percent dorsal cortex category. Additionally, patterns can be seen in the categories concerning the platform attributes. In general, though not in all cases (see Tables B-16 thru B-20), statistically more than expected flakes show no signs of reduction, releasing, isolation, platform abrasion, or dorsal surface abrasion in the ≤50-percent to 100-percent dorsal cortex categories. This changes in the 0-percent dorsal cortex category. Here, more than expected flakes do show signs of reduction, releasing, isolation, and platform and dorsal surface abrasion.

Interestingly, this pattern extends to the attribute of thermal damage (Table B-21). When separated from the other flake types and when categorized by the amount of dorsal surface cortex, thermal damage did become significant. The categories of ≤50-

percent to 100-percent dorsal cortex showed a greater than expected number of flakes without thermal damage, while the 0-percent dorsal cortex category showed a greater than expected number of flakes with thermal damage.

As for the flake sizes, the normal flakes ranged from having some of the longest and widest flakes (aside from the blades) to having some of the smallest flakes. (See Table B-62 for maximum and minimum measures and standard deviations.) The normal flakes had greater maximum thicknesses and weights than most of the other flakes, excluding the blades; though, similar to the sequent flakes, also they had the smallest measure of the minimum measures of thickness. Similarly, the platform depths and the platform widths of the normal flakes had the greatest maximum measures and the smallest minimum measures of the flake types. Finally, when taking the mean averages of the measurements, though, it was shown that the normal flakes had an average thickness of 3.17 mm and an average weight of 1.50 g. (See Table B-63.) The averages of the measures of length divided by width were 1.11 for the trajectory flake by the trajectory width and 1.19 for the morphological length by the morphological width. For the platform, the average of the measures of platform width divided by platform depth was 4.21.

Biface Thinning Flakes. Of the total flakes, 352 were classified as biface thinning flakes. The first set of chi-square tests show some of the significant patterns within this flake type compared with the other four flake types. Most biface thinning flakes had feather terminations, but a chi-square test indicated that it was significant that there were two flakes with overshot terminations (see Fig. 6 below and Table B-1). Additionally, the biface thinning flakes predominantly had normal bulbs, though the chi-square test showed that there were significantly fewer flakes with exuberant bulbs than was expected (Table B-2). This flake type also had a greater number of normally lipped flakes and significantly fewer flakes with no lipping (Table B-3). Further, there were significantly more flakes with no dorsal cortex, and significantly less flakes than expected with ≤50-percent and 100-percent cortex (Table B-4). Of note, no biface thinning flakes had 100-percent cortex. Moreover, most biface thinning flakes showed no significant evidence of thermal damage (Table B-5).

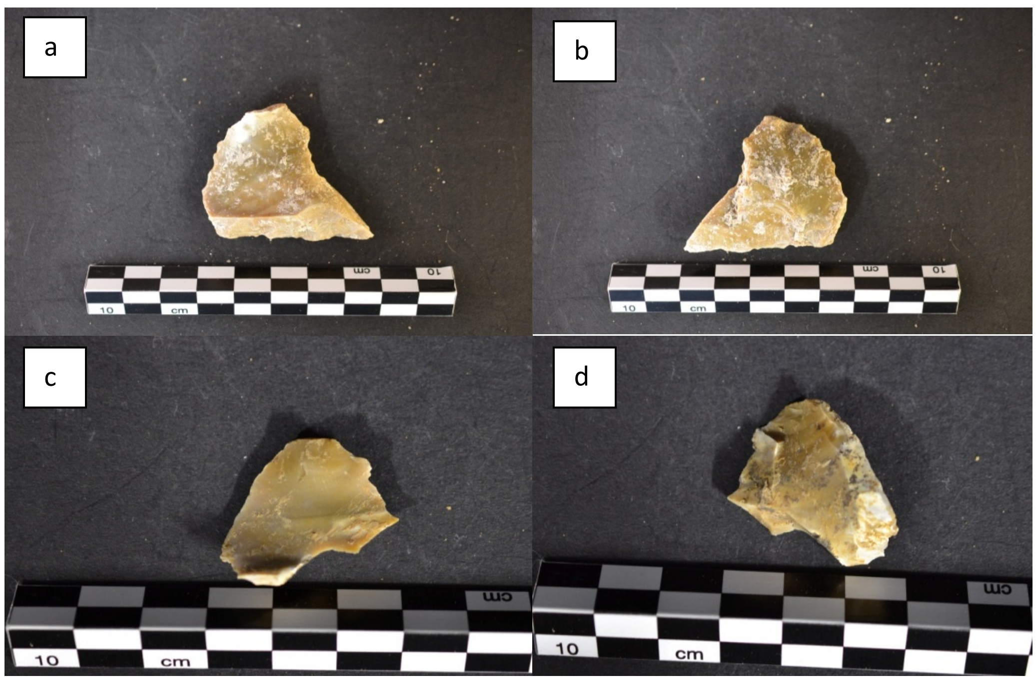


Figure 6. Overshot flakes: a.) OTC-2387 ventral view; b.) OTC-2387 dorsal view; c.) OTC-2223 ventral view; and d.) OTC-2223 dorsal view.

As for the platforms of the biface thinning flakes, most were multi-faceted, and the number of both multi-faceted and ground platforms was significantly higher than expected (Table B-6). Conversely, there were significantly fewer flakes with cortical and single-faceted platforms. The chi-square tests further showed that a significant portion of the biface thinning flake platforms were reduced, released, isolated, and abraded, and a significantly higher number than expected also showed evidence of dorsal surface abrasion (Tables B-7 through B-11).

The second set of chi-square tests, which broke the flake types down further by the amount of dorsal cortex, also revealed patterns within some of the attributes of this flake type. The tests showed that no biface thinning flakes had 100-percent dorsal cortex, few had >50-percent cortex, slightly more had ≤50-percent cortex, and the majority of biface thinning flakes had no cortex. No patterns for the flake terminations were found to be statistically significant when considering dorsal cortex amount within this flake type sub-sample (Table B-22). When looking at the bulbs of percussion, however, the test showed that more flakes had exuberant bulbs than expected in the >50-percent dorsal cortex category, and none of the flake had exuberant bulbs in the 0-percent dorsal cortex category (Table B-23). The 0-percent category did, however, have significantly more flakes with normal bulbs than expected. Most of the flakes also had normal lipping, no matter how much dorsal cortex they possessed, though none of the lipping attributes were statistically significant (Table B-24).

When analyzing the platform data, the second set of chi-square tests found that a greater number of flakes had cortical and dihedral platforms than expected in the ≤50-percent cortex category (Table B-25). There were also fewer flakes than expected with cortical platforms in the 0-percent dorsal cortex category, and there were no single-faceted platforms in the >50-percent category. Additionally, these tests showed that, when only focusing on the biface thinning flakes, the majority of the flakes were not significantly reduced, released, or isolated according to the dorsal cortex categories

(Tables B-26 through B-28). This was also true for dorsal surface abrasion (Table B-29). There was, however, significantly less platform abrasion in the >50-percent category than expected (Table B-30).

Furthermore, a pattern of thermal damage was found through the second set of chi-square tests. As with the normal flakes, when looking at the biface thinning flakes by the categories of dorsal cortex, it was found that less flakes exhibited thermal damage than expected in the ≤50-percent cortex category (Table B-31). Also, more flakes than expected exhibited thermal damage in the 0-percent cortex category.

Finally, the measurements taken on the biface thinning flakes were examined (Table B-62). The maximum length measures (both trajectory and morphological) were slightly shorter than those of the normal flakes, but slightly longer than those of the sequent flakes. The minimum lengths, however, tended to be slightly larger than those of the normal flakes. Both forms of maximum widths tended to be slightly smaller, or thinner, than those of the normal flakes, and the biface thinning flakes appeared to have less thick flakes, for the most part. Also, the platforms tended to be smaller in width and depth than the average normal flake, and the biface thinning flakes had a smaller maximum weight than the normal flakes.

Looking at the average metrics of these flakes (Table B-63), however, the overall average weight and thickness of the biface thinning flakes was very close to those of the normal flakes. The averages of the lengths divided by widths were also very close to those of the normal flakes, meaning they tended to be approximately the same size on average. The average of the platform widths divided by platform depths, though, was smaller than that of the normal flakes, meaning that the average platform size of the biface thinning flakes was smaller.

Sequent Flakes. Of the total sample of flakes, 153 were determined to be sequent flakes. Most of these flakes ended in feather terminations, and a chi-square test showed that there fewer hinge terminations than would be statistically expected (Table B-1). The flakes predominantly had normal bulbs of percussion. Statistically, however, there were more sequent flakes with normal and exuberant bulbs than expected, and fewer sequent flakes with flat bulbs of percussion than expected (Table B-2). Normal lipping was most common among these flakes. No type of lipping appeared to be significantly greater or less than would be statistically expected (Table B-3). The majority of the sequent flakes also had no dorsal cortex, yet the chi-square tests showed that significantly more flakes had ≤50-percent cortex and significantly fewer flakes had 100-percent cortex (Table B-4). Further, most of the sequent flakes did not show signs of thermal damage, and the chi-square tests showed that there was no significance in the amount of thermal damage (Table B-5).

The platforms of the sequent flakes were mostly multi-faceted, and there were more multi-faceted than statistically expected (Table B-6). In addition, there were fewer flakes with crushed platforms than expected. The sequent flake platforms were, in general, not reduced, released, isolated, or abraded (Tables B-7 through B-10). All of the sequent flakes, except one, also showed no signs of dorsal surface abrasion (Table B-11).

The second set of chi-square tests revealed more patterns within this flake type according to the amount of dorsal cortex. These tests showed that there were significantly more flakes with hinge terminations in the ≤50-percent cortex category and a greater number with feather terminations in the 0-percent cortex category (Table B-32). There was also significantly less flakes with feather terminations in the ≤50-percent cortex category. Statistically fewer flakes within the >50-percent category had flat bulbs of percussion (Table B-33) and were normally lipped (Table B-34), though more flakes than expected had no lipping.

The chi-squares tests further showed that there were more flakes than expected with cortical platforms in the >50-percent and ≤50-percent cortex categories, and more flakes had multi-faceted platforms in the 0-percent cortex category (Table B-35). Conversely, there were fewer than expected flakes with cortical platforms in the 0-percent cortex category, and fewer flakes with multi-faceted platforms in the ≤50-percent cortex category. Again, these tests showed that most of the striking platforms of the sequent flakes are not generally reduced, released, isolated, or abraded (Tables B-36 through B-39), though no statistical significance of the distribution of these attributes was shown within the dorsal cortex categories. The majority of the sequent flakes also had no dorsal surface abrasion (Table B-40) or signs of thermal damage (Table B-41), neither of which was shown to be statistically significant according to the dorsal cortex categories.

As for the flake sizes (see Tables B-62 and B-63), most of the sequent flakes appeared to be slightly smaller in lengths and widths than the normal and biface thinning flakes. These flakes were, on average, the thinnest flakes, but also had the average widest platforms. Finally, the flakes tended to weigh less than most of the other flakes, except the flakes in the “other” category.

Blades. Within the total sample, nine flakes were designated as blades. This was a very small sub-sample, and thus the results of the chi-square tests cannot be strongly relied upon in terms of significance. Most of the blades had step and feather terminations, though the first set of chi-square tests showed that the presence of one flake with a plunging termination was significant (Table B-1). The majority had flat or normal bulbs of percussion and were normally lipped (Tables B-2 and B-3), though these presence of these attributes was not shown to be statistically significant. These flakes tended to have little or no dorsal cortex (Table B-4) and none showed signs of thermal damage (Table B-5).

The platforms of the blades were predominantly faceted (five being multi-faceted and one being single-faceted), though the chi-square tests showed that the three flakes with crushed platforms were more than statistically expected (Table B-6). The platforms tended to be reduced and isolated (Tables B-7 and B-9). More of the blades than expected were also released (Table B-8). None of the blades had dorsal surface abrasion, though about half had platform abrasion (Tables B-10 and B-11). These two attributes, however, were not shown to be statistically significant for this flake type.

Few of the second set of chi-square tests showed any statistical significance of the attributes for this flake type according to the amount of dorsal cortex. No significant patterns were found according to the chi-square tests for the types of terminations (Table B-42), bulbs of percussion (Table B-43), or lipping (Table B-44). In addition, no significance was associated with thermal damage according to the amount of dorsal cortex (Table B-45), though, as previously noted, none of the blades were thermally damaged.

As for the platforms, the chi-square tests showed that it was statistically significant that one of the blades had a single-faceted platform, and this blade had >50-percent dorsal cortex (Table B-46). Within the dorsal cortex categories, the platform attributes of reduction, releasing, and abrasion were shown to not have any statistical significance (Tables B-47, B-48, and B-49). One blade was shown to be statistically significant, however, for having no evidence of isolation while all eight of the other blades were isolated (Table B-50). Finally, no flakes showed signs of dorsal surface abrasion, and the test showed this to not be significant within the dorsal surface categories (Table B-51).

The measurements for the blades were, for the most part, larger than those of the other flake types (see Tables B-62 and B-63). As was to be expected, the blades were the longest of the flakes, both in trajectory and morphological widths. On average, they were also the widest, thickest, and heaviest of the flakes. The average platform sizes, though, were somewhat smaller than those of most of the other flake types.

Other Flakes. Thirty-two of the total flake sample did not fit in the abovementioned flake type categories, and were thus placed in the "Other" category. The different flake types identified within this category were: edge-collapse flakes (n=24), double-bulb flakes (n=4), one channel flake, one end-thinning flake, one ridge-removal flake, and one scraper-retouch flake. Edge-collapse flakes (Fig.7) are flakes formed during the biface production process, often during the later middle-to-late stage in the reduction sequence (Collins 1974:177-178; Nancy Littlefield, personal communication 2013). Typical edge-collapse flakes have well-prepared, multi-faceted platforms. The flakes themselves were likely struck further back from the edge margin of the flake, taking off part of the biface edge. Due to this, the flakes typically have prominent lips and flat bulbs of percussion (Collins 1974:177-178).

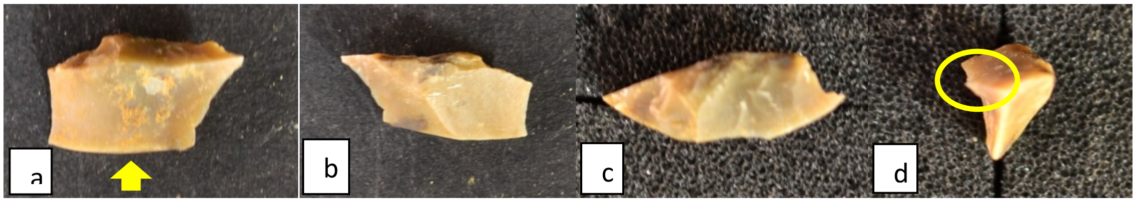


Figure 7. Edge-collapse flake (OTC-1932): a.) ventral view with an arrow pointing toward the step termination of the flake; b.) dorsal view; c.) aerial view of the striking platform (previously the edge of a biface or bifacial preform); and d.) side view of the flake with the prominent lip and flat bulb of percussion circled in yellow. (Photos by the author.)

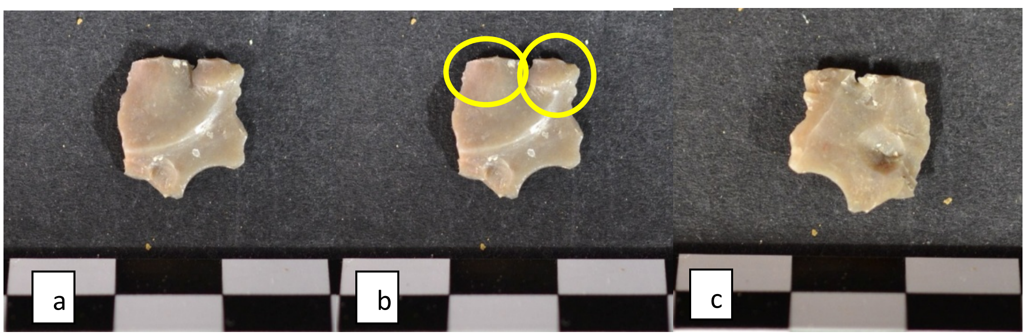


Figure 8. Double-bulb flake (OTC-105): a.) ventral view of the flake; b.) ventral view of the flake with the two bulbs and platform areas circled in yellow; and c.) dorsal view of the flake. (Photos by the author.)

The double-bulb flakes, as the name implies, are flakes with two bulbs of percussion emanating from the same platform area (Fig. 8). The two bulbs on such flakes may be made either from the knapper hitting the core or biface in two different spots before the flake is driven off, or from a hammerstone or other tool that has two prongs that each create a bulb as they hit the core or biface (Michael Collins, personal communication 2013). (This is different from bipolar flaking in which two bulbs are created on the same flake on opposing platforms.) Double-bulb flakes are not uncommon to lithic assemblages and are often thought of as a normal flake type, but they were considered as part of the "Other" category here because their lengths could not be measured in the same way as the rest of the flakes. For the other flake types, the trajectory and morphological lengths were measured from the point of impact. Double-bulb flakes had two points of impact, and because of this, they could not be measured in the same way. Thus, lengths were not recorded for these four flakes, and they were not included in any tests or calculations that considered length.

One intact channel flake was found in the OTC sample. Channel flakes (Fig. 9) are narrow, elongated flakes with parallel lateral edges often (though not always) broken in multiple sections (Sellet 2004:1554). These flakes are also known as final fluting flakes as they are used to make flutes for hafted points.

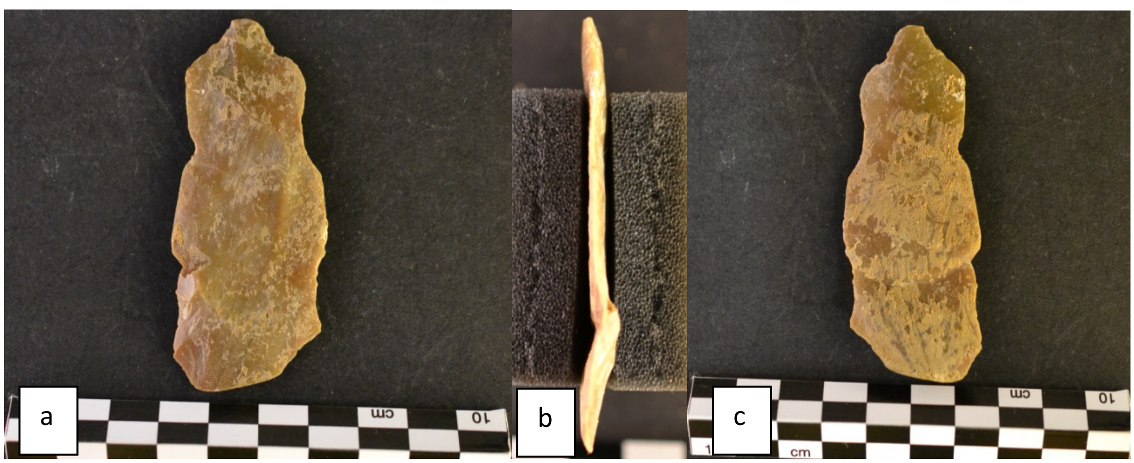


Figure 9. Channel flake (OTC-1449): a.) dorsal view; b.) side view; and c.) ventral view. (Photos by the author.)

One end-thinning flake was also identified, though its morphology was somewhat odd. An end-thinning flake (Fig.10) is a narrow, elongated flake with generally parallel lateral edges that is struck from one end of a tool or preform in order to thin the surface of that tool or preform (Kooyman 2000:109). These flakes are very similar to channel flakes, but precede them in the reduction process. The end-thinning flake found within the sample used in this analysis also had a slight curve toward the end as it terminated, instead of remaining predominantly parallel along its edges, which may have been caused by a flaw in the material or the way in which the knapper was holding the piece the flake was struck from.

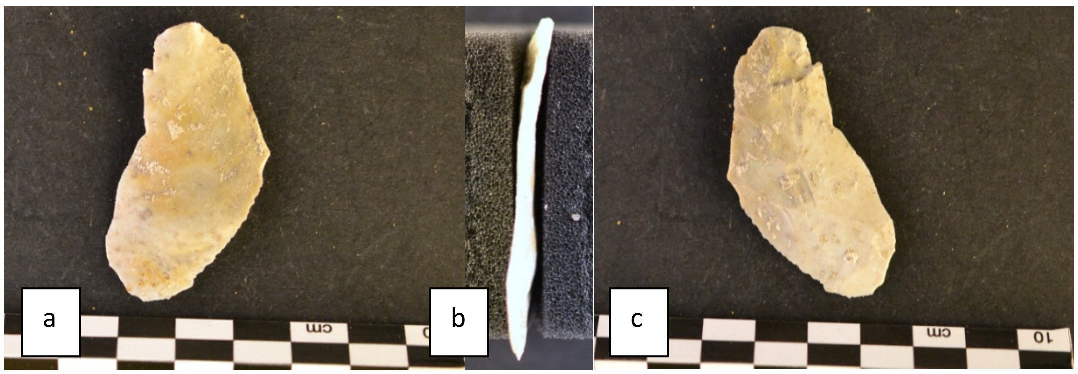


Figure 10. End-thinning flake (OTC-264): a.) ventral view; b.) side view; and c.) dorsal view. (Photos by the author.)

Finally, the last two "Other" flakes were a ridge-removal flake and a scraper-retouch flake, both identified by Bruce Bradley. A ridge-removal flake (Fig.11), as the name implies, is often used to intentionally remove a ridge left from previous flake removals in order to further thin the tool being made (Bruce Bradley, personal communication 2013). A scraper-retouch flake (Fig.12) is a flake that is often made when a scraper is being used or re-sharpened. The flake pops off the scraper due to the pressure placed on the scraper when in use and is often identified by the curvature of the flake (Bruce Bradley, personal communication 2013).

When analyzing these flakes using the first set of chi-square tests, it was found that most of the flakes ended in feathered terminations, though this was not shown to be significant (Table B-1). The chi-square tests also showed that there were significantly more flakes with flat bulbs of percussion than expected and fewer flakes with normal bulbs than expected (Table B-2). This was mostly due to the overall larger count of edge-collapse flakes present in this sub-sample. Likewise, more flakes were prominently lipped than statistically expected (Table B-3). Also, significantly more flakes had no dorsal cortex than expected (Table B-4), and none had 100-percent dorsal cortex. Most of the flakes had no signs of thermal damage, though this was not shown to be statistically significant (Table B-5).

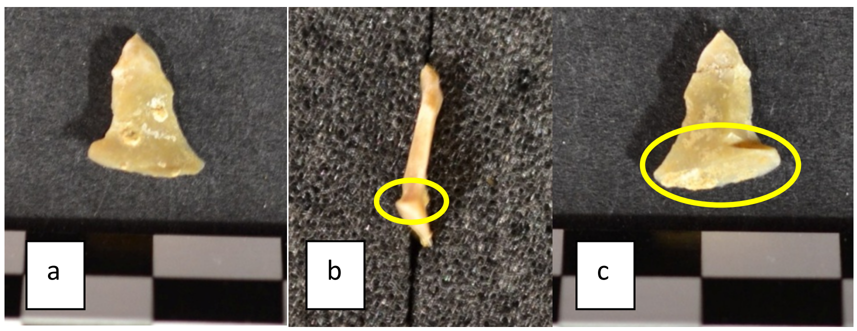


Figure 11. Ridge-removal flake (OTC-690): a.) ventral view; b.) side view; and c.) dorsal view. (The ridge that the flake removed is circled in yellow.) (Photos by the author.)

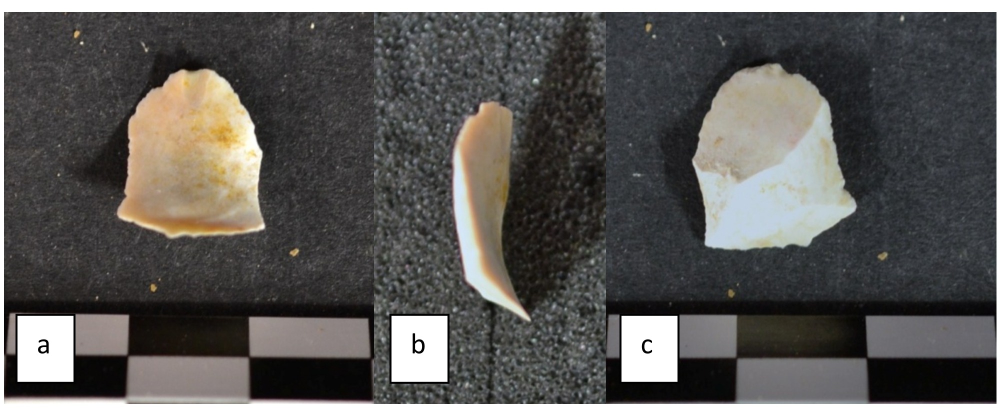


Figure 12. Scraper-retouch flake (OTC-415): a.) ventral view; b.) side view; and c.) dorsal view. (Photos by the author.)

All of the flakes, except two, had multi-faceted platforms, which was significant; and none of the flakes had cortical or single-faceted platforms, which was also considered statistically significant (Table B-6). More flakes than expected were reduced (Table B-7), and a greater number than expected had dorsal surface abrasion (Table B-11). Most flakes were not released (Table B-8), and about half of the flakes were isolated and abraded (Tables B-9 and B-10, respectively), though these three attributes were not shown to be statistically significant.

The results from the second set of chi-square tests showed no significant relationship between the amount of dorsal surface cortex and the following attributes: terminations (Table B-52), reduction (Table B-53), releasing (Table B-54), platform isolation (Table B-55), platform abrasion (Table B-56), dorsal surface abrasion (Table B-57), and thermal damage (Table B-58). It was shown, however, that more flakes than expected had normal bulbs of percussion in the ≤50-percent dorsal cortex category (Table B-59). Fewer flakes than statistically expected had prominent lipping, though more than statistically expected had no lipping, in the ≤50-percent dorsal cortex category (Table B-60). Finally, concerning the types of platforms, more flakes than statistically expected had crushed platforms in the ≤50-percent dorsal cortex category (Table B-61). Fewer flake than expected had crushed platforms in the 0-percent dorsal cortex category and fewer had multi-faceted platforms in the ≤50-percent dorsal cortex category.

The flakes in the “Other” category also tended to be smaller in size on average than the flake types discussed above (Tables B-62 and B-63). The maximum and minimum lengths and widths of these flakes were somewhat similar to those of the biface thinning flakes and the sequent flakes, though the averages of the ratio of lengths to widths were smaller than those of the other flake types. On average, however, these flakes were thicker than the other flake types, excluding the blades. The platform measurements on average were similar to those of the biface thinning flakes. Lastly, these flakes weighed less on average than the other flakes.

Cluster Analyses

Several cluster analyses were run in SPSS and JMP Pro 9 to see if and how the attributes and measures would cluster. When all of the data was put into the SPSS system using Two-Step cluster analysis, no real prominent clusters could be determined. Most of the flakes clustered together in one large cluster, though the blades were found to be slightly outside of the general cluster due to their larger measurements of lengths. A number of other cluster analyses were run in SPSS excluding some of the attributes or the measurements to check to see whether any of these variables could have been the cause behind the lumped cluster. No real patterns could be found in these clusters, either. When put into the JMP Pro 9 system, and when programming the software to circle groupings based on the flake type category, the different groups of flake types could be seen. However, again, the groups generally clustered together in one lump-group with the blades being slightly outside this large cluster due to the flake measurements. (No images of the clusters are included here.)

Scatterplots and Linear Regression

Bivariate scatterplots of the flake measurements of length by width and platform depth by platform width were made in order to better see if there were patterns in the flake sizes according to flake type. Three scatterplots were produced in Microsoft Excel 2010: one showing the trajectory length measurements by the trajectory widths, one showing the morphological lengths by the morphological widths, and one showing the measurements of the platform depth by the platform width. Two blade fragments (OTC-

2339 and OTC-2392) and the channel flake (OTC-1449) and end-thinning flake (OTC-264) were excluded from the scatterplots because they skewed the trajectories of the measurements. (The blade fragments were much smaller than the whole or only slightly broken blades, and the channel and end-thinning flakes were much longer than the rest of the flakes in the "Other" category.)

The scatterplot showing the trajectory length by trajectory width (Fig. 13) illustrates how the flakes within each flake type progressively get wider as they become longer, though at different rates. As can be seen, the majority of flakes cluster together by size. The normal, biface thinning, and sequent flakes appear to have very similar trends in flake size. The "other" flakes, while somewhat similar to the previously mentioned flakes, appear to diverge slightly from those flake types, tending to be wider than they are long. For the blades, the opposite pattern can be seen. The blades, as would be expected, are shown to be longer than they are wide.

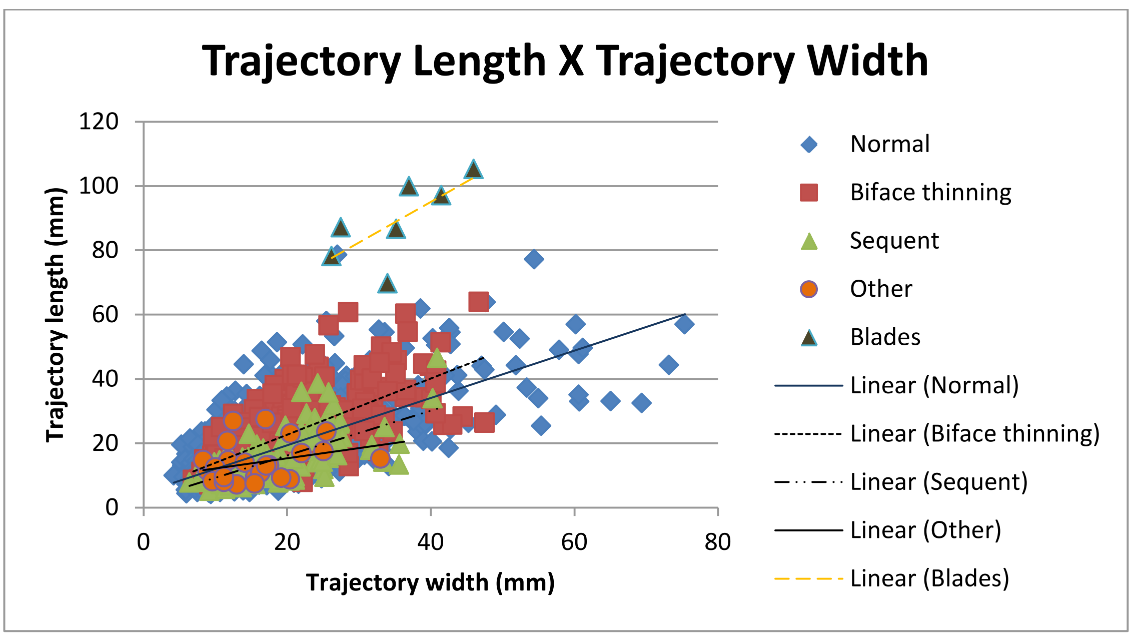


Figure 13. Scatterplot of the trajectory length by the trajectory width. The scatterplot illustrates the trajectory lengths and widths of each of the flake types and their linear trend line.

The second scatterplot (Fig. 14) illustrates the flake morphological lengths by morphological widths of each flake type. This scatterplot is very similar to the scatterplot of the trajectory lengths and widths shown above. The main differences are that the morphological lengths of some of the flakes were slightly longer than the trajectory lengths, and the morphological widths were slightly smaller than the trajectory widths. Again, it can be seen that the normal, biface thinning, and sequent flakes share similar trends in length and width. The "other" flakes differ slightly in their trend, tending to be wider rather than longer. The blades, once again, are shown to have greater lengths than widths, becoming longer before they become wider.

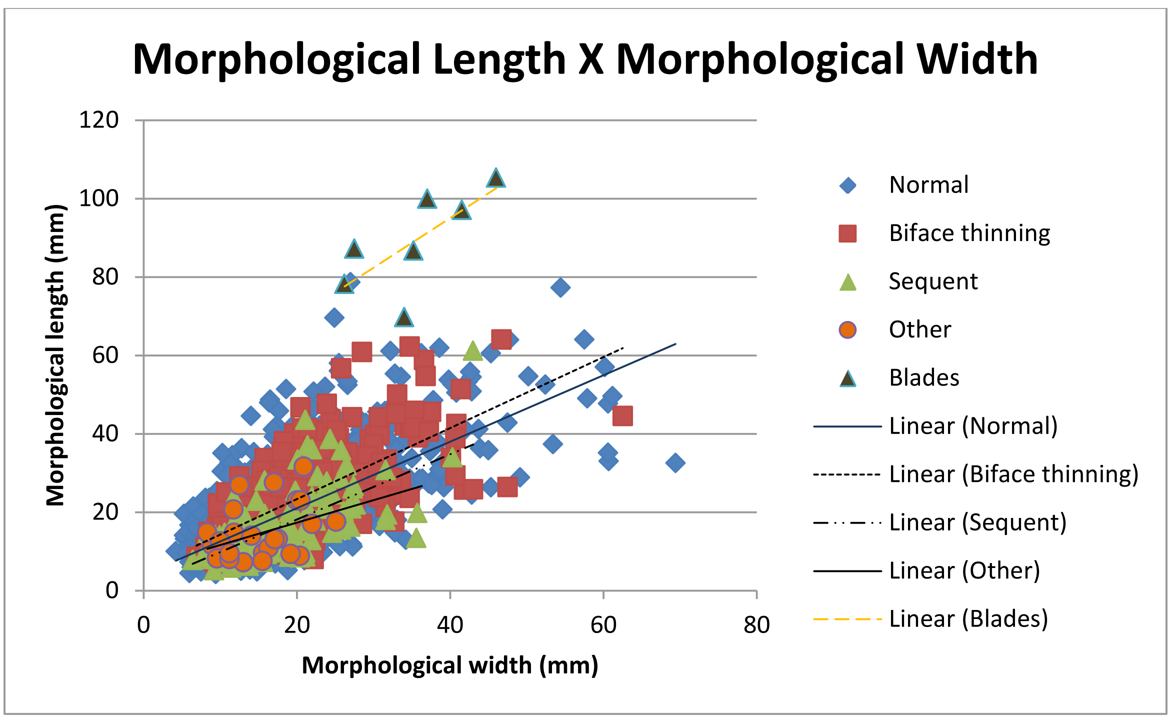


Figure 14. Scatterplot of the morphological length by the morphological width. This scatterplot illustrates the morphological lengths and widths of each of the flake types and their linear trend line.

The third scatterplot (Fig. 15) illustrates the platform depths by the platform widths of the flake types. The normal and biface thinning flakes are shown here to have similar trends in platform size. Both flake types tend to have thicker rather than wider platforms, though the normal flakes appear to have some of the largest platforms in overall size. The blades tend to have smaller platforms that are thicker than they are wide. In general, most of the "other" flakes also follow this trend, though their platforms tend to become slightly wider than those of the blades. The sequent flakes, contrary to most of the other flake types, appear to become wider before becoming thicker; and these flakes appear to have some of the thinnest platforms. Interestingly, six of the "other" flakes appear to follow the sequent flake trend. These six flakes were found to be the double-bulb flakes and the ridge-removal and scraper-retouch flakes, meaning that all of the "other" flakes that followed a similar trajectory to the blades were edge-collapse flakes.

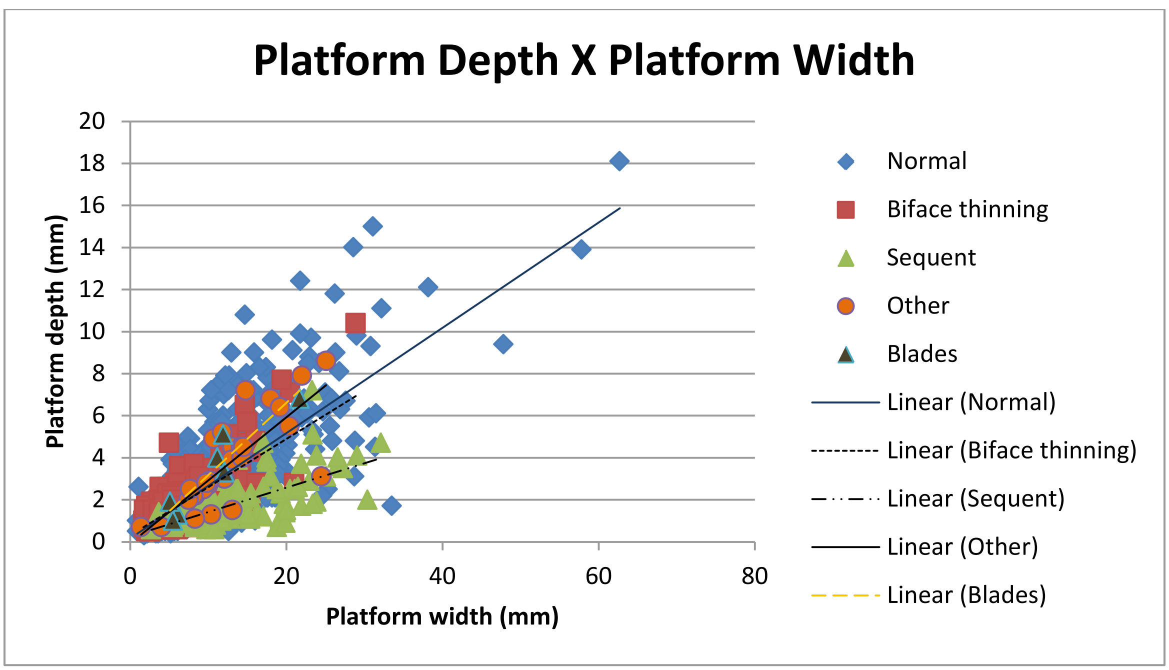


Figure 15. Scatterplot of the platform depth by the platform width. This scatterplot illustrates the platform depths and widths of each of the flake types and their linear trend line.

Linear regression was then used to test the relationships between the lengths and widths and the platform depths and widths. This was done in order to determine if the trends seen in the scatterplots above were significant. (See Appendix C, Figures C-1 through C-15.) Most of the regression analyses results were significant, meaning that there was a relationship between the lengths and widths and between the platform depth and width measurements, and these relationships were not statistically by chance. Additionally, as the scatterplots above illustrate, the relationships were positive. In general, the longer a flake became, the wider it tended to become, though at different increments among the flake types. The blades, however, were an exception. The scatterplots did illustrate positive relationships between the flake measurements and platform measurements of the blades, but the summary outputs of the regression analyses showed that the relationships between the measurements had little to no significance. This, however, was likely due to the small size of this sub-sample since there were only nine blades in total.

Spatial Distribution of the Flakes

As previously noted, the flakes analyzed in this study came from six unit squares of Area 15 of the Gault site. The percentages of the total flakes were calculated for each of the unit squares to see if there were any patterns of flake distribution (Fig. 16). Interestingly, the highest percentages of flakes (over half of the flakes) came from the two northern-most units (Units N1161 E1082 and N1161 E1083), and the southwestern-most unit (Unit N1159 E1082) had the lowest percentage of flakes present. Units N1161 E1082 and N1161 E1083 also had the highest percentages of each individual flake type out of the total number of flakes (n=2,395), and they contained the highest percentages flakes with thermal damage out of the total number of flakes. Units N1159 E1083, N1160 E1082, and N1160 E1083 saw decreases in the total percentages of flakes and in percentages of flakes with thermal damage from the northernmost units. Unit N1159 E1082 had the lowest percentages of each flake type and had the lowest percentage of flakes that showed evidence of thermal damage.

Unit N1161 E1082
• Contains 28.4% of total flakes
• Out of total flakes, contains:
    o 4.7% Biface thinning flakes
    o 0.1% Blades
    o 21.2% Normal flakes
    o 0.5% Other flakes
    o 1.9% Sequent flakes
• Out of total flakes, 4.5% have thermal damage
	Unit N1161 E1083
	• Contains 34.2% of total flakes
	• Out of total flakes, contains:
	    o 5.4% Biface thinning flakes
	    o 0.1% Blades
	    o 25.6% Normal flakes
	    o 0.5% Other flakes
	    o 2.5% Sequent flakes
	• Out of total flakes, 6.3% have thermal damage

Unit N1160 E1082
• Contains 16.3% of total flakes
• Out of total flakes, contains:
    o 2.0% Biface thinning flakes
    o 0.1% Blades
    o 13.0% Normal flakes
    o 0.3% Other flakes
    o 1.0% Sequent flakes
• Out of total flakes, 3.6% have thermal damage
	Unit N1160 E1083
	• Contains 8.9% of total flakes
	• Out of total flakes, contains:
	    o 0.9% Biface thinning flakes
	    o <0.1% Blades
	    o 7.5% Normal flakes
	    o 0% Other flakes
	    o 0.5% Sequent flakes
	• Out of total flakes, 1.4% have thermal damage

Unit N1159 E1082
• Contains 3.1% of total flakes
• Out of total flakes, contains:
    o 0.1% Biface thinning flakes
    o 0% Blades
    o 2.8% Normal flakes
    o 0% Other flakes
    o 0.2% Sequent flakes
• Out of total flakes, 0.2% have thermal damage
	Unit N1159 E1083
	• Contains 9.1% of total flakes
	• Out of total flakes, contains:
	    o 1.5% Biface thinning flakes
	    o 0% Blades
	    o 7.1% Normal flakes
	    o 0.2% Other flakes
	    o 0.3% Sequent flakes
	• Out of total flakes, 1.6% have thermal damage

Figure 16. Percentages of flakes by units. This represents a layout of the units according to their positions at the site and details the percentages of flakes from the total sample (n=2395) and the percentages of flakes with thermal damage within each unit. The units are color coded with the northern units being shaded darker and the more southern units being shaded lighter according to the greater and lesser percentages of flakes.

Additionally, flake count, average weight and size, and thermal damage were examined according to elevation. Sixteen flakes had questionable elevations since they came from a sump and a wall cleaning in the OTC levels. Thus, these sixteen flakes were not included in the analyses concerning flakes per elevation. The total sample examined below, then, equaled 2,379 flakes out of the entire sample of 2,395 flakes.

The bar chart below (Fig. 17) shows the total count of flakes by elevation out of the 2,379 flakes with good elevation information. (Also, see Table D-1.) As can be seen, the amount of flakes is somewhat consistent with minor increases and decreases between the 5 cm elevation levels of 92.65-92.60 m and 92.30-92.25 m. There is a significant drop in the flake count at 92.25-92.20, where only 61 of the flakes which met the analysis criteria were recovered. Below this, there is a sharp increase in the flake count, followed by another decrease at 91.95-91.90 m. This, in turn, was followed by another sharp increase in the flake count which again decreased sharply below 91.85 m.

In addition to the flake count, the average measures of the trajectory flake lengths, trajectory flake widths, and flake weights were also taken into consideration when looking at the spatial occurrences of the flakes. Since trajectory flake lengths and widths were found to be very similar to the morphological flake lengths and widths, only the first set of lengths and widths was used for this part of the analysis. (See Table D-2.) The bar and line graph below (Fig. 18) shows the relationship between the measurements and the elevation. A decrease in flake lengths and widths can be seen most sharply at the 92.25-92.20 m level. When looking at the measures of average weight by elevation (compared with the mean average flake weight), it can be seen that the weight somewhat gradually decreases from 92.65 m to 92.40 m. It then increases until reaching 92.30 m, at which point the weight begins to decrease again. There is a sharp decrease at 92.25-92.20 m. This is followed by a sharp increase in the weight up to the 92.20-92.15 m elevation level. After this, there is another gradual decrease with minor spikes of increasing weights down to the lowest elevation.

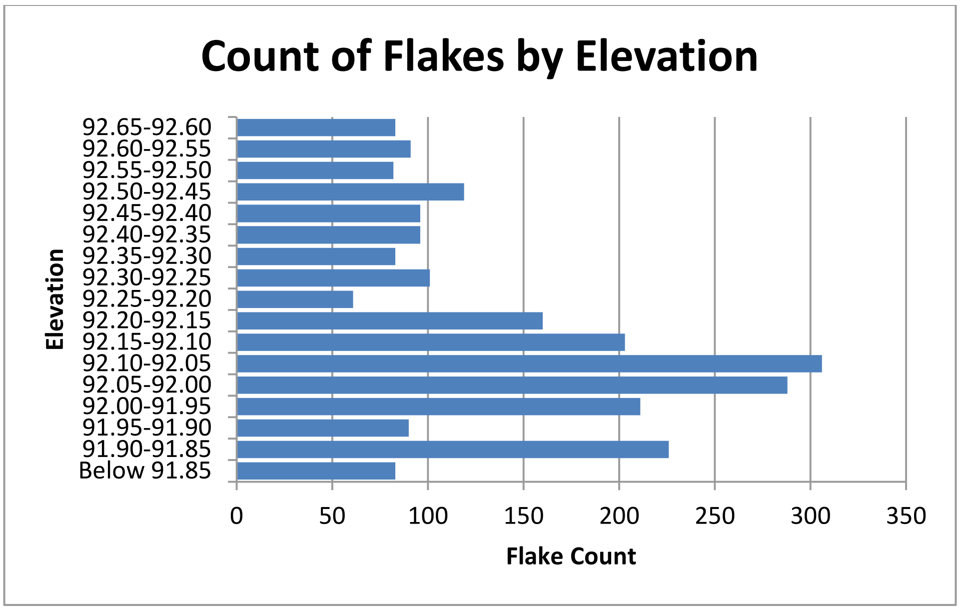


Figure 17. Bar chart of the flake count by elevation.

The averages of trajectory lengths by widths was also calculated and compared with the averages of flake weight by elevation (Fig. 19). Additionally, these sets of averages were compared with flake count (Figs. 20 and 21). Both sets of averages were very similar to one another when compared according to the elevations. Each of the figures, though, shows a common decrease (in flake count, average size, and average weight) at 92.25-92.20 m.

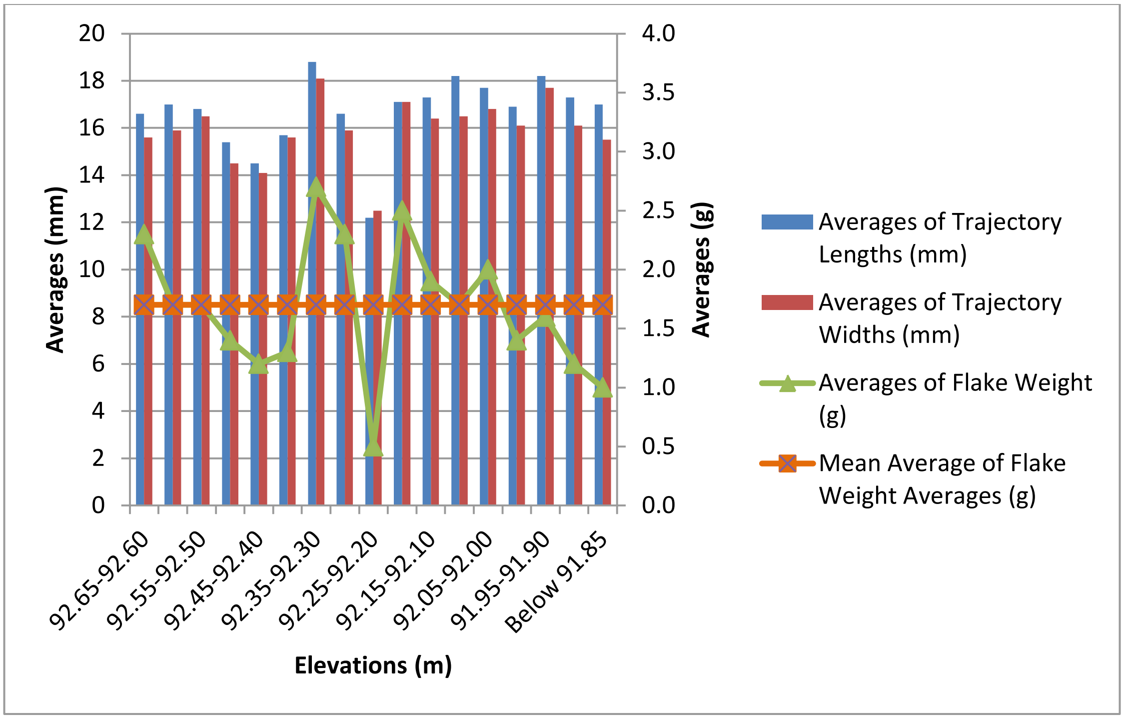


Figure 18. Chart showing the relationship of the mean average flake sizes and mean of flake weight averages.

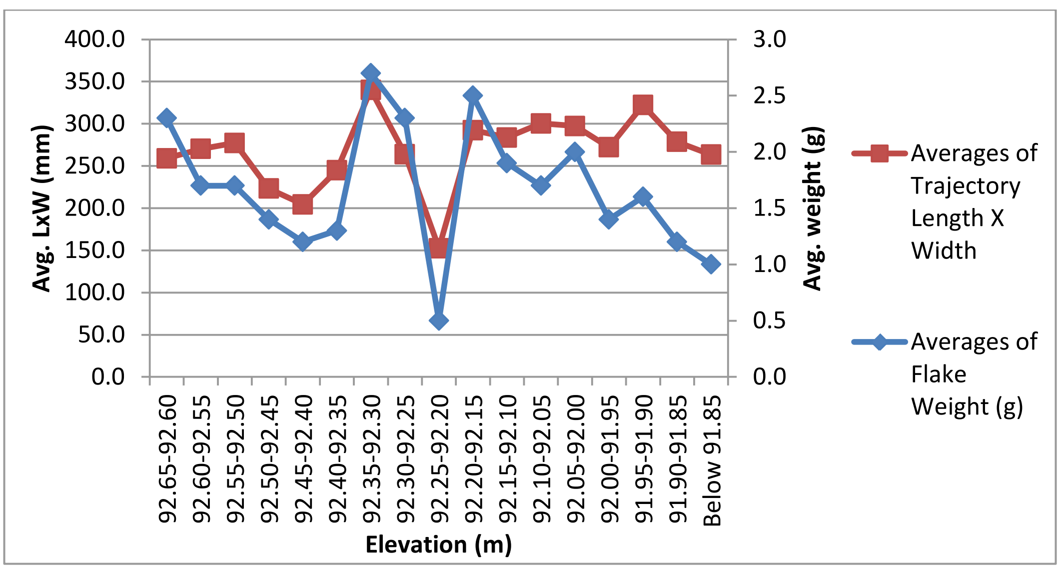


Figure 19. Averages of flake size (length by width) and flake weight by elevation.

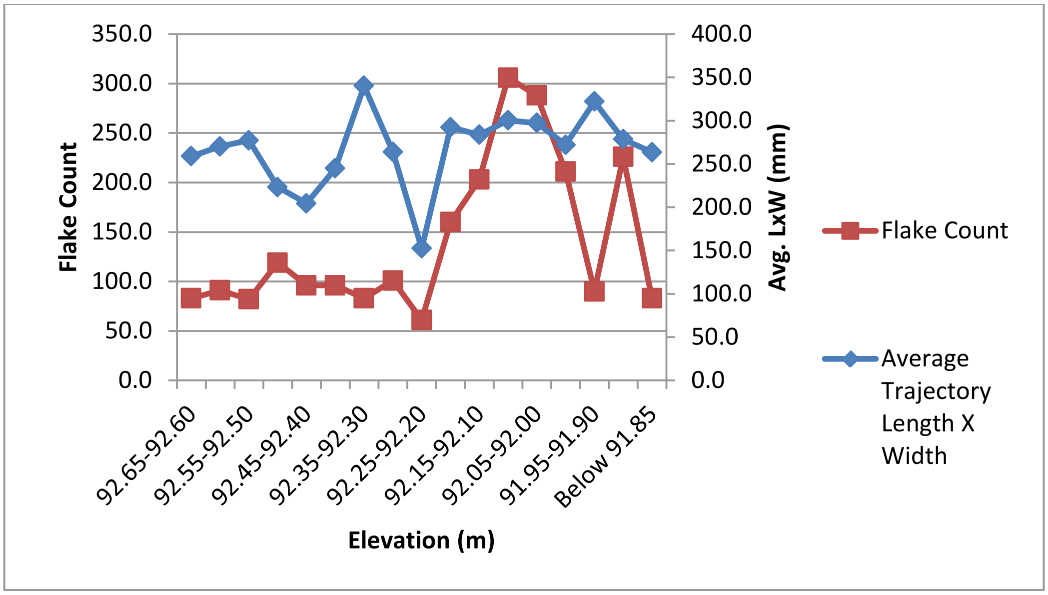


Figure 20. Flake count and the averages of flake size (length by width) by elevation.

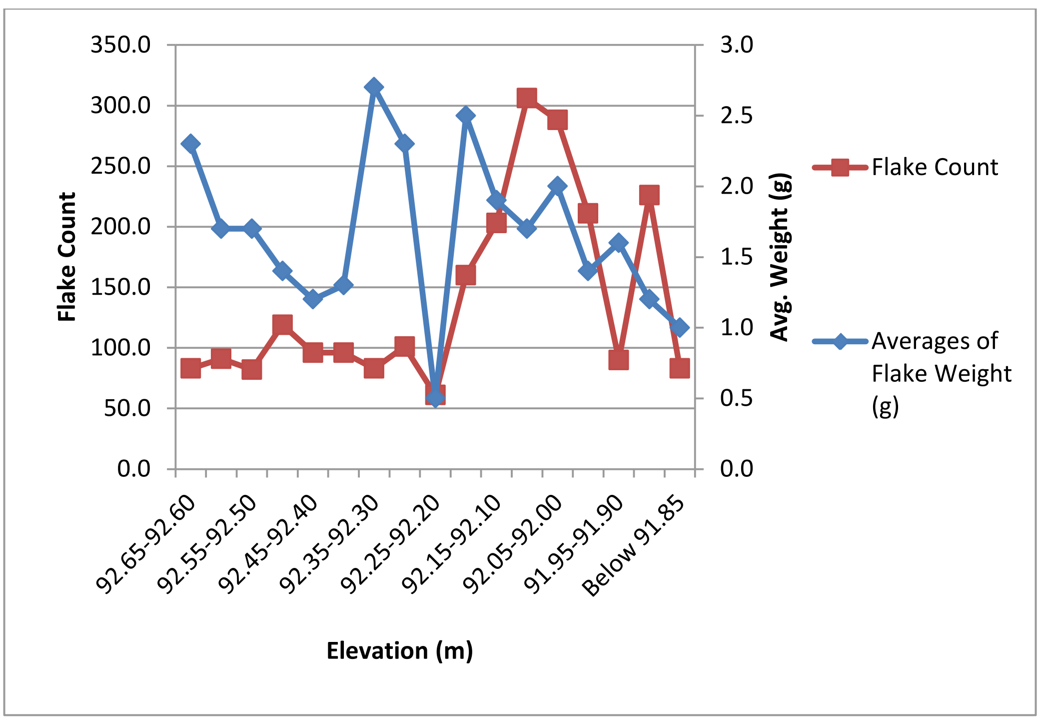


Figure 21. Flake count and averages of flake weight by elevation.

Finally, flakes with thermal damage were counted according to elevation (Table D-3). As Figure 22 below shows, there is a lower percentage of flakes with thermal damage in the uppermost layers. This figure also shows a significant decrease in thermal damage occurs at 92.15-92.10 m rather than the decrease seen in the other charts at 92.25-92.20 m. The percentage of thermal damage increases again after this.

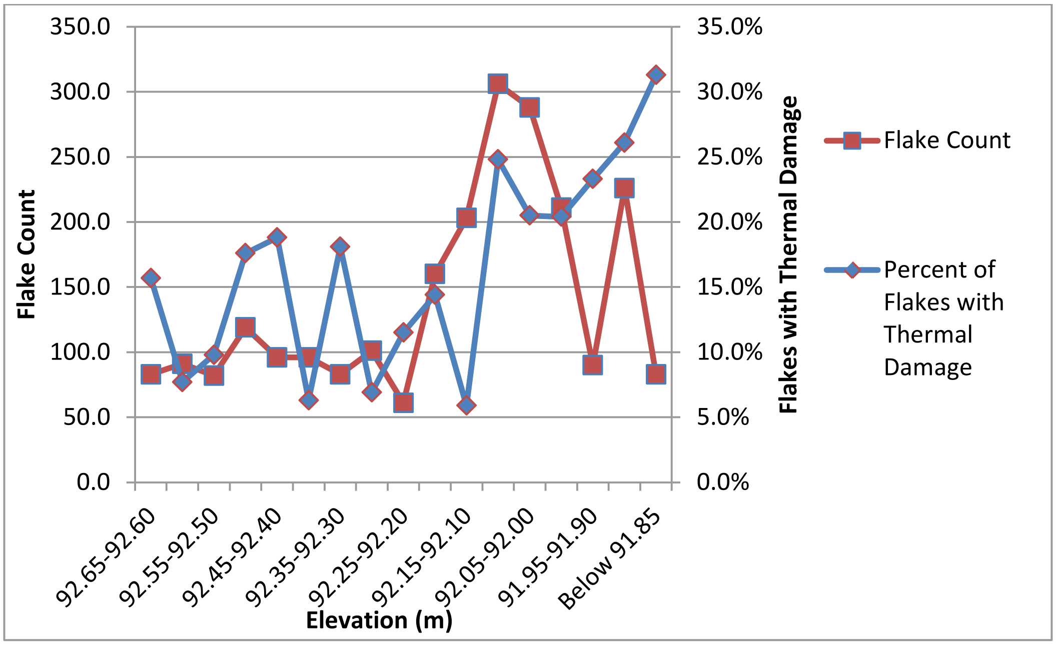


Figure 22. Flake count and percent of flakes with thermal damage by elevation.

CHAPTER 5

Discussion

Flake Patterns

Overall, the flakes range from small to large sizes with blades being the largest of the flakes. The general flake is on average whole, roughly between 17.0 by 16.2 mm (trajectory length/width) to 17.7 by 15.7 mm (morphological length/width) in size, 3.2 mm thick, with platforms 8.0 by 2.1 mm (platform width/depth) in size, and weighs about 1.7 g. Most of the flakes have little to no dorsal cortex, and most do not have thermal damage. Those with thermal damage tend more often to be flakes with no cortex, which may suggest that these flakes were knapped in the later stages of reduction around campfires or hearths, places often associated with social interaction; though natural fires and heating may also have affected the flakes. While no hearth features have been found associated with the OTC units at this time, these results may suggest that hearths are present in unexcavated portions of the site. Future researchers may want to investigate this further. The flakes overall tend to have feather terminations, normal bulbs and lipping, and platforms that are multi-faceted, isolated, and abraded. The normal bulb size and normal lipping size may also suggest that many of the flakes were knapped using direct percussion with a soft hammer such as a soft stone or a billet (Whittaker 1994:185; Inizan et al. 1999:74).

As the cluster analyses and the scatterplots have shown, statistically, all of the flakes (excepting the blades) could be grouped together. This means, statistically, the differences in the flakes are not pronounced enough to say that they are not from the same sample. A sample of all the flakes from a single knapping event, however, could include a very wide range of different sizes and forms (Michael Collins, personal communication 2013). Differences can be seen, however, in the attributes of the identified flake types, as shown by the scatterplot trend lines and the chi-square tests.

The normal flakes were the most numerous flakes, which is to be expected within lithic assemblages since they are produced throughout the reduction sequence (Whittaker 1994). These were some of the larger flakes within the flake sample, though some of the smallest flakes were also normal flakes. The data from the analyses suggests that a number of these normal flakes were part of the initial or early reduction sequence. For instance, the normal flake sub-sample was the only flake group that had flakes with 100-percent dorsal cortex. Additionally, this group had higher counts than expected of flakes with cortical and single-faceted platforms and had a lower number of flakes with multi-faceted and ground platforms than expected. The platforms also generally had much less platform preparation, mostly having no signs of reduction, releasing, and isolation, and few with platform abrasion and dorsal surface abrasion. Conversely, the normal flakes with no dorsal cortex show more signs of being worked or prepared (i.e. more signs of reduction, releasing, isolation and abrasion, as well as multi-faceting). Therefore, the flakes with 100-percent dorsal cortex are likely from early flaking in the reduction sequence, while the flakes with no dorsal cortex and with more signs of preparation are more likely from the middle and later stages of reduction (Andrefsky 2001, 2005).

The biface thinning flakes, as the name implies, were used in thinning and shaping bifaces. These flakes are similar in size to the normal flakes, though there are fewer very small biface thinning flakes, and the platforms of the biface thinning flakes tend to be smaller in size. Most of these flakes end in feather terminations, which are desired for thinning without leaving many mistakes such as steps, hinges, or stacks. Two of these flakes, though, have overshot terminations. Controlled overshots also aided in the thinning process. Both seem to be part of the middle-to-late stage removals in the thinning process as they have little to no cortex. One (OTC-2387), as seen in Fig. 6 above, appears to have been intentionally used to remove a previously made hinge flaking scar which may indicate a mistake during a fluting attempt (Nancy Littlefield and Michael Collins, personal communications 2013). This is evidenced by the hinge flaking scar present on the overshot flake and by the intentionally raised margin opposite the distal end. The second overshot (OTC-2223) appears to have removed a cortical edge, though it is hard to say whether or not this was intentional.

Most of the biface thinning flakes had little to no dorsal cortex, suggesting that they may have been formed later in the reduction sequence (possibly middle-to-late stage). In addition, and contrary to the patterns seen in the normal flakes, these flakes have much more evidence of preparation. Many of the flakes have multi-faceted platforms, and this flake type also has the highest number of flakes with ground platforms. A large portion of these flake platforms are also reduced, released, isolated, abraded, and have some dorsal surface abrasion. The most platform preparation is seen on the flakes with no dorsal cortex. This again suggests that the biface thinning flakes are part of the middle-to-late reduction stage and are likely part of the finishing stage in the production of a biface (Andrefsky 2001, 2005).

The sequent flakes are somewhat smaller in size compared to the normal and biface thinning flakes, and are also, on average, the thinnest flakes. They do, however, have the average widest platforms. Most have normal or exuberant bulbs, normal or no lipping, and little to no dorsal cortex. This is to be expected. By definition, a previous flake was removed before these flakes, leaving a negative impression on these flakes and likely taking off part of the cortex if any was present. The sequent flakes were struck off at the same spot the previous flake was struck, keeping the negative flake impression and obtaining a gull-winged shape on the platform. Due to the lesser amount of dorsal cortex on these flakes, it is likely that they were struck off during the middle or late stage of the tool production process. In addition, many of these flakes had multi-faceted platforms, suggesting some platform preparation, though there was not as much evidence of the other forms of platform preparation.

The flakes in the "other" category generally are of smaller sizes than the normal and biface thinning flakes and have multi-faceted platforms, though these do not have as much evidence of platform preparation as the biface thinning flakes. They overall have little to no dorsal cortex, likely suggesting that these flakes were made during middle or later stages of tool production. These "other" flakes are mostly edge-collapse flakes, flakes typically seen in the middle-to-late stage of reduction (Nancy Littlefield, personal communication 2013). These edge-collapse flakes mostly exhibit well-prepared, multi-faceted platforms, and generally have thicker platforms due to their taking off an excessive part of a bifacial edge. Also, the presence of the scraper-retouch flake indicates the production and use of scrapers at the site, which is not unlikely. Further, the well-prepared channel flake suggests that at least one biface was fluted at Gault before Clovis. However, this is not a technological pattern seen in the bifaces recovered from the OTC layers. None of the OTC bifaces (approximately 10 whole bifaces and numerous biface fragments identified and preliminarily examined at this time) show evidence of fluting, and they do not appear to be morphologically prepared for fluting, as opposed to Clovis bifaces whose flakes demonstrate much platform preparation for fluting (Huckell 2007:197-199; Bradley et al. 2010; Stanford and Bradley 2012:109-111; Michael Collins and Nancy Littlefield, personal communications 2013). The presence of this single channel flake and the absence of fluting scars on the OTC bifaces suggest that fluting was not prevalent in the OTC technology. As of writing this analysis, additional investigations of the stratigraphic layers near where the channel flake was recovered are ongoing in order to check for evidence of krotovina or other soil disturbances, though none has been identified as of yet.

Finally, the blades were made somewhat differently from the other flake types. Blades from the Clovis levels at Gault were generally struck off of conical or wedge-shaped cores, though more wedge-shaped cores have been recovered from the site than conical cores (Bradley et al. 2010; Tom Williams, personal communication 2013). Only Clovis-like wedge-shaped cores (and one small core that has a mix of the characteristics of both conical and wedge-shaped cores) have been recovered from OTC levels (Collins et al. 2013a; Michael Collins and Tom Williams, personal communications 2013). Since the OTC cores are predominantly wedge-shaped cores, it is likely that this was the primary kind of core used at Area 15 of the Gault site, similar to the Clovis blade technology at Gault. As was expected, the OTC blades (with the exception of the two blade fragments) are on average the largest of the flakes in length, width, and weight. These flakes have little to no dorsal cortex, and none have 100-percent dorsal cortex. This may suggest that the initial flaking of the wedge-shaped cores was done elsewhere before these flakes were made at Area 15, or it could just be that the core material used to make the blades already had little cortex present.

Most of the blades have feather or step terminations, though one blade has a plunging termination (possibly due to flaws or cracks in the core material or the amount of energy applied to strike the blade off the core). These blades mostly have flat and normal bulbs of percussion and are normally lipped. This suggests that these blades were struck off the cores with direct percussion using a soft hammer stone or billet (Whittaker 1994; Inizan et al. 1999). The platforms of the blades are mostly multi-faceted, reduced, isolated, and abraded. No thermal damage was found on the blades, which also likely suggests that they may not have been made or left near sources of heat such as campfires or hearths. Overall, from these attributes, the blades appear similar to the Clovis blade technology (see further discussion in the section on OTC technology below). Since there were only nine blades that met the criteria of this study and were analyzed, though, it is hard to say how prominent any of these patterns were in the blade production technology.

OTC Technology

Due to the amount of debitage and other artifacts collected from Area 15, it is likely that this area was used by the early peoples as a campsite and workshop for tool shaping and maintenance, though since there are fewer flakes with large amounts of dorsal cortex, the initial flaking may have taken place at another area of the site. Considering this and all the data presented, what kind of technology or technologies could be interpreted from the Gault OTC debitage? First, the blades themselves and cores, as briefly discussed above, represent an OTC blade technology. Second, the other debitage flakes, particularly the biface thinning flakes, and the presence of bifaces appear to represent an OTC biface technology.

As previously mentioned, the blades at Area 15 were likely made with Clovis-like wedge-shaped core technology. From the blades analyzed in this study, it appears that the platforms were prepared on the wedge-shaped cores mostly by reduction and isolation. They were then struck off the platform by direct percussion, possibly with the use of a soft hammerstone or billet since they generally had normal to no lipping and normal or flat bulbs of percussion (Whittaker 1994; Inizan et al. 1999). Since very few blades and blade fragments were recovered, it may be that they were not a very prominent part of the OTC toolkit. However, another explanation may be that the blades were simply taken and left elsewhere after they were produced. Yet another explanation may be that the blades stratigraphically derived from the higher Clovis occupational layers, though at this time this explanation is does not appear to be supported (see Chapter 2 for details about the investigations of Gault stratigraphic integrity). Future studies may wish to investigate the other six OTC units not examined in this study to see if more can be learned about the blade production.

The blades also appear to share some similarities with Clovis-age blades. Like the Clovis blades, most of the OTC blades tended to have relatively flat to normal bulbs and somewhat small platforms that were on average moderately wide but not deep

(Bradley et al. 2010). Clovis blades were often in excess of 100 mm in length and the length to width ratios generally exceeded 3 to 1 (Bradley et al. 2010:11). Only one of the OTC blades analyzed here (OTC-2381) exceeds 100 mm in length. When the length and measurements were rounded, it was found that about three of the blades had a ratio of approximately 3 to 1, while the others (excluding the two blade fragments) had approximate ratios of 2 to 1 (the definitional ratio for blades). Thus, the OTC flakes shared some of the general Clovis attributes, though they appear to not be quite as long as the typical Clovis blade. Again, though, it is difficult to rely too much on the OTC blade data since so few have been recovered and analyzed at this time.

In addition to the blades, bifaces and much lithic debitage from biface manufacture were recovered from Area 15, suggesting a primarily biface-producing technology. Through the data collected from the lithic debitage, a tentative reduction sequence can be interpreted. For instance, there are fewer flakes with 100-percent dorsal cortex, and the number of flakes increases as the amount of dorsal cortex decreases, with the flakes having no dorsal cortex being the most numerous. Since a number of normal flakes have 100-percent dorsal cortex, and none of the other flake types have dorsal surfaces completely covered in cortex, it is likely that these normal flakes were some of the first flakes to be driven off cores (though this is not always the case in all lithic reduction sequences) (Andrefsky 2001, 2005). Additionally, these normal flakes showed little evidence of platform preparation, most of the platforms being cortical or single-faceted, also suggesting that less time was taken to prepare these flakes for removal.

These flakes were followed by the removal of more normal flakes with >50-percent dorsal cortex, some of the sequent flakes, and a few biface thinning flakes and two "other" flakes (both edge-collapse flakes). These flakes were used in shaping and thinning the biface preforms. Following these flakes, in the later middle-to-late stages of reduction (represented by flakes generally having little to no dorsal cortex) (Andrefsky 2001, 2005), greater numbers of sequent flakes and biface thinning flakes were removed, as well as more normal flakes. The number of "other" flakes (mostly edge-collapse flakes, but also the end-thinning flake and channel flake) being removed also appears to increase in the middle-to-later stages of reduction. These middle and later stage flakes have more evidence of intentional platform preparation, meaning time was taken in order to prepare the flakes for more specific removals; and these preparations were made to partially guide the removal of the flakes in predicted ways by the knappers in order to shape their tools into desired forms. Together these flakes were used to continue in the shaping and thinning the bifaces, as well as to make final touch-ups. Some of these later stage flakes, though, also likely represent maintenance or re-sharpening of already completed bifaces.

Lithic Raw Materials: Local or Exotic?

In addition to the data collection and analyses of the flake traits and attributes in this study, Tom Williams and Wilson W. Crook III (2013) also performed an XRF analysis at the Gault laboratory at Texas State University to determine the types of raw materials from which the tools and debitage flakes from the OTC levels at Gault were made. One of their goals was to try to see if they could determine the sources for the materials used to make the tools and debitage, and whether or not the sources were local to the site. Using a Bruker Tracer III-SD portable energy-dispersive x-ray fluorescence spectrometer, they examined 200 randomly selected flakes that were to be used in this analysis (though one of the flakes was subsequently misplaced before the flake attributes were analyzed, and thus it was not included in the 2,395 flake sample for this study). They found that the raw lithic materials were mostly Edwards chert, though two odd flakes examined after the initial 200 flake sample were made of dolomitic limestone pieces. This suggests that the materials used were likely local, though the materials could have come from anywhere on the Edwards Plateau. Since Gault has good chert sources at the site, it is very likely that the majority of the tools and flakes were knapped from chert obtained at the site.

Tentative Comparison with Gault Clovis Biface Technology

Nancy Littlefield (personal communication 2013) has been examining Gault Clovis materials, particularly the platform attributes of the debitage from Area 4, southwest of Area 15 (Fig. 23), and also aided in identifying or confirming the presence of flake attributes on part of the OTC flakes analyzed within this study. She notes from what she has seen of the Clovis and OTC debitage from Gault that the OTC debitage, while similar in some regards to Clovis, also differs in some ways.

Littlefield's (2013) ongoing analysis of 850 or more debitage flakes with identifiable platforms, performed in a similar manner to the analyses within this study, has thus far found that the average sizes of the Clovis flakes at Gault were 34.77 mm (length, measured by flake trajectory) by 29.05 mm (width) by 6.16 mm (thickness) with standard deviations of 17.92 mm by 13.99 mm by 3.71 mm, respectively. Clovis platform sizes measured, on average, 12.24 mm (width) by 3.76 mm (depth). Most

Clovis flakes had normal or small lips and normal bulbs of percussion. Additionally, there were five main Clovis platform preparation techniques identified: reducing, releasing, abrading (platform grinding), isolating, and multi-faceting (Bradley et al. 2010; Littlefield 2013). About 88 percent of the Clovis flakes Littlefield has analyzed exhibit some of these preparation techniques, and approximately 14 percent of the Clovis flakes exhibited all five of these attributes (Littlefield 2013).

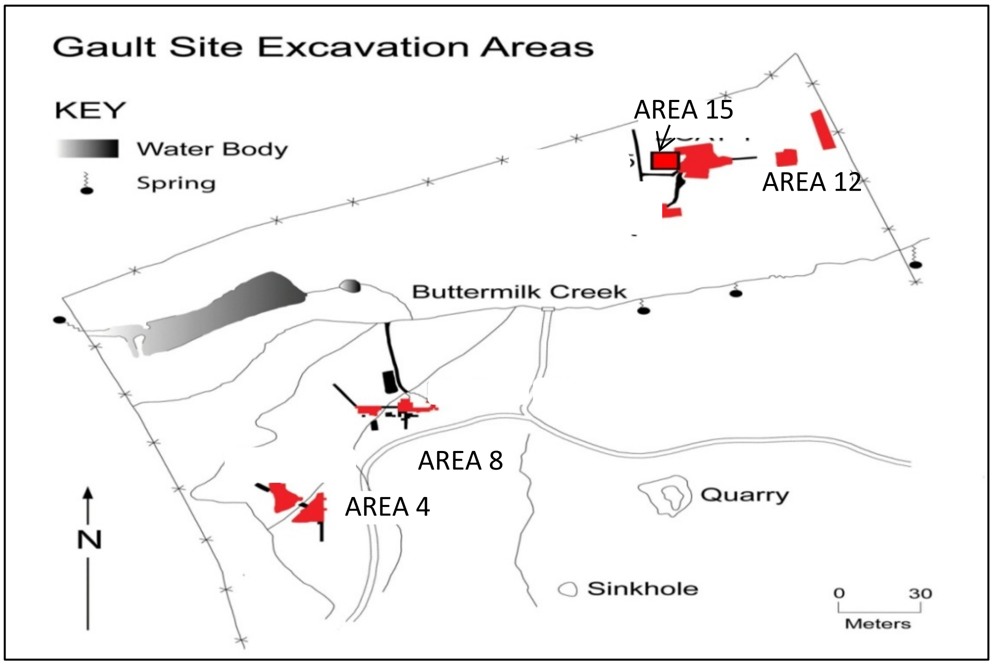


Figure 23. Map showing some of the excavation areas at Gault. (Graphic courtesy of the Gault School of Archaeological Research.)

The OTC flakes appear to be somewhat smaller in average size than the Clovis flakes (Figs. 24 and 25), though this may be because more and larger initial flakes have been found at Area 4, a workshop area (Nancy Littlefield, personal communication 2013). Like the Clovis flakes, though, the OTC flakes did have mostly normal or small lips and normal bulbs of percussion. However, probably the most important difference between the Clovis and OTC flakes is the fact that, overall, the OTC platforms exhibit less preparation than Clovis platforms on average. Looking at the flakes analyzed in this study, only 61 flakes (about 2.5 percent) had all five of the Clovis preparation attributes. Of these, 36 flakes (about 1.5 percent) are biface thinning flakes. This means that not as much time or effort was being applied by the OTC knappers to prepare platforms for flake removal. In other words, OTC biface technology does not put as much emphasis on platform preparation for flake removal as does the Clovis biface technology. Perhaps then, for the peoples at the site before Clovis, it was not as important to produce a specific point type for hafting (unlike Clovis), but rather to just make a useable biface.

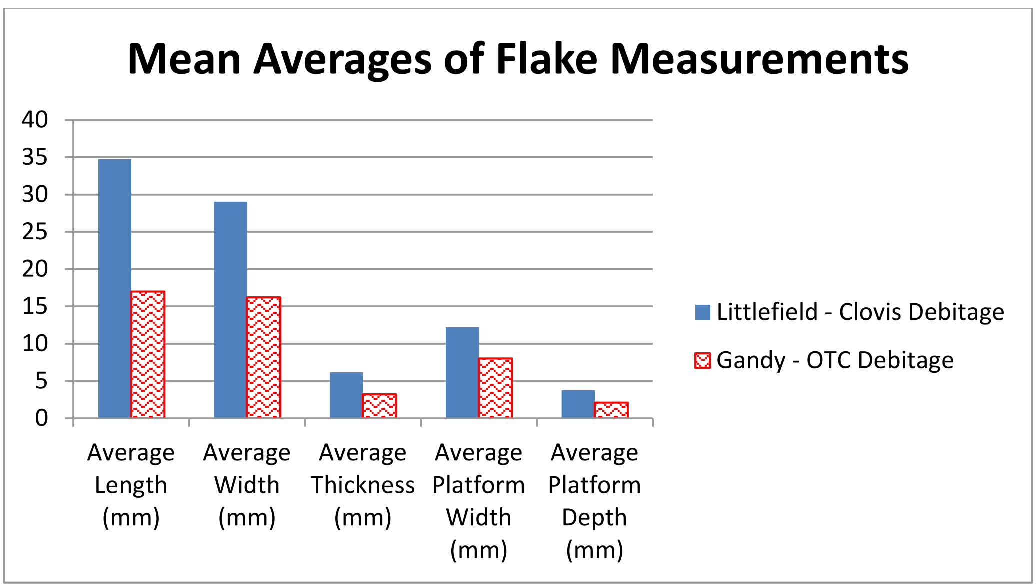


Figure 24. Bar chart showing the differences in the mean averages of the Clovis and OTC debitage measurements. The OTC average length and width are based on the trajectory measurements.

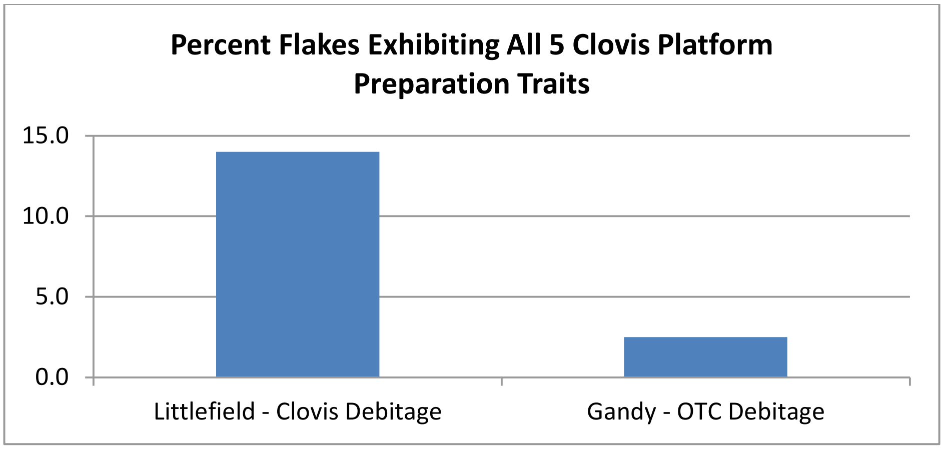


Figure 25. Bar chart showing the percentages of the Clovis and OTC flakes that exhibit all five of the typical Clovis platform preparation techniques: reducing, releasing, isolating, abrading (grinding), and multi-faceting.

Aside from the flakes discussed above which exhibit the five main platform attributes, the primary examples of Clovis diagnostic flakes are intentional overshot flakes, end-thinning flakes, and channel flakes. Littlefield (personal communication 2013) has identified about 254 overshot flakes in good Clovis context, the majority in Area 4 alone. Only two overshot flakes were found in the OTC levels of Area 15. An estimated total of 30 to 40 end-thinning and channel flakes have been found in Areas 4, 8, and 12 (Nancy Littlefield, personal communication 2013). Only one end-thinning flake and one channel flake were identified from the Area 15 OTC debitage. There are, thus, very few (almost no) Clovis diagnostic-like flakes from the Area 15 OTC debitage, while the Clovis levels of the site do appear to produce a large number of diagnostics.

According to this information and the data gathered in this study, therefore, it appears that, while the OTC and Clovis materials share some similarities, they appear to be two different technologies. The basic knapping techniques and flake preparation techniques appear somewhat similar, but the OTC debitage shows much less flake preparation. Further, it appears that the OTC technology did not often employ the production of flakes such as overshot flakes, end-thinning flakes, and channel flakes, which are diagnostic of fluted Clovis bifacial point production. It is possible, though, that the OTC technology was a precursor of the Clovis technology, with the knappers eventually coming to prefer well-prepared platforms and the thinning techniques that produced the Clovis bifacial points and resulted in the production of Clovis diagnostic flakes. More research in the future at Area 15 in the OTC and Clovis layers may be necessary to further confirm or disprove this interpretation. As of this writing, the analysis of the Clovis debitage from Area 15 and the OTC debitage from the other six OTC units is incomplete, but underway. Further, additional analyses of the OTC bifaces and other artifacts in comparison with the Clovis materials are encouraged for future studies.

Flake Spatial Distribution: Flake Locations by Unit

As previously mentioned, the majority of the OTC flakes came from the northern-most two units (Units N1161 E1082 and N1161 E1083) of the six units that were analyzed in this study. The least amount of flakes came from the southwestern-most unit (Unit N1159 E1082). This could be interpreted as meaning that more intensive flaking activities were occurring at and around Units N1161 E1082 and N1161 E1083 (and probably further north) resulting in a greater accumulation of debitage and other artifacts. This might explain why more flakes had thermal damage in these units as well. It may have been that campfires or hearths were closer to these units, and such features are often considered social areas for hunter-gatherers (Binford 1983; Stevenson 1991). The peoples may have been knapping or retouching their tools around the campfires or hearths, with a higher proportion of these flakes accidentally making their way into or near the fires and getting damaged. However, no hearths have been found in the OTC levels, possibly meaning there were none in this area or just that none of these features has been uncovered and identified as of yet.

Another interpretation, though, may be that a living area or high traffic area was located closer to the south of the units. Marc Stevenson (1991) discusses how debitage can be sorted in an area used by hunter-gatherer groups. If a living or frequently-used area was situated near the southern units, then perhaps the reason why more flakes are found in the northern units is due to refuse clean-up (i.e., secondary discard). The waste flakes that were no longer wanted or needed in the area may have been intentionally moved further away from the main area of use.

On the other hand, the southern area may merely represent a footpath area. Recently, Andrefsky (2013) has put forth an experimental test for determining the distinctive patterns of flake edge-damage caused by trampling or treading, but such experimental testing was not within the scope of this study. Future analyses are necessary to investigate this further. However, artifacts, particularly medium to larger sized artifacts, are susceptible to foot traffic, and thus are often kicked or pushed to the peripheries of the footpath (Wilk and Schiffer 1979; DeBoer 1983; Stevenson 1991:272). Thus the reason more flakes were found in the northern units may be that they were unintentionally (or possibly even intentionally) moved there by foot traffic. If this was so, then the flakes left in the southern units would likely be smaller in size and would have been trampled down by the foot traffic (Stevenson 1991). Future research may wish to further investigate this by comparing the sizes and amounts of the flakes in each of the units and in surrounding units.

Flake Spatial Distribution: Flake Location by Elevation

As Gilmer's (2013) work and Ayala's (2013) ongoing research, as well as previous studies such as those of Luchsinger (2002) and Alexander (2008), have shown that there appears to be minimal size sorting and shifting of artifacts within the Gault stratigraphy of Area 15. The flake counts, sizes, and weights recorded in this study (Figs. 17-22) appear to agree with this as there are patterns with highs of each of these followed by generally gradual decreases before another increase, which my indicate periods of greater and lesser use of the area. As shown in these figures, however, there is a marked decrease in count, size, and weight at the elevation level of 92.25-92.20 m. This is believed to indicate a break in the occupation of the site (or at least a reduction in the use of Area 15). Other occupation breaks (or periods of disuse) may be represented at 92.45-92.40 m, 92.35-92.30 m, and 92.00-91.95 m, though these are not as pronounced as the break at 92.25-92.20 m (Figs. 17-22). Interestingly, Gilmer's (2013:88, her Fig. 25) preliminary assessment of the debitage in some of the OTC units (aided by Nick Rodriguez of the Gault School of Archaeological Research) showed a similar possible break in occupation at 92.30-92.25 due to a significant decrease in flake count and weight. Thus, taking both her work and the data from the analyses within this study into account, it appears that there is at least one occupation break in the OTC stratigraphic layers at Area 15 that can be seen by the decreases in the counts, sizes, and weights of the lithic debitage between 92.30 m and 92.20 m. None the less, there also appears to be a gradational reduction in flake numbers and sizes in the lower 25 cm or more, and this does look like downward drift, a possibility that has to be further examined.

Additionally, the percentage of thermally damaged flakes (particularly normal and biface thinning flakes) appears to have a break at 92.15-92.10 m, with a lower percentage of flakes above this level and a higher percentage below this level (See Fig. 22 and Table D-3). This could be interpreted as meaning that more flakes were being exposed to heat in this area during the periods the stratigraphic layers below 92.15-92.10 m were deposited because the area was more intensively in use. This may also explain the increase in flake count in the levels below 92.15-92.10 m, particularly the spike in the thermally damaged flake count at 91.90-91.85 and the decrease in flake weight and size. The increase in flake pieces may be due to the heating causing the flakes to crack and break apart, also causing them to lose some of their size.

CHAPTER 6

Conclusions

Most archaeologists now seem to agree that there were people in the Americas prior to the cultural period designated as Clovis. A number of sites now deemed to be older-than-Clovis (OTC) have been discovered and investigated in order to learn about the earliest peoples in the Americas. Most of these analyses have focused on the site stratigraphy and site formation, any features at the sites, and artifacts such as bifaces. Many note the presence of lithic debitage, as well, but often fail to perform any analyses on the debitage to learn about the technology. This situation is changing, however, as more and more archaeologists recognize the importance of debitage analysis in defining a lithic technology.

At the Gault site in Texas, approximately 80 cm of cultural deposits were discovered below known Clovis stratigraphic layers. Debitage was the most numerous type of artifact recovered from the OTC stratigraphic layers. The main question, though, is: does the OTC debitage represent a different technology from Clovis technology at Gault? It was the goal of this study to define the OTC debitage according to flake and platform attributes and to determine if the debitage was similar or dissimilar to Clovis debitage. Three definitional scenarios were formed in regards to the comparison between Clovis and OTC technology. The first was that Clovis and OTC technology were completely different technologies, meaning they had little or no similarities. The second was that Clovis and OTC technology were exactly the same, meaning that the OTC debitage was basically Clovis debitage in older contexts and possibly meaning that

Clovis dated further back in time than previously thought at the Gault site. Finally, the third hypothesis was that the OTC debitage was in some ways similar to Clovis, but was also distinct in some significant ways, thus meaning it was a somewhat different technology.

Through the use of attribute analysis by chi-square statistical tests, scatterplots, and spatial analyses, much was learned from the OTC debitage. The following conclusions were made based on the results of these analyses:

1. The general flake can be described as: whole, measuring roughly between 17.0 by 16.2 mm (trajectory length/width) to 17.7 by 15.7 mm (morphological length/width) in size, 3.2 mm thick, with platforms 8.0 by 2.1 mm (platform width/depth) in size, and weighing about 1.7 g. Most flakes have little to no cortex or thermal damage. The majority have feather terminations, normal bulbs of percussion, and normal lipping (possibly meaning that they were made by direct percussion using a soft hammer such as a soft stone or billet). Overall, though, all the flakes could be grouped together (with the exception of the blades), meaning that there were no overwhelming differences between the flakes.
2. Chi-square tests helped identify and define specific differences between the OTC flake types. Normal flakes generally had more cortex than statistically expected and less platform preparation. Biface thinning flakes had the most platform preparation on average. Sequent flakes were generally thinner with the widest platforms. Most of the "other" flakes were edge-collapse flakes, though this category also included a channel flake, an end-thinning flake, four double-bulb

flakes, a scraper-retouch flake, and a ridge-removal flake. Finally, blades were the largest flakes by length, width, and weight.

3. The OTC technology consists primarily of biface production and possibly some blade production using Clovis-like wedge-shaped cores. Using statistical analyses of the flake attributes by flake type and the amount of dorsal cortex, a reduction sequence for the biface technology was determined. Normal flakes were created throughout the reduction process, but also appear to be the main type of initial reduction flakes since they were the only flakes with 100-percent dorsal cortex and had much less platform preparation. The other flake types ranged between the middle-to-late stages of reduction with the majority of the biface thinning flakes having the most platform preparation, and thus likely being part of the finishing flakes.
4. Edwards chert was used to make the tools and debitage, so it is likely the raw material used was local, though it is also possible that the material came from anywhere within the Edwards Plateau.
5. The blades shared many technological similarities with Clovis blades, though they were on average slightly smaller than the typical Clovis blades.
6. The rest of the OTC lithic debitage, when compared with Littlefield's ongoing analysis of Clovis debitage from Gault, appeared to have some basic similarities. However, the OTC flake sizes appear to be smaller than the Clovis flakes on average, and there was much less platform preparation on the OTC debitage, distinguishing it from the Clovis debitage.

7. Only four OTC flakes (two overshot flakes, one channel flake, and one end-thinning flake) out of the total sample of 2,395 flakes were similar to Clovis diagnostic flakes.
8. Therefore, OTC technology is similar in some ways to Clovis technology, but can be distinguished by the general lack of Clovis diagnostic flakes and much lower percentages of striking platform preparation. Thus, OTC is a somewhat different technology from Clovis, but there is a possibility that Clovis developed from the OTC technology. Future research is needed to determine this.
9. Spatially, most OTC flakes were located in the northern-most units. This might suggest either that more activity was occurring in the north, resulting in the larger quantities of materials; or it could suggest that more activity was occurring in the south, causing the debitage to be intentionally or unintentionally moved to the northern units.
10. Finally, the analyses in this study showed a steep decrease in flake count, size, and weight at the elevation level of 92.25-92.20 m. This may indicate that there was at least one break in the OTC occupation(s) of the site, or at the least, a break or reduction in the use of Area 15. Again, continued research in the future is needed to investigate this, possibly including more investigations of the OTC levels of other units.

The primary conclusion for this study, though, is that the OTC debitage from Area 15 of the Gault site represents a different technology than Clovis. However, since there appear to be similarities between OTC and Clovis debitage, particularly in the blade technologies, it is possible that the OTC technology is an antecedent to Clovis. More research will be necessary to support this hypothesis. Future research should include analyses of the OTC debitage and other artifacts from the other six units that were dug through the OTC layers down to bedrock, as well as analyses of the Clovis debitage and other artifacts from above the OTC layers at Area 15. This would allow for a better comparison between the Clovis and OTC artifacts. Future research may also include excavating into the OTC layers in the units surrounding the twelve already dug down to bedrock. The analyses of cultural materials collected from these surrounding units may aid in learning more about the spatial distribution of the flakes and thermal damage. In addition, future analyses of the flakes by elevation in each individual unit may reveal more information about flake distribution and the stratigraphic integrity of Area 15.

APPENDIX A: DEFINITIONS AND IMAGES

Table A-1. Flake condition: a.) Whole flake; b.) Longitudinally broken flake; and c.) Transversely broken flake. (Drawings by the author.)

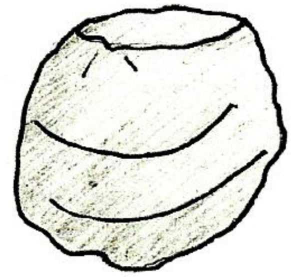
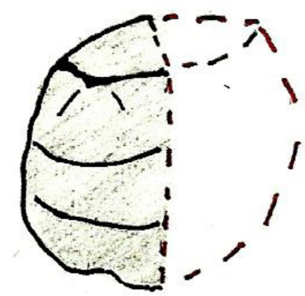
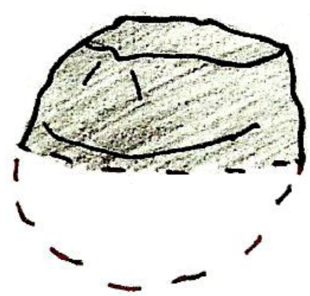
Term	Definition	Images
Flake Condition:	Indicates whether a flake is whole or broken	
Whole	A flake that has little or no breaking along the edges or distal end and which has an identifiable platform or platform remnant and an identifiable dorsal termination (Odell 2003:45)	 a.
Longitudinal Break	The flake is broken vertically (from the proximal end to the distal end), meaning that a portion has been broken off of side of the flake, though a platform and flake termination are still identifiable	 b.
Transverse Break	The flake is broken horizontally, meaning that the distal end and possibly part of the medial section of the flake has been broken off; only the proximal end is present and includes an identifiable platform	 c.

Table A-2. Flake terminations: a.) feather; b.) hinge; c.) overshot; d.) plunging; and e.) step. (Drawings by the author.)

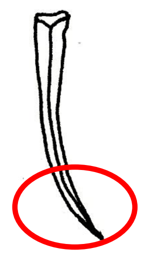
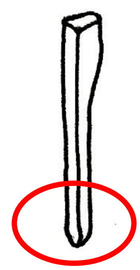
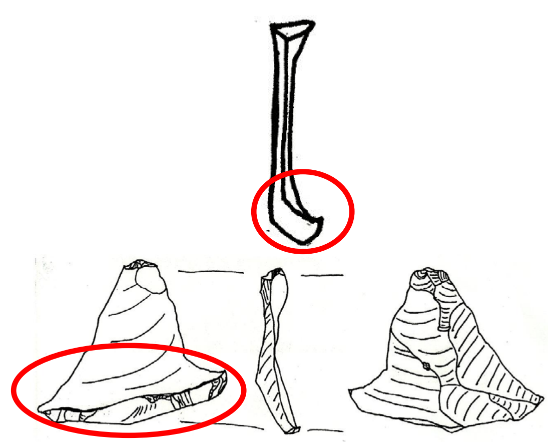
Term	Definition	Images
Flake Terminations:	The type of distal end present on a flake	
Feather	A termination in which a fracture propagating roughly parallel to the outside surface of the core gradually comes to meet it and this results in a flake possessing a relatively thin edge all around (Odell 2003:57)	 a.
Hinge	A termination in which, as the energy applied to remove the flake dissipates, the force path angles outward, resulting in a flake with a curved-over distal end (Odell 2003:57-58)	 b.
Overshot	(also called outrepassé); a termination in which a flake is struck on one side of a biface and terminates on the other side, taking a part of the opposite edge off; the flake does not exit the core on the near side but curves away to terminate on the opposite face (Odell 2003:58)	 c.

Table A-2 continued.

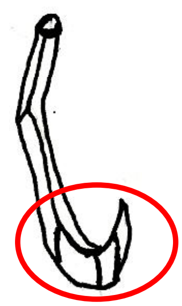
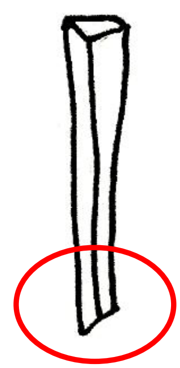
Term	Definition	Images
Plunging	A termination (similar to an overshot termination) that occurs when a flake, often a blade, is struck and the distal end, instead of terminating at the end or edge of a core, plunges or swoops under it and up a short distance on the opposite side (Tom Williams, personal communication 2013)	 d.
Step	The flake was broken at the distal end, caused either by a complete dissipation of energy or by the intersection of the fracture front with an internal crack or impurity, leaving a step-like shape as the termination (Odell 2003:58); since a step termination is often difficult to discern from a post-knapping or natural break, flakes with broken distal ends were also classified as having step terminations within this study	 e.

Table A-3. Flake types: a.) Biface thinning flake; b.) Blade; c.) Normal flake; d.) "Other" flake (shown here is a ridge-removal flake in the "Other" category); e.) Sequent flake; f.) Sequent flake (OTC-581) ventral and dorsal views, respectively; g.) Sequent flake (OTC-581) platform, aerial view; and h.) Sequent flake (OTC-450) platform, aerial view. (Pictures and drawings by the author.)

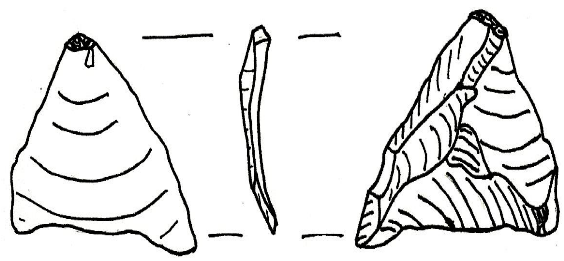
Term	Definition	Images
Biface Thinning Flake	A flake that is removed during bifacial trimming and often contains a striking platform that is rounded or ground, indicating preparation, and is usually thin relative to width, with a feathered termination (Andrefsky 2005:253); the bulb of percussion tends to be relatively flat and the platform is often very small and should have a lip on the interior, which would be a remnant of the edge of the biface, and the platform may be extensively prepared, often rounded and reduced by abrasion (Whittaker 1994:185-186)	 a.

Table A-3 continued.

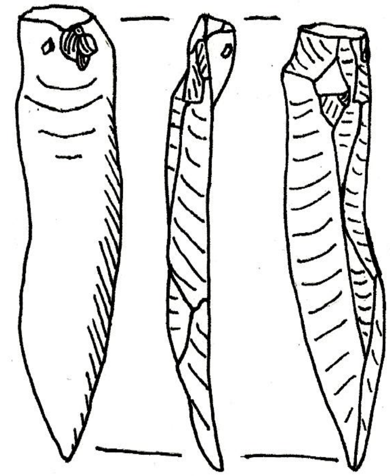
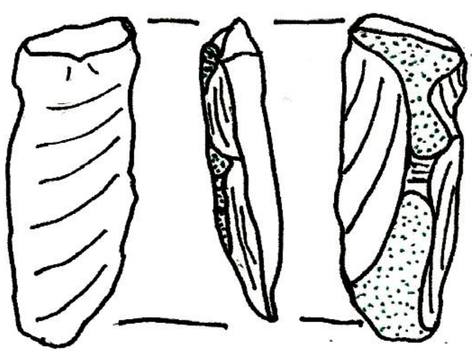
Blade	A specialized, elongated flake at least twice as long as it is wide; Clovis blade attributes generally include small platforms, a curve in the longitudinal section, relatively flat bulbs and ripple marks (giving a very smooth aspect to the ventral face), are long (often in excess of 100 mm) and narrow with robust cross sections that range from triangular, prismatic, and trapezoidal, to trapezium-like, and have margins that are relatively even and often sharp (Bradley et al. 2010)	 b.
Normal Flake	A common flake that fits the requirements of a flake (such as having a platform and identifiable dorsal and ventral sides), but which has no special traits that identify it as a more specific flake type; there are no remarkable traits on these flakes	 c.

Table A-3 continued.

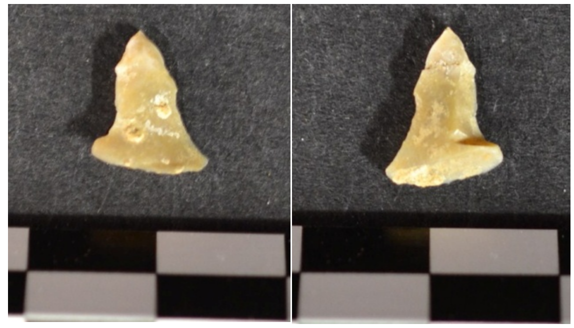
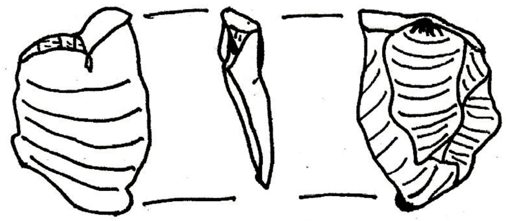
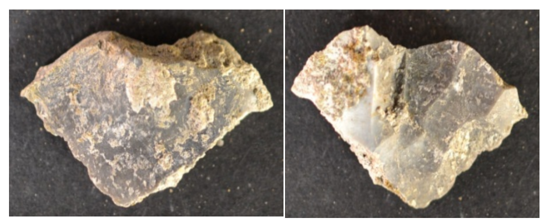
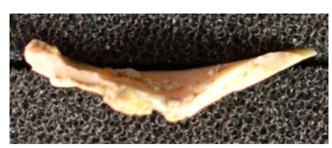
Other	A type of flake that does not fall into any of the specific type categories and does not fit within the "normal flake" category due to some remarkable or abnormal trait(s)	 d.
Sequent Flake	"gull-winged flake"; a flake with a shallow, U- or V- shaped platform which results from the removal of a flake directly in line with the negative scar left by the removal of a previous flake (Collins 1974:161-164); the platform angles, generally sharply, down into a steep depression while the edges flare up and outward forming a winged shape; and the depth of the "U" or "V" varies and is directly related to their sequence of manufacture (Dickens 2005:95-98)	 e.  f.  g.  h.

Table A-4. Dorsal cortex: a.) 0% Dorsal cortex; b.) ≤50% Dorsal cortex; c.) >50% Dorsal cortex; and d.) 100% Dorsal cortex. (Drawings by the author.)

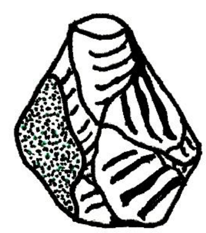
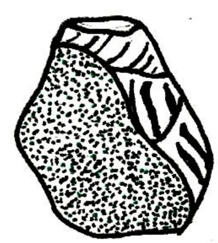
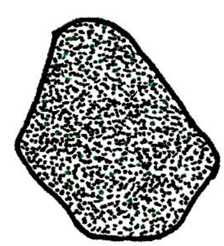
Term	Definition	Images
Dorsal Cortex:	The natural, weathered, outer covering of a cobble or lithic piece; the approximate amount of cortex located on the dorsal surface of a flake was visually estimated in this study using a similar method used by Andrefsky (2005:105-107)	
0% Dorsal Cortex	No dorsal cortex is present on the flake	 a.
≤50% Dorsal Cortex	About half or less of the dorsal surface is covered with cortex	 b.
>50% Dorsal Cortex	Over half of the dorsal surface is covered with cortex	 c.
100% Dorsal Cortex	The entire dorsal surface is covered with cortex	 d.

Table A-5. Bulb of percussion. Side views of flakes exhibiting the following bulb types: a.) Flat; b.) Normal; c.) Exuberant. For each of these, the bulb area is circled in red. (Drawings by the author.)

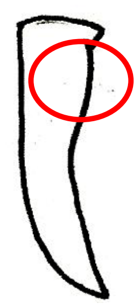
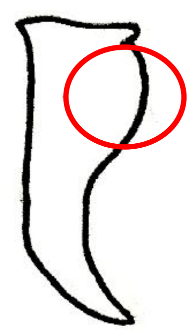
Term	Definition	Images
Bulb of Percussion:	A portion of the Hertzian cone of force caused by the blow that detached a flake; here, it refers to the state of the bulb of a flake (i.e., flat, normal, or exuberant)	
Flat	No bulb can be seen near the platform	 a.
Normal	A bulb is visibly present, but is not especially pronounced; it has average proportions, i.e., noticeable but not greatly protuberant (Collins 1974:165)	 b.
Exuberant	A very pronounced bulb is visible on the flake; the bulb protrudes strongly and is decidedly rounded when viewed from the side (perpendicular to the axis of flaking) or from either end (parallel to the flaking axis) (Collins 1974:165)	 c.

Table A-6. Type of platform: a.) Cortical; b.) Single-faceted; c.) Dihedral; d.) Multi-faceted; e.) Ground; and f.) Crushed. (Drawings by the author.)

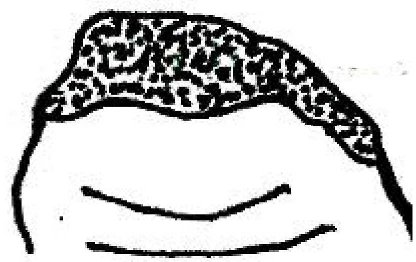
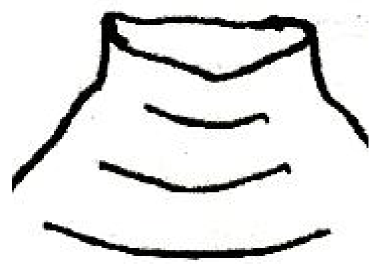
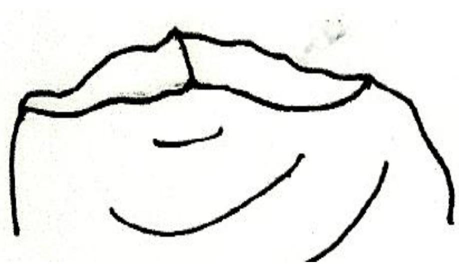
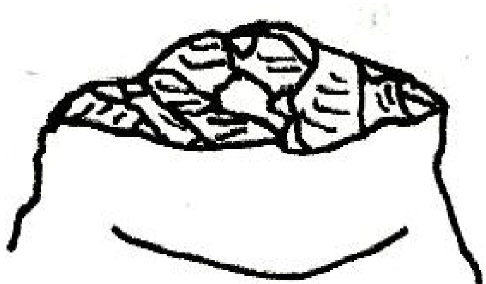
Term	Definition	Images
Cortical	A platform which retains the weathered surface of the raw material and indicates that no preparation of that surface was made prior to flake removal (Collins 1974:164)	 a.
Single-faceted	(also called ‘straight’ or ‘flat’); A flat platform at right angles to the dorsal surface of the flake and most often associated with concoidal fractures (Kooyman 2000; Andrefsky 2005)	 b.
Dihedral	(also called ‘double-faceted’); generally a prepared platform that may be associated with concoidal fractures, and has two facets that generally meet in a peak at the striking point of the flake (Kooyman 2000)	 c.
Multi-faceted	A platform which contains generally three or more facets (Kooyman 2000)	 d.

Table A-6 continued

Term	Definition	Images
Ground	A platform that has been ground down, or abraded, over most of its surface, possibly for isolating and/or strengthening the platform	 e.
Crushed	(also called 'shattered'); a platform whose position is observable, but whose form may not be observable due to crushing or shattering under the force which removed the flake (Collins 1974:164); within this study, flakes with this type of platform were only included if a platform remnant was still observable even though part of the platform was crushed	 f.

Table A-7. Lipping: a.) No lipping; b.) Lipped; and c.) Prominently lipped. (Drawings by the author.)

Term	Definition	Images
Lipping:	A lip is a projection found on the proximal, ventral surface of some flakes, believed to be associated with soft hammer percussion or pressure (Crabtree 1972:74). The presence and type of lipping is recorded in this study.	
No lipping	The flake does not appear to be lipped; no lip can be seen or felt with a finger near the ventral side of the platform	 a.
Lipped	A lip can be seen or felt with a finger	 b.
Prominently lipped	The flake is visibly, heavily lipped	 c.

Table A-8. Platform traits: a.) Reduced; b.) Released; c.) Isolation; d.) Abrasion; e.) Dorsal surface abrasion near the platform. (Drawings by the author.)

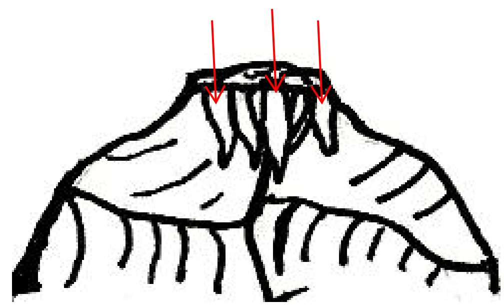
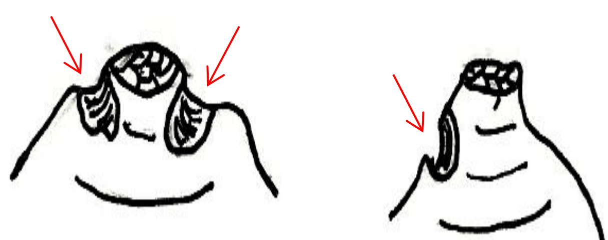
Term	Definition	Images
Reduced	Refers to evidence of tiny flakes being removed behind the platform in order to bring up the margin, allowing for a better striking area and flake removal (Bradley et al. 2010:66-67); recorded in this study as being either present or absent	 a.
Released	Refers to the removal of two flake scars that create a weak point where fracture initiates (Bradley et al. 2010:66-67), or this may be achieved by creating a small notch on one or both side of the platform which creates the weak point; recorded in this study as being either present or absent	 b.

Table A-8 continued.

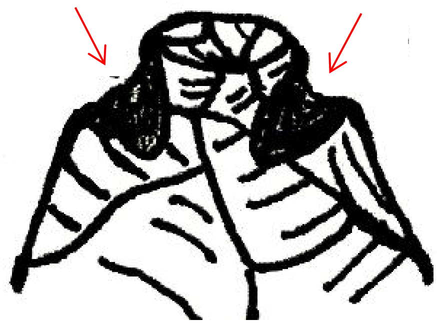
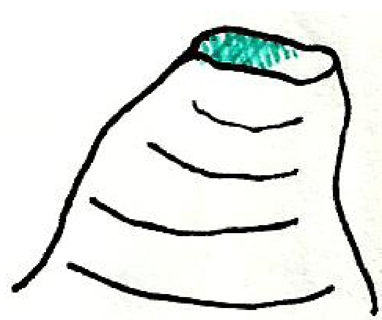
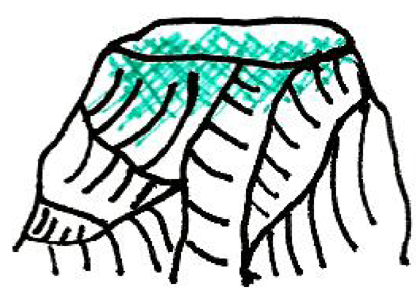
Term	Definition	Images
Platform Isolation	Refers to a platform which has been freed on the dorsal side of a flake from the mass by the removal of small flakes to isolate or cause the platform part to protrude or become prominent (Crabtree 1972:71); recorded in this study as being either present or absent	 c.
Platform Abrasion	Refers to a platform which has evidence of abrasion or grinding that can be felt with a finger or seen macroscopically and/or microscopically; recorded in this study as being either present or absent	 d.
Dorsal Surface Abrasion	Visible evidence of grinding or abrasion on the dorsal surface of the flake near the platform; recorded in this study as being either present or absent	 e.

Table A-9. Thermal damage: a.) Crazing (OTC-1910); and b.) Pot-lidding (OTC-1227). (Photos by the author.)

Term	Definition	Images
Thermal Damage	Evidence of heating, such as crazing or pot-lidding on a flake; recorded in this study as either present or absent	a.  b. 

Table A-10. Metrics: a.) Trajectory flake length; b.) Trajectory flake width; c.) Morphological flake length; d.) Morphological flake width; e.) Thickness; f.) Platform depth (ventral and aerial views); and g.) Platform width (ventral and aerial views). (Drawings by the author.)

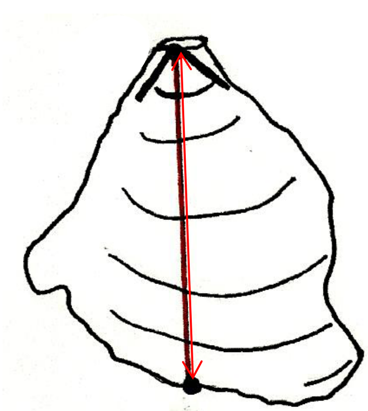
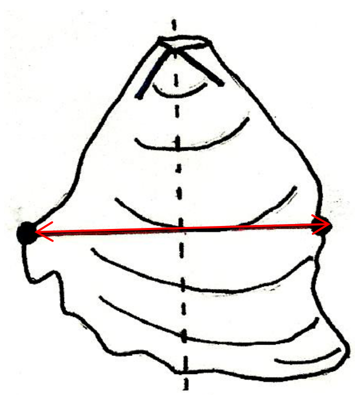
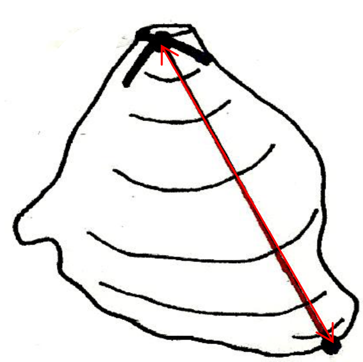
Term	Definition	Images
Trajectory Flake Length (mm)	Length measured, using digital calipers, from the point of impact on the platform straight down to the distal end	 a.
Trajectory Flake Width (mm) (or 'Width Perpendicular to Trajectory Length')	Width of the flake measured, using digital calipers, from the widest portion of the flake perpendicular to the trajectory length	 b.
Morphological Flake Length (mm)	Length measured from the point of impact on the platform, following the ripples of the flake to the distal-most endpoint	 c.

Table A-10 continued.

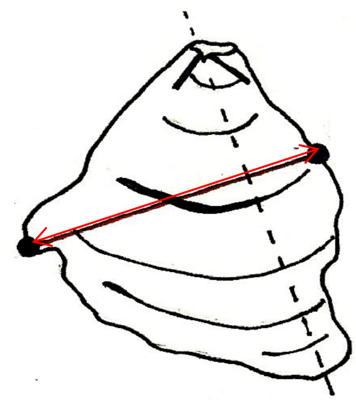
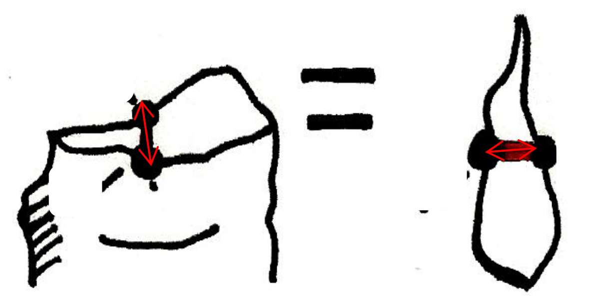
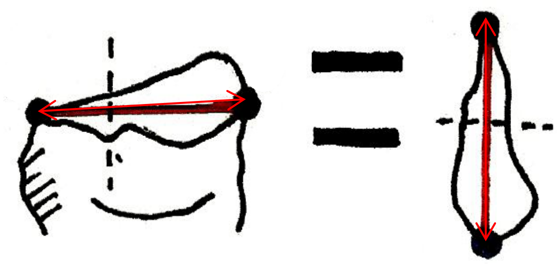
Term	Definition	Images
Morphological Flake Width (mm) (or 'Width Perpendicular to Morphological Length')	Width measured at the widest point of the flake, perpendicular to the morphological flake length	 d.
Flake Thickness (mm)	Measured at the thickest portion of the flake	 e.
Platform Depth (mm)	The distance between the two points where the platform surface intersects with the edges of the flake (Collins 1974:174); measured from the point of impact on the ventral side of the flake, straight back to the dorsal side of the flake platform	 f.

Table A-10 continued.

Term	Definition	Images
Platform Width (mm)	Maximum width of the entire present platform surface or platform remnant, perpendicular to the line of measurement of the platform depth (Collins 1974)	 g.

APPENDIX B: METRIC AND STATISTICAL TABLES

Table B-1. Chi-square: flake type by terminations. (χ^2=283.729; df=16; p=.048; CV=.172)

Flake Type * Terminations							
		Feather	Hinge	Overshot	Plunging	Step	Total
Normal flakes	Observed Expected Adj. residual	978 970.4 0.74	249 242.4 0.95	0 1.5 -2.60	0 0.8 -1.84	622 633.8 -1.21	1849
Biface thinning flakes	Observed Expected Adj. residual	172 184.7 -1.47	48 46.1 0.32	2 0.3 3.41	0 0.1 -0.42	130 120.7 1.14	352
Sequent flakes	Observed Expected Adj. residual	86 80.3 0.95	12 20.1 -2.00	0 0.1 -0.37	0 0.1 -0.26	55 52.4 0.45	153
Blades	Observed Expected Adj. residual	3 4.7 -1.15	1 1.2 -0.18	0 0 -0.09	1 0 16.29	4 3.1 0.64	9
Other flakes	Observed Expected Adj. residual	18 16.8 0.43	4 4.2 -0.10	0 0 -0.16	0 0 -0.12	10 11.0 -0.36	32
	Total	1257	314	2	1	821	2395

Table B-2. Chi-square: flake type by bulb of percussion. (χ^2=102.423; df=8; p=.000; CV=.146)

Flake Type * Bulb of Percussion					
		Flat	Normal	Exuberant	Total
Normal flakes	Observed Expected Adj. residual	408 406.9 0.13	1329 1338.7 -1.06	112 103.5 1.81	1849
Biface thinning flakes	Observed Expected Adj. residual	86 77.5 1.19	263 254.9 1.05	3 19.7 -4.19	352
Sequent flakes	Observed Expected Adj. residual	6 33.7 -5.58	129 110.8 3.41	18 8.6 3.43	153
Blades	Observed Expected Adj. residual	4 2.0 1.63	4 6.5 -1.88	1 0.5 0.72	9
Other flakes	Observed Expected Adj. residual	23 7.0 6.86	9 23.2 -5.64	0 1.8 -1.39	32
	Total	527	1734	134	2395

Table B-3. Chi-square: flake type by lipping. (χ^2=535.624; df=8; p=.000; CV=.334)

Flake Type * Lipping					
		No lipping	Lipped	Prominently lipped	Total
Normal flakes	Observed Expected Adj. residual	323 307.3 2.06	1485 1486.1 -0.14	41 55.6 -4.16	1849
Biface thinning flakes	Observed Expected Adj. residual	43 58.5 -2.40	302 282.9 2.77	7 10.6 -0.21	352
Sequent flakes	Observed Expected Adj. residual	29 25.4 0.80	123 123.0 0.01	1 4.6 -1.76	153
Blades	Observed Expected Adj. residual	1 1.5 -0.44	8 7.2 0.64	0 0.3 -0.53	9
Other flakes	Observed Expected Adj. residual	2 5.3 -1.59	7 25.7 -8.39	23 1.0 22.97	32
	Total	398	1925	72	2395

Table B-4. Chi-square: flake type by the amount of dorsal cortex. (χ^2=55.566; df=12; p=.000; CV=.088)

Flake Type * Dorsal Cortex						
		0% Dorsal cortex	≤50% Dorsal cortex	>50% Dorsal cortex	100% Dorsal cortex	Total
Normal flakes	Observed Expected Adj. residual	1207 1246.0 -4.06	360 352.8 0.89	179 170.6 1.41	103 79.5 5.64	1849
Biface thinning flakes	Observed Expected Adj. residual	273 237.2 4.41	51 67.2 -2.37	28 32.5 -0.89	0 15.1 -4.31	352
Sequent flakes	Observed Expected Adj. residual	102 103.1 -0.20	40 29.2 2.30	11 14.1 -0.90	0 6.6 -2.71	153
Blades	Observed Expected Adj. residual	4 6.1 -1.47	4 1.7 1.94	1 0.8 0.20	0 0.4 -0.64	9
Other flakes	Observed Expected Adj. residual	28 21.6 2.44	2 6.1 -1.86	2 3.0 -0.59	0 1.4 -1.21	32
	Total	1614	457	221	103	2395

Table B-5. Chi-square: flake type by thermal damage. (χ^2=2.208; df=4; p=.437; CV=.030)

Flake Type * Thermal Damage				
		No Thermal Damage	Thermally Damaged	Total
Normal flakes	Observed	1522	327	1849
	Expected	1523.2	325.8	
	Adj. residual	-0.15	0.15	
Biface thinning flakes	Observed	288	64	352
	Expected	290.0	62.0	
	Adj. residual	-0.30	0.30	
Sequent flakes	Observed	128	25	153
	Expected	126.0	27.0	
	Adj. residual	0.43	-0.43	
Blades	Observed	9	0	9
	Expected	7.4	1.6	
	Adj. residual	1.39	-1.39	
Other flakes	Observed	26	6	32
	Expected	26.4	5.6	
	Adj. residual	-0.17	0.17	
	Total	1973	422	2395

Table B-6. Chi-square: flake type by platform type. (χ^2=109.129; df=20; p=.000; CV=.107)

Flake Type * Type of Platform								
		Cortical	Single-faceted	Dihedral	Multi-faceted	Ground	Crushed	Total
Normal flakes	Observed	268	391	15	1017	15	143	1849
	Expected	225.4	365.2	14.7	1085.5	19.3	139.0	
	Adj. residual	6.34	3.16	0.18	-6.77	-2.06	0.75	
Biface thinning flakes	Observed	10	56	1	244	10	31	352
	Expected	42.9	69.5	2.8	206.6	3.7	26.5	
	Adj. residual	-5.81	-1.96	-1.17	4.38	3.59	0.99	
Sequent flakes	Observed	14	25	2	110	0	2	153
	Expected	18.7	30.2	1.2	89.8	1.6	11.5	
	Adj. residual	-1.19	-1.09	0.74	3.42	-1.31	-3.01	
Blades	Observed	0	1	0	5	0	3	9
	Expected	1.1	1.8	0.1	5.3	0.1	0.7	
	Adj. residual	-1.12	-0.65	-0.27	-0.19	-0.31	2.94	
Other flakes	Observed	0	0	1	30	0	1	32
	Expected	3.9	6.3	0.3	18.8	0.3	2.4	
	Adj. residual	-2.12	-2.83	1.50	4.05	-0.58	-0.95	
	Total	292	473	19	1406	25	180	2395

Table B-7. Chi-square: flake type by reduced. (χ^2=221.949; df=4; p=.000; CV=.304)

Flake Type * Reduced				
		Not Reduced	Reduced	Total
Normal flakes	Observed	1630	219	1849
	Expected	1553.3	295.7	
	Adj. residual	10.19	-10.19	
Biface thinning flakes	Observed	212	140	352
	Expected	295.7	56.3	
	Adj. residual	-13.18	13.18	
Sequent flakes	Observed	148	5	153
	Expected	128.5	24.5	
	Adj. residual	4.44	-4.44	
Blades	Observed	3	6	9
	Expected	7.6	1.4	
	Adj. residual	-4.16	4.16	
Other flakes	Observed	19	13	32
	Expected	26.9	5.1	
	Adj. residual	-3.83	3.83	
	Total	2012	383	2395

Table B-8. Chi-square: flake type by released. (χ^2=221.041; df=4; p=.000; CV=.304)

Flake Type * Released				
		Not Released	Released	Total
Normal flakes	Observed	1657	192	1849
	Expected	1589.6	259.4	
	Adj. residual	9.45	-9.45	
Biface thinning flakes	Observed	217	135	352
	Expected	302.6	49.4	
	Adj. residual	-14.23	14.23	
Sequent flakes	Observed	151	2	153
	Expected	131.5	21.5	
	Adj. residual	4.68	-4.68	
Blades	Observed	5	4	9
	Expected	7.7	1.3	
	Adj. residual	-2.63	2.63	
Other flakes	Observed	29	3	32
	Expected	27.5	4.5	
	Adj. residual	0.76	-0.76	
	Total	2059	336	2395

Table B-9. Chi-square: flake type by platform isolation. (χ^2=383.488; df=4; p=.000; CV=.400)

Flake Type * Platform Isolation				
		Not Isolated	Isolated	Total
Normal flakes	Observed Expected Adj. residual	994 911.0 8.09	855 938.0 -8.09	1849
Biface thinning flakes	Observed Expected Adj. residual	27 173.4 -16.90	325 178.6 16.90	352
Sequent flakes	Observed Expected Adj. residual	143 75.4 11.30	10 77.6 -11.30	153
Blades	Observed Expected Adj. residual	1 4.4 -2.29	8 4.6 2.29	9
Other flakes	Observed Expected Adj. residual	15 15.8 -0.27	17 16.2 0.27	32
	Total	1180	1215	2395

Table B-10. Chi-square: flake type by platform abrasion. (χ^2=148.035; df=4; p=.000; CV=.249)

Flake Type * Platform Abrasion				
		Not Abraded	Abraded	Total
Normal flakes	Observed Expected Adj. residual	925 853.9 6.95	924 995.1 -6.95	1849
Biface thinning flakes	Observed Expected Adj. residual	62 162.6 -11.64	290 189.4 11.64	352
Sequent flakes	Observed Expected Adj. residual	99 70.7 4.75	54 82.3 -4.75	153
Blades	Observed Expected Adj. residual	5 4.2 0.57	4 4.8 -0.57	9
Other flakes	Observed Expected Adj. residual	15 14.8 0.08	17 17.2 -0.08	32
	Total	1106	1289	2395

Table B-11. Chi-square: flake type by dorsal surface abrasion. (χ^2=107.504; df=4; p=.000; CV=.212)

Flake Type* Dorsal Surface Abrasion				
		Not Abraded	Abraded	Total
Normal flakes	Observed Expected Adj. residual	1738 1701.5 6.55	111 147.5 -6.55	1849
Biface thinning flakes	Observed Expected Adj. residual	282 323.9 -8.93	70 28.1 8.93	352
Sequent flakes	Observed Expected Adj. residual	152 140.8 3.46	1 12.2 -3.46	153
Blades	Observed Expected Adj. residual	9 8.3 0.88	0 0.7 -0.88	9
Other flakes	Observed Expected Adj. residual	23 29.4 -4.24	9 2.6 4.24	32
	Total	2204	191	2395

Table B-12. Chi-square (Normal flakes): dorsal cortex by terminations. (χ^2=19.745; df=6; p=.003; V=.073)

Dorsal Cortex * Terminations					
		Feather	Hinge	Step	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	67 54.5 2.54	12 13.9 -0.56	24 34.6 -2.29	103
>50% Dorsal Cortex	Observed Expected Adj. Residuals	100 94.7 0.84	31 24.1 1.59	48 60.2 -2.03	179
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	192 190.4 0.19	59 48.5 1.81	109 121.1 -1.50	360
0% Dorsal Cortex	Observed Expected Adj. Residuals	619 638.4 -1.90	147 162.5 -2.22	441 406.0 3.62	1207
	Total	978	249	622	1849

Table B-13. Chi-square (Normal flakes): dorsal cortex by bulb of percussion. (χ^2=38.045; df=6; p=.000; CV=.101)

Dorsal Cortex * Bulb of Percussion					
		Flat	Normal	Exuberant	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	19 22.7 -0.91	69 74.0 -1.14	15 6.2 3.72	103
>50% Dorsal Cortex	Observed Expected Adj. Residuals	45 39.5 1.04	113 128.7 -2.74	21 10.8 3.35	179
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	76 79.4 -0.49	255 258.8 -0.49	29 21.8 1.77	360
0% Dorsal Cortex	Observed Expected Adj. Residuals	268 266.3 0.20	892 867.6 2.66	47 73.1 -5.35	1207
	Total	408	1329	112	1849

Table B-14. Chi-square (Normal flakes): dorsal cortex by lipping. (χ^2=30.465; df=6; p=.000; CV=.091)

Dorsal Cortex * Lipping					
		No lipping	Lipped	Prominently lipped	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	26 18.0 2.14	76 82.7 -1.71	1 2.3 -0.88	103
>50% Dorsal Cortex	Observed Expected Adj. Residuals	46 31.3 3.05	129 143.8 -2.92	4 4.0 0.02	179
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	82 62.9 2.96	271 289.1 -2.68	7 8.0 -0.39	360
0% Dorsal Cortex	Observed Expected Adj. Residuals	169 210.8 -5.38	1009 969.4 4.87	29 26.8 0.74	1207
	Total	323	1485	41	1849

Table B-15. Chi-square (Normal flakes): dorsal cortex by type of platform. (χ^2=664.324; df=15; p=.000; CV=.346)

Dorsal Cortex * Type of Platform								
		Cortical	Single-Faceted	Dihedral	Multi-faceted	Ground	Crushed	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	61 14.9 13.27	21 21.8 -0.19	0 0.8 -0.94	15 56.7 -8.49	0 0.8 -0.94	6 8.0 -0.75	103
>50% Dorsal Cortex	Observed Expected Adj. Residuals	68 25.9 9.40	48 37.9 1.95	2 1.5 0.48	50 98.5 -7.66	2 1.5 0.48	9 13.8 -1.43	179
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	136 52.2 13.98	82 76.1 0.84	4 2.9 0.71	114 198.0 -9.92	0 2.9 -1.91	24 27.8 -0.84	360
0% Dorsal Cortex	Observed Expected Adj. Residuals	3 174.9 -23.86	240 255.2 -1.82	9 9.8 -0.43	838 663.9 17.10	13 9.8 1.75	104 93.3 1.95	1207
	Total	268	391	15	1017	15	143	1849

Table B-16. Chi-square (Normal flakes): dorsal cortex by reduced. (χ^2=34.833; df=3; p=.000; CV=.137)

Dorsal Cortex * Reduced				
		Not reduced	Reduced	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	101 90.8 3.20	2 12.2 -3.20	103
>50% Dorsal Cortex	Observed Expected Adj. Residuals	171 157.8 3.21	8 21.2 -3.21	179
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	331 317.4 2.48	29 42.6 -2.48	360
0% Dorsal Cortex	Observed Expected Adj. Residuals	1027 1064.0 -5.60	180 143.0 5.60	1207
	Total	1630	219	1849

Table B-17. Chi-square (Normal flakes): dorsal cortex by released. (χ^2=13.255; df=3; p=.000; CV=.085)

Dorsal Cortex * Released				
		Not released	Released	Total
100% Dorsal Cortex	Observed	102	1	103
	Expected	92.3	10.7	
	Adj. Residuals	3.22	-3.22	
>50% Dorsal Cortex	Observed	163	16	179
	Expected	160.4	18.6	
	Adj. Residuals	0.67	-0.67	
≤50% Dorsal Cortex	Observed	327	33	360
	Expected	322.6	37.4	
	Adj. Residuals	0.84	-0.84	
0% Dorsal Cortex	Observed	1065	142	1207
	Expected	1081.7	125.3	
	Adj. Residuals	-2.67	2.67	
	Total	1657	192	1849

Table B-18. Chi-square (Normal flakes): dorsal cortex by platform isolation. (χ^2=63.361; df=3; p=.000; CV=.185)

Dorsal Cortex * Platform Isolation				
		Not isolated	Isolated	Total
100% Dorsal Cortex	Observed	88	15	103
	Expected	55.4	47.6	
	Adj. Residuals	6.64	-6.64	
>50% Dorsal Cortex	Observed	107	72	179
	Expected	96.2	82.8	
	Adj. Residuals	1.70	-1.70	
≤50% Dorsal Cortex	Observed	215	145	360
	Expected	193.5	166.5	
	Adj. Residuals	2.53	-2.53	
0% Dorsal Cortex	Observed	584	623	1207
	Expected	648.9	558.1	
	Adj. Residuals	-6.36	6.36	
	Total	994	855	1849

Table B-19. Chi-square (Normal flakes): dorsal cortex by platform abrasion. (χ^2=61.745; df=3; p=.000; CV=.183)

Dorsal Cortex * Platform Abrasion				
		Not abraded	Abraded	Total
100% Dorsal Cortex	Observed	74	29	103
	Expected	51.5	51.5	
	Adj. Residuals	4.56	-4.56	
>50% Dorsal Cortex	Observed	112	67	179
	Expected	89.5	89.5	
	Adj. Residuals	3.53	-3.53	
≤50% Dorsal Cortex	Observed	212	148	360
	Expected	180.1	179.9	
	Adj. Residuals	3.75	-3.75	
0% Dorsal Cortex	Observed	527	680	1207
	Expected	603.8	603.2	
	Adj. Residuals	-7.51	7.51	
	Total	925	924	1849

Table B-20. Chi-square (Normal flakes): dorsal cortex by dorsal surface abrasion. (χ^2=8.642; df=3; p=.020; CV=.068)

Dorsal Cortex * Dorsal Surface Abrasion				
		Not abraded	Abraded	Total
100% Dorsal Cortex	Observed	101	2	103
	Expected	96.8	6.2	
	Adj. Residuals	1.79	-1.79	
>50% Dorsal Cortex	Observed	172	7	179
	Expected	168.3	10.7	
	Adj. Residuals	1.24	-1.24	
≤50% Dorsal Cortex	Observed	344	16	360
	Expected	338.4	21.6	
	Adj. Residuals	1.39	-1.39	
0% Dorsal Cortex	Observed	1121	86	1207
	Expected	1134.5	2.78	
	Adj. Residuals	-2.78	2.78	
	Total	1738	111	1849

Table B-21. Chi-square (Normal flakes): dorsal cortex by thermal damage. (χ^2=44.489; df=3; p=.000; CV=.155)

Dorsal Cortex * Thermal Damage				
		Not thermally damaged	Thermally damaged	Total
100% Dorsal Cortex	Observed	101	2	103
	Expected	84.8	18.2	
	Adj. Residuals	4.31	-4.31	
>50% Dorsal Cortex	Observed	163	16	179
	Expected	147.3	31.7	
	Adj. Residuals	3.23	-3.23	
≤50% Dorsal Cortex	Observed	312	48	360
	Expected	296.3	63.7	
	Adj. Residuals	2.41	-2.41	
0% Dorsal Cortex	Observed	946	261	1207
	Expected	993.5	213.5	
	Adj. Residuals	-6.09	6.09	
	Total	1522	327	1849

Table B-22. Chi-square (Biface thinning flakes): dorsal cortex by termination. (χ^2=6.554; df=6; p=.381; CV=.096)

Dorsal Cortex * Terminations						
		Feather	Hinge	Step	Overshot	Total
100% Dorsal Cortex	Observed	0	0	0	0	0
	Expected	0	0	0	0	
	Adj. Residuals	0	0	0	0	
>50% Dorsal Cortex	Observed	14	2	12	0	28
	Expected	13.7	3.8	0.2	0.2	
	Adj. Residuals	0.13	-1.04	-0.42	-0.42	
≤50% Dorsal Cortex	Observed	30	7	13	1	51
	Expected	24.9	7.0	18.8	0.3	
	Adj. Residuals	1.54	0.02	-1.83	-1.83	
0% Dorsal Cortex	Observed	128	39	105	1	273
	Expected	133.4	37.2	100.8	1.6	
	Adj. Residuals	-1.38	0.66	1.11	-0.94	
	Total	172	48	130	2	352

Table B-23. Chi-square (Biface thinning flakes): dorsal cortex by bulb of percussion. (χ^2=37.795; df=4; p=.001; CV=.232)

Dorsal Cortex * Bulb of Percussion					
		Flat	Normal	Exuberant	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	0 0 0	0 0 0	0 0 0	0
>50% Dorsal Cortex	Observed Expected Adj. Residuals	7 6.8 0.07	18 20.9 -1.32	3 0.2 5.92	28
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	17 12.5 1.60	34 38.1 -1.43	0 0.4 -0.72	51
0% Dorsal Cortex	Observed Expected Adj. Residuals	62 66.7 -1.40	211 204.0 2.07	0 2.3 -3.23	273
	Total	86	263	3	352

Table B-24. Chi-square (Biface thinning flakes): dorsal cortex by lipping. (χ^2=2.921; df=4; p=.642; CV=.064)

Dorsal Cortex * Lipping					
		No lipping	Lipped	Prominently lipped	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	0 0 0	0 0 0	0 0 0	0
>50% Dorsal Cortex	Observed Expected Adj. Residuals	6 3.4 1.55	21 24.0 -1.71	1 0.6 0.63	28
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	6 6.2 -0.11	44 43.8 0.11	1 1.0 -0.02	51
0% Dorsal Cortex	Observed Expected Adj. Residuals	31 33.3 -0.92	237 234.2 1.02	5 5.4 -0.39	273
	Total	43	302	7	352

Table B-25. Chi-square (Biface thinning flakes): dorsal cortex by type of platform. (χ^2=42.998; df=10; p=.000; CV=.247)

		Cortical	Single-faceted	Dihedral	Multi-faceted	Ground	Crushed	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0
>50% Dorsal Cortex	Observed Expected Adj. Residuals	2 0.8 1.43	0 4.5 -2.40	0 0.1 -0.29	23 19.4 1.53	0 0.8 -0.94	3 2.5 0.37	28
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	7 1.4 5.06	9 8.1 0.37	1 0.1 2.43	30 35.4 -1.76	1 1.4 -0.41	3 4.5 -0.80	51
0% Dorsal Cortex	Observed Expected Adj. Residuals	1 7.8 -5.19	47 43.4 1.25	0 0.8 -1.86	191 189.2 0.49	9 7.8 0.96	25 24.0 0.43	273
	Total	10	56	1	244	10	31	352

Table B-26. Chi-square (Biface thinning flakes): dorsal cortex by reduced. (χ^2=1.652; df=2; p=.424; CV=.069)

Dorsal Cortex * Reduced				
		Not reduced	Reduced	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	0 0 0	0 0 0	0
>50% Dorsal Cortex	Observed Expected Adj. Residuals	20 16.9 1.26	8 11.1 -1.26	28
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	31 30.7 0.09	20 20.3 -0.09	51
0% Dorsal Cortex	Observed Expected Adj. Residuals	161 164.4 -0.89	112 108.6 0.89	273
	Total	212	140	352

Table B-27. Chi-square (Biface thinning flakes): dorsal cortex by released. (χ^2=0.135; df=2; p=.935; CV=.020)

Dorsal Cortex * Released				
		Not released	Released	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	18	10	28
	Expected	17.3	10.7	
	Adj. Residuals	0.30	-0.30	
≤50% Dorsal Cortex	Observed	32	19	51
	Expected	31.4	19.6	
	Adj. Residuals	0.17	-0.17	
0% Dorsal Cortex	Observed	167	106	273
	Expected	168.3	104.7	
	Adj. Residuals	-0.34	0.34	
	Total	217	135	352

Table B-28. Chi-square (Biface thinning flakes): dorsal cortex by isolation. (χ^2=0.597; df=2; p=.749; CV=.041)

Dorsal Cortex * Platform Isolation				
		Not isolated	Isolated	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	3	25	28
	Expected	2.1	25.9	
	Adj. Residuals	0.63	-0.63	
≤50% Dorsal Cortex	Observed	3	48	51
	Expected	3.9	47.1	
	Adj. Residuals	-0.52	0.52	
0% Dorsal Cortex	Observed	21	252	273
	Expected	20.9	252.1	
	Adj. Residuals	0.03	-0.03	
	Total	27	325	352

Table B-29. Chi-square (Biface thinning flakes): dorsal cortex by dorsal surface abrasion. (χ^2=0.806; df=2; p=.657; CV=.048)

Dorsal Cortex * Dorsal Surface Abrasion				
		Not Abraded	Abraded	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	23	5	28
	Expected	22.4	5.6	
	Adj. Residuals	0.28	-0.28	
≤50% Dorsal Cortex	Observed	43	8	51
	Expected	40.9	10.1	
	Adj. Residuals	0.81	-0.81	
0% Dorsal Cortex	Observed	216	57	273
	Expected	218.7	54.3	
	Adj. Residuals	-0.87	0.87	
	Total	282	70	352

Table B-30. Chi-square (Biface thinning flakes): dorsal cortex by platform abrasion. (χ^2=4.866; df=2; p=.119; CV=.118)

Dorsal Cortex * Platform Abrasion				
		Not Abraded	Abraded	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	9	19	28
	Expected	4.9	23.1	
	Adj. Residuals	2.10	-2.10	
≤50% Dorsal Cortex	Observed	10	41	51
	Expected	9.0	42.0	
	Adj. Residuals	0.40	-0.40	
0% Dorsal Cortex	Observed	43	230	273
	Expected	48.1	224.9	
	Adj. Residuals	-1.71	1.71	
	Total	62	290	352

Table B-31. Chi-square (Biface thinning flakes): dorsal cortex by thermal damage. (χ^2=6.049; df=2; p=.031; CV=.131)

Dorsal Cortex * Thermal Damage				
		Not thermally damaged	Thermally damaged	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	25	3	28
	Expected	22.9	5.1	
	Adj. Residuals	1.07	-1.07	
≤50% Dorsal Cortex	Observed	47	4	51
	Expected	41.7	9.3	
	Adj. Residuals	2.07	-2.07	
0% Dorsal Cortex	Observed	216	57	273
	Expected	223.4	49.6	
	Adj. Residuals	-2.44	2.44	
	Total	288	64	352

Table B-32. Chi-square (Sequent flakes): dorsal cortex by terminations. (χ^2=9.215; df=4; p=.060; CV=.174)

Dorsal Cortex * Terminations					
		Feather	Hinge	Step	Total
100% Dorsal Cortex	Observed	0	0	0	0
	Expected	0	0	0	
	Adj. Residuals	0	0	0	
>50% Dorsal Cortex	Observed	7	1	3	11
	Expected	6.2	0.9	4.0	
	Adj. Residuals	0.52	0.16	-0.62	
≤50% Dorsal Cortex	Observed	15	6	19	40
	Expected	22.5	3.1	14.4	
	Adj. Residuals	-2.78	1.96	1.77	
0% Dorsal Cortex	Observed	64	5	33	102
	Expected	57.3	8.0	36.7	
	Adj. Residuals	2.30	-1.91	-1.31	
	Total	86	12	55	153

Table B-33. Chi-square (Sequent flakes): dorsal cortex by bulb of percussion. (χ^2=7.268; df=3; p=.309; CV=.154)

Dorsal Cortex * Bulb of Percussion					
		Flat	Normal	Exuberant	Total
100% Dorsal Cortex	Observed	0	0	0	0
	Expected	0	0	0	
	Adj. Residuals	0	0	0	
>50% Dorsal Cortex	Observed	2	8	1	11
	Expected	0.4	9.3	1.3	
	Adj. Residuals	2.53	-1.10	-0.29	
≤50% Dorsal Cortex	Observed	2	34	4	40
	Expected	1.6	33.7	4.7	
	Adj. Residuals	0.41	0.14	-0.40	
0% Dorsal Cortex	Observed	2	87	13	102
	Expected	4.0	86.0	12.0	
	Adj. Residuals	-1.77	0.47	0.53	
	Total	6	129	18	153

Table B-34. Chi-square (Sequent flakes): dorsal cortex by lipping. (χ^2=10.273; df=4; p=.077; CV=.183)

Dorsal Cortex * Lipping					
		No lipping	Lipped	Prominently lipped	Total
100% Dorsal Cortex	Observed	0	0	0	0
	Expected	0	0	0	
	Adj. Residuals	0	0	0	
>50% Dorsal Cortex	Observed	6	5	0	11
	Expected	2.1	8.8	0.1	
	Adj. Residuals	3.13	-3.03	-0.28	
≤50% Dorsal Cortex	Observed	7	33	0	40
	Expected	7.6	32.2	0.3	
	Adj. Residuals	-0.27	0.39	-0.60	
0% Dorsal Cortex	Observed	16	85	1	102
	Expected	19.3	82.0	0.7	
	Adj. Residuals	-1.46	1.30	0.71	
	Total	29	123	1	153

Table B-35. Chi-square (Sequent flakes): dorsal cortex by type of platform. (χ^2=31.032; df=8; p=.000; CV=.318)

Dorsal Cortex * Type of Platform							
		Cortical	Single-faceted	Dihedral	Multi-faceted	Crushed	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0
>50% Dorsal Cortex	Observed Expected Adj. Residuals	3 1.0 2.16	1 1.8 -0.67	0 0.1 -0.40	7 7.9 -0.63	0 0.1 -0.40	11
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	10 3.7 4.05	10 6.5 1.72	0 0.5 -0.85	20 28.8 -3.58	0 0.5 -0.85	40
0% Dorsal Cortex	Observed Expected Adj. Residuals	1 9.3 -4.96	14 16.7 -1.24	2 1.3 1.01	83 73.3 3.69	2 1.3 1.01	102
	Total	14	25	2	110	2	153

Table B-36. Chi-square (Sequent flakes): dorsal cortex by reduced. (χ^2=2.584; df=2; p=.126; CV=.130)

Dorsal Cortex * Reduced				
		Not reduced	Reduced	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	0 0 0	0 0 0	0
>50% Dorsal Cortex	Observed Expected Adj. Residuals	11 10.6 0.63	0 0.4 -0.63	11
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	40 38.7 1.35	0 1.3 -1.35	40
0% Dorsal Cortex	Observed Expected Adj. Residuals	97 98.7 -1.61	5 3.3 1.61	102
	Total	148	5	153

Table B-37. Chi-square (Sequent flakes): dorsal cortex by released. (χ^2=0.671; df=2; p=.694; CV=.066)

Dorsal Cortex * Released				
		Not released	Released	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	11	0	11
	Expected	10.9	0.1	
	Adj. Residuals	0.40	-0.40	
≤50% Dorsal Cortex	Observed	39	1	40
	Expected	39.5	0.5	
	Adj. Residuals	-0.77	0.77	
0% Dorsal Cortex	Observed	101	1	102
	Expected	100.7	1.3	
	Adj. Residuals	0.50	-0.50	
	Total	151	2	153

Table B-38. Chi-square (Sequent flakes): dorsal cortex by platform isolation. (χ^2=1.209; df=2; p=.382; CV=.089)

Dorsal Cortex * Platform Isolation				
		Not isolated	Isolated	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	11	0	11
	Expected	10.3	0.7	
	Adj. Residuals	0.91	-0.91	
≤50% Dorsal Cortex	Observed	38	2	40
	Expected	37.4	2.6	
	Adj. Residuals	0.46	-0.46	
0% Dorsal Cortex	Observed	94	8	102
	Expected	95.3	6.7	
	Adj. Residuals	-0.93	0.93	
	Total	143	10	153

Table B-39. Chi-square (Sequent flakes): dorsal cortex by platform abrasion. (χ^2=0.134; df=2; p=.936; CV=.030)

Dorsal Cortex * Platform Abrasion				
		Not Abraded	Abraded	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	7	4	11
	Expected	7.1	3.9	
	Adj. Residuals	-0.08	0.08	
≤50% Dorsal Cortex	Observed	25	15	40
	Expected	25.9	14.1	
	Adj. Residuals	-0.34	0.34	
0% Dorsal Cortex	Observed	67	35	102
	Expected	66.0	36.0	
	Adj. Residuals	0.36	-0.36	
	Total	99	54	153

Table B-40. Chi-square (Sequent flakes): dorsal cortex by dorsal surface abrasion. (χ^2=2.844; df=2; p=.259; CV=.136)

Dorsal Cortex * Dorsal Surface Abrasion				
		Not abraded	Abraded	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	11	0	11
	Expected	10.9	0.1	
	Adj. Residuals	0.28	-0.28	
≤50% Dorsal Cortex	Observed	39	1	40
	Expected	39.7	0.3	
	Adj. Residuals	-1.69	1.69	
0% Dorsal Cortex	Observed	102	0	102
	Expected	101.3	0.7	
	Adj. Residuals	1.42	-1.42	
	Total	152	1	153

Table B-41. Chi-square (Sequent flakes): dorsal cortex by thermal damage. (χ^2=3.377; df=2; p=.076; CV=.149)

Dorsal Cortex * Thermal Damage				
		Not thermally damaged	Thermally damaged	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	11	0	11
	Expected	9.2	1.8	
	Adj. Residuals	1.52	-1.52	
≤50% Dorsal Cortex	Observed	35	5	40
	Expected	33.5	6.5	
	Adj. Residuals	0.76	-0.76	
0% Dorsal Cortex	Observed	82	20	102
	Expected	85.3	16.7	
	Adj. Residuals	-1.55	1.55	
	Total	128	25	153

Table B-42. Chi-square (Blades): dorsal cortex by terminations. (χ^2=6.000; df=6; p=.238; CV=.577)

Dorsal Cortex * Terminations						
		Feather	Hinge	Step	Plunging	Total
100% Dorsal Cortex	Observed	0	0	0	0	0
	Expected	0	0	0	0	
	Adj. Residuals	0	0	0	0	
>50% Dorsal Cortex	Observed	1	0	0	0	1
	Expected	0.3	0.1	0.1	0.4	
	Adj. Residuals	1.50	-0.38	-0.38	-0.95	
≤50% Dorsal Cortex	Observed	0	1	1	2	4
	Expected	1.3	0.4	0.4	1.8	
	Adj. Residuals	-1.90	1.19	1.19	0.30	
0% Dorsal Cortex	Observed	2	0	0	2	4
	Expected	1.3	0.4	0.4	1.8	
	Adj. Residuals	0.95	-0.95	-0.95	0.30	
	Total	3	1	1	4	9

Table B-43. Chi-square (Blades): dorsal cortex by bulb of percussion. (χ^2=2.813; df=4; p=.477; CV=.395)

Dorsal Cortex * Bulb of Percussion					
		Flat	Normal	Exuberant	Total
100% Dorsal Cortex	Observed	0	0	0	0
	Expected	0	0	0	
	Adj. Residuals	0	0	0	
>50% Dorsal Cortex	Observed	0	1	0	1
	Expected	0.4	0.4	0.1	
	Adj. Residuals	-0.95	1.19	-0.38	
≤50% Dorsal Cortex	Observed	2	2	0	4
	Expected	1.8	1.8	0.4	
	Adj. Residuals	0.30	0.30	-0.95	
0% Dorsal Cortex	Observed	2	1	1	4
	Expected	1.8	1.8	0.4	
	Adj. Residuals	0.30	-1.05	1.19	
	Total	4	4	1	9

Table B-44. Chi-square (Blades): dorsal cortex by lipping. (χ^2=1.406; df=2; p=.411; CV=.395)

Dorsal Cortex * Lipping				
		No lipping	Lipped	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	0	1	1
	Expected	0.1	0.9	
	Adj. Residuals	-0.38	0.38	
≤50% Dorsal Cortex	Observed	1	3	4
	Expected	0.4	3.6	
	Adj. Residuals	1.19	-1.19	
0% Dorsal Cortex	Observed	0	4	4
	Expected	0.4	3.6	
	Adj. Residuals	-0.95	0.95	
	Total	1	8	9

Table B-45. Chi-square (Blades): dorsal cortex by thermal damage. (χ^2= n/a; df= n/a; p= n/a; CV= n/a)

Dorsal Cortex * Thermal Damage				
		Not thermally damaged	Thermally damaged	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	1	0	1
	Expected	1.0	0	
	Adj. Residuals	n/a	0	
≤50% Dorsal Cortex	Observed	4	0	4
	Expected	4.0	0	
	Adj. Residuals	n/a	0	
0% Dorsal Cortex	Observed	4	0	4
	Expected	4.0	0	
	Adj. Residuals	n/a	0	
	Total	9	0	9

Table B-46. Chi-square (Blades): dorsal cortex by type of platform. (χ^2=9.600; df=4; p=.146; CV=.730)

Dorsal Cortex * Type of Platform					
		Single-faceted	Multi-faceted	Crushed	Total
100% Dorsal Cortex	Observed	0	0	0	0
	Expected	0	0	0	
	Adj. Residuals	0	0	0	
>50% Dorsal Cortex	Observed	1	0	0	1
	Expected	0.1	0.6	0.3	
	Adj. Residuals	3.00	-1.19	-0.75	
≤50% Dorsal Cortex	Observed	0	3	1	4
	Expected	0.4	2.2	1.3	
	Adj. Residuals	-0.95	1.05	-0.47	
0% Dorsal Cortex	Observed	0	2	2	4
	Expected	0.4	2.2	1.3	
	Adj. Residuals	-0.95	-0.30	0.95	
	Total	1	5	3	9

Table B-47. Chi-square (Blades): dorsal cortex by reduced. (χ^2=4.500; df=2; p=.052; CV=.707)

Dorsal Cortex * Reduced				
		Not reduced	Reduced	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	1	0	1
	Expected	0.3	0.7	
	Adj. Residuals	1.50	-1.50	
≤50% Dorsal Cortex	Observed	2	2	4
	Expected	1.3	2.7	
	Adj. Residuals	0.95	-0.95	
0% Dorsal Cortex	Observed	0	4	4
	Expected	1.3	2.7	
	Adj. Residuals	-1.90	1.90	
	Total	3	6	9

Table B-48. Chi-square (Blades): dorsal cortex by released. (χ^2=0.900; df=2; p=.529; CV=.316)

Dorsal Cortex * Released				
		Not released	Released	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	1	0	1
	Expected	0.6	0.4	
	Adj. Residuals	0.95	-0.95	
≤50% Dorsal Cortex	Observed	2	2	4
	Expected	2.2	1.8	
	Adj. Residuals	-0.30	0.30	
0% Dorsal Cortex	Observed	2	2	4
	Expected	2.2	1.8	
	Adj. Residuals	-0.30	0.30	
	Total	5	4	9

Table B-49. Chi-square (Blades): dorsal cortex by platform abrasion. (χ^2=0.900; df=2; p=.529; CV=.316)

Dorsal Cortex * Platform Abrasion				
		Not abraded	Abraded	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	1	0	1
	Expected	0.6	0.4	
	Adj. Residuals	0.95	-0.95	
≤50% Dorsal Cortex	Observed	2	2	4
	Expected	2.2	1.8	
	Adj. Residuals	-0.30	0.30	
0% Dorsal Cortex	Observed	2	2	4
	Expected	2.2	1.8	
	Adj. Residuals	-0.30	0.30	
	Total	5	4	9

Table B-50. Chi-square (Blades): dorsal cortex by platform isolation. (χ^2=9.000; df=2; p=.043; CV=1.000)

Dorsal Cortex * Platform Isolation				
		Not isolated	Isolated	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	1	0	1
	Expected	0.1	0.9	
	Adj. Residuals	3.00	-3.00	
≤50% Dorsal Cortex	Observed	0	4	4
	Expected	0.4	3.6	
	Adj. Residuals	-0.95	0.95	
0% Dorsal Cortex	Observed	0	4	4
	Expected	0.4	3.6	
	Adj. Residuals	-0.95	0.95	
	Total	1	8	9

Table B-51. Chi-square (Blades): dorsal cortex by dorsal surface abrasion. (χ^2= n/a; df= n/a; p= n/a; CV= n/a)

Dorsal Cortex * Dorsal Surface Abrasion				
		Not abraded	Abraded	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	1	0	1
	Expected	1.0	0	
	Adj. Residuals	n/a	0	
≤50% Dorsal Cortex	Observed	4	0	4
	Expected	4.0	0	
	Adj. Residuals	n/a	0	
0% Dorsal Cortex	Observed	4	0	4
	Expected	4.0	0	
	Adj. Residuals	n/a	0	
	Total	9	0	9

Table B-52. Chi-square (“Other” flakes): dorsal cortex by terminations. (χ^2=3.556; df=4; p=.283; CV=.236)

Dorsal Cortex * Terminations					
		Feather	Hinge	Step	Total
100% Dorsal Cortex	Observed	0	0	0	0
	Expected	0	0	0	
	Adj. Residuals	0	0	0	
>50% Dorsal Cortex	Observed	2	0	0	2
	Expected	1.1	0.3	0.6	
	Adj. Residuals	1.29	-0.55	-0.98	
≤50% Dorsal Cortex	Observed	2	0	0	2
	Expected	1.1	0.3	0.6	
	Adj. Residuals	1.29	-0.55	-0.98	
0% Dorsal Cortex	Observed	14	4	10	28
	Expected	15.8	3.5	8.8	
	Adj. Residuals	-1.89	0.81	1.44	
	Total	18	4	10	32

Table B-53. Chi-square ("Other" flakes): dorsal cortex by reduced. (χ^2=1.499; df=2; p=.331; CV=.216)

Dorsal Cortex * Reduced				
		Not reduced	Reduced	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	1	1	2
	Expected	1.2	0.8	
	Adj. Residuals	-0.28	0.28	
≤50% Dorsal Cortex	Observed	2	0	2
	Expected	1.2	0.8	
	Adj. Residuals	1.21	-1.21	
0% Dorsal Cortex	Observed	16	12	28
	Expected	16.6	11.4	
	Adj. Residuals	-0.68	0.68	
	Total	19	13	32

Table B-54. Chi-square ("Other" flakes): dorsal cortex by released. (χ^2=0.473; df=2; p=.656; CV=.122)

Dorsal Cortex * Released				
		Not released	Released	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	2	0	2
	Expected	1.8	0.2	
	Adj. Residuals	0.47	-0.47	
≤50% Dorsal Cortex	Observed	2	0	2
	Expected	1.8	0.2	
	Adj. Residuals	0.47	-0.47	
0% Dorsal Cortex	Observed	25	3	28
	Expected	25.4	2.6	
	Adj. Residuals	-0.69	0.69	
	Total	29	3	32

Table B-55. Chi-square ("Other" flakes): dorsal cortex by platform isolation. (χ^2=0.018; df=2; p=.991; CV=.024)

Dorsal Cortex * Platform Isolation				
		Not isolated	Isolated	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	1	1	2
	Expected	0.9	1.1	
	Adj. Residuals	0.09	-0.09	
≤50% Dorsal Cortex	Observed	1	1	2
	Expected	0.9	1.1	
	Adj. Residuals	0.09	-0.09	
0% Dorsal Cortex	Observed	13	15	28
	Expected	13.1	14.9	
	Adj. Residuals	-0.13	0.13	
	Total	15	17	32

Table B-56. Chi-square ("Other" flakes): dorsal cortex by platform abrasion. (χ^2=2.456; df=2; p=.200; CV=.277)

Dorsal Cortex * Platform Abrasion				
		Not abraded	Abraded	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	1	1	2
	Expected	0.9	1.1	
	Adj. Residuals	0.09	-0.09	
≤50% Dorsal Cortex	Observed	2	0	2
	Expected	0.9	1.1	
	Adj. Residuals	1.55	-1.55	
0% Dorsal Cortex	Observed	12	16	28
	Expected	13.1	14.9	
	Adj. Residuals	-1.21	1.21	
	Total	15	17	32

Table B-57. Chi-square ("Other" flakes): dorsal cortex by dorsal surface abrasion. (χ^2=1.789; df=2; p=.239; CV=.236)

Dorsal Cortex * Dorsal Surface Abrasion				
		Not abraded	Abraded	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	2	0	2
	Expected	1.4	0.6	
	Adj. Residuals	0.91	-0.91	
≤50% Dorsal Cortex	Observed	2	0	2
	Expected	1.4	0.6	
	Adj. Residuals	0.91	-0.91	
0% Dorsal Cortex	Observed	19	9	28
	Expected	20.1	7.9	
	Adj. Residuals	-1.34	1.34	
	Total	23	9	32

Table B-58. Chi-square ("Other" flakes): dorsal cortex by thermal damage. (χ^2=2.930; df=2; p=.305; CV=.303)

Dorsal Cortex * Thermal Damage				
		Not thermally damaged	Thermally damaged	Total
100% Dorsal Cortex	Observed	0	0	0
	Expected	0	0	
	Adj. Residuals	0	0	
>50% Dorsal Cortex	Observed	1	1	2
	Expected	1.6	0.4	
	Adj. Residuals	-1.17	1.17	
≤50% Dorsal Cortex	Observed	1	1	2
	Expected	1.6	0.4	
	Adj. Residuals	-1.17	1.17	
0% Dorsal Cortex	Observed	24	4	28
	Expected	22.8	5.3	
	Adj. Residuals	1.71	-1.71	
	Total	26	6	32

Table B-59. Chi-square ("Other" flakes): dorsal cortex by bulb of percussion. (χ^2=6.029; df=2; p=.038; CV=.434)

Dorsal Cortex * Bulb of Percussion				
		Flat	Normal	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	0 0 0	0 0 0	0
>50% Dorsal Cortex	Observed Expected Adj. Residuals	2 1.4 0.91	0 0.6 -0.91	2
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	0 1.4 -2.33	2 0.6 2.33	2
0% Dorsal Cortex	Observed Expected Adj. Residuals	21 20.1 1.04	7 7.9 -1.04	28
	Total	23	9	32

Table B-60. Chi-square ("Other" flakes): dorsal cortex by lipping. (χ^2=9.430; df=4; p=.109; CV=.384)

Dorsal Cortex * Lipping					
		No lipping	Lipped	Prominently lipped	Total
100% Dorsal Cortex	Observed Expected Adj. Residuals	0 0 0	0 0 0	0 0 0	0
>50% Dorsal Cortex	Observed Expected Adj. Residuals	0 0.1 -0.38	0 0.4 -0.77	2 1.4 0.91	2
≤50% Dorsal Cortex	Observed Expected Adj. Residuals	1 0.1 2.64	1 0.4 0.99	0 1.4 -2.33	2
0% Dorsal Cortex	Observed Expected Adj. Residuals	1 1.8 -1.66	6 6.1 -0.16	21 20.1 1.04	28
	Total	2	7	23	32

Table B-61. Chi-square ("Other" flakes): dorsal cortex by type of platform. (χ^2=15.581; df=4; p=.176; CV=.493)

Dorsal Cortex * Type of Platform					
		Dihedral	Multi-faceted	Crushed	Total
100% Dorsal Cortex	Observed	0	0	0	0
	Expected	0	0	0	
	Adj. Residuals	0	0	0	
>50% Dorsal Cortex	Observed	0	2	0	2
	Expected	0.1	1.9	0.1	
	Adj. Residuals	-0.26	0.38	-0.26	
≤50% Dorsal Cortex	Observed	0	1	1	2
	Expected	0.1	1.9	0.1	
	Adj. Residuals	-0.26	-2.64	3.93	
0% Dorsal Cortex	Observed	1	27	0	28
	Expected	0.9	26.3	0.9	
	Adj. Residuals	0.38	1.66	-2.69	
	Total	1	1	30	32

Table B-62. Flake metrics by flake types. (*Blades include two blade fragments.)

		Normal	Biface Thinning	Sequent	Blades*	Other
Count (Total = 2395)		1849	352	153	9	32
Percent (%)		77.20	14.70	6.39	0.38	1.34
Trajectory flake length (mm)	Max.	78.6	64.0	46.5	105.3	65.3
	Min.	4.2	7.2	5.2	36.1	7.2
	St. Dev.	8.789	10.097	7.041	25.704	12.116
Morphological flake length (mm)	Max.	78.6	64.0	61.2	105.3	65.3
	Min.	4.2	7.2	5.2	36.1	7.2
	St. Dev.	9.389	10.337	8.310	25.704	13.149
Trajectory flake width (mm)	Max.	75.4	47.5	40.9	46.0	36.3
	Min.	4.2	6.9	6.4	26.2	8.3
	St. Dev.	8.227	7.769	6.870	6.719	7.398
Morphological flake width (mm)	Max.	69.4	62.5	43.0	46.0	36.3
	Min.	4.2	6.9	6.4	26.2	8.3
	St. Dev.	7.688	7.851	6.700	6.719	6.463
Flake thickness (mm)	Max.	19.2	11.7	8	21	8.6
	Min.	0.4	1.0	0.8	6.9	1.5
	St. Dev.	2.350	1.705	1.459	4.997	1.993
Platform depth (mm)	Max.	18.1	10.4	7.2	6.8	8.6
	Min.	0.3	0.5	0.6	1.0	0.7
	St. Dev.	1.625	1.052	1.011	1.905	2.128
Platform width (mm)	Max.	62.7	28.9	32.1	27.5	25.1
	Min.	0.9	1.7	2.7	5.1	1.4
	St. Dev.	5.043	3.412	5.831	7.557	5.670
Flake weight (g)	Max.	54.8	21.0	12.0	75.2	7.8
	Min.	0.1	0.1	0.1	8.3	0.1
	St. Dev.	4.419	2.828	1.785	22.337	1.907

Table B-63. Average metrics by flake types.

Average Metrics by Flake Type					
	Mean Average of Morphological Length/Width Ratios	Mean Average of Trajectory Length/Width Ratios	Mean Average of Platform Width/Depth Ratios	Mean Average of Flake Thickness (mm)	Mean Average of Flake Weight (g)
Normal	1.19	1.11	4.21	3.17	1.50
Biface thinning	1.21	1.17	3.92	3.21	2.00
Sequent	0.94	0.85	8.20	2.55	1.10
Blades	2.57	2.57	3.55	14.36	40.70
Other	0.87	0.83	3.93	4.10	1.00
Grand Total Average	1.17	1.10	4.42	3.18	1.69

APPENDIX C: REGRESSION OUTPUT FIGURES

Regression Statistics	
Multiple R	0.687828215
R Square	0.473107653
Adjusted R Square	0.472822384
Standard Error	5.973329137
Observations	1849

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	59174.94595	59174.94595	1658.459914	2.761E-259
Residual	1847	65902.18083	35.68066098		
Total	1848	125077.1268			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	5.007660091	0.287436745	17.42178123	4.68775E-63	4.44393	5.57140
	0.643832109	0.015809573	40.72419323	2.761E-259	0.61283	0.67484

Figure C-1. Regression output: Normal flakes – trajectory length by trajectory width.

Regression Statistics	
Multiple R	0.694118539
R Square	0.481800547
Adjusted R Square	0.481519984
Standard Error	5.535721779
Observations	1849

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	52624.22861	52624.22861	1717.264664	5.8196E-266
Residual	1847	56599.86624	30.64421561		
Total	1848	109224.0949			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	5.308889824	0.261602472	20.29372956	8.07112E-83	4.79582	5.82196
	0.568338275	0.013714762	41.43989218	5.8196E-266	0.54144	0.59524

Figure C-2. Regression output: Normal flakes – morphological length by morphological width.

Regression Statistics	
Multiple R	0.777898919
R Square	0.605126727
Adjusted R Square	0.604912936
Standard Error	3.169824712
Observations	1849

ANOVA

	df	SS	MS	F	Significance F
Regression	1	28439.76383	28439.76383	2830.450029	0
Residual	1847	18558.26574	10.0477887		
Total	1848	46998.02956			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	2.696936776	0.120980673	22.2922943	1.09673E-97	2.45966	2.93421
	2.414838371	0.045390015	53.20197392	0	2.32582	2.50386

Figure C-3. Regression output: Normal flakes – platform depth by platform width.

Regression Statistics	
Multiple R	0.6724655
R Square	0.4522098
Adjusted R Square	0.4506447
Standard Error	5.7581359
Observations	352

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	9579.826	9579.826	288.9307729	1.14271E-47
Residual	350	11604.645	33.156		
Total	351	21184.471			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	8.179578334	0.750	10.902	5.05425E-24	6.70398	9.65518
	0.517417192	0.030	16.998	1.14271E-47	0.45755	0.57729

Figure C-4. Regression output: Biface thinning flakes – trajectory length by trajectory width.

Regression Statistics	
Multiple R	0.68731374
R Square	0.47240018
Adjusted R Square	0.47089275
Standard Error	5.71095053
Observations	352

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	10220.92621	10220.92621	313.3815733	1.5645E-50
Residual	350	11415.23459	32.61495596		
Total	351	21636.1608			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	7.58274318	0.742939089	10.206413	1.39257E-21	6.1216	9.0439
	0.52201812	0.02948824	17.70258663	1.56454E-50	0.4640	0.5800

Figure C-5. Regression output: Biface thinning flakes – morphological length by morphological width.

Regression Statistics	
Multiple R	0.743689869
R Square	0.553074621
Adjusted R Square	0.551797692
Standard Error	2.284000212
Observations	352

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2259.482789	2259.48279	433.1284966	3.535E-63
Residual	350	1825.829938	5.21665697		
Total	351	4085.312727			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	2.087240028	0.236396492	8.82940357	5.13609E-17	1.6223	2.5522
	2.411063034	0.115851106	20.8117394	3.5346E-63	2.1832	2.6389

Figure C-6. Regression output: Biface thinning flakes – platform depth by platform width.

Regression Statistics	
Multiple R	0.680102736
R Square	0.462539731
Adjusted R Square	0.458980391
Standard Error	5.053326967
Observations	153

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3318.443473	3318.443473	129.9509999	4.1407E-22
Residual	151	3855.953128	25.53611343		
Total	152	7174.396601			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	7.764271501	0.927478816	8.37137341	3.58579E-14	5.93176	9.59678
	0.663650533	0.058216975	11.39960525	4.14066E-22	0.54863	0.77868

Figure C-7. Regression output: Sequent flakes – trajectory length by trajectory width.

Regression Statistics	
Multiple R	0.6699925
R Square	0.44888995
Adjusted R Square	0.445240215
Standard Error	4.990530128
Observations	153

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3063.175378	3063.175378	122.9924631	2.7909E-21
Residual	151	3760.714034	24.90539096		
Total	152	6823.889412			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	8.301161748	0.847651747	9.793127631	7.75215E-18	6.62637	9.97595
	0.540195701	0.048709298	11.09019671	2.79086E-21	0.44396	0.63644

Figure C-8. Regression output: Sequent flakes – morphological length by morphological width.

Regression Statistics	
Multiple R	0.668136704
R Square	0.446406655
Adjusted R Square	0.442740474
Standard Error	4.352897066
Observations	153

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2307.13784	2307.13784	121.7633947	3.929E-21
Residual	151	2861.104644	18.94771287		
Total	152	5168.242484			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	6.001671173	0.697715502	8.601888818	9.36877E-15	4.6231	7.3802
	3.854279313	0.349288921	11.0346452	3.92939E-21	3.1642	4.5444

Figure C-9. Regression output: Sequent flakes – platform depth by platform width.

Regression Statistics	
Multiple R	0.457744262
R Square	0.20952981
Adjusted R Square	0.096605497
Standard Error	6.386234868
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	75.67425173	75.67425173	1.855488906	0.21535353
Residual	7	285.4879705	40.78399578		
Total	8	361.1622222			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	25.39162692	7.126269519	3.563102245	0.009181241	8.5407	42.2426
	0.119654647	0.08784163	1.362163319	0.21535353	-0.0881	0.3274

Figure C-10. Regression output: Blades – trajectory length by trajectory width.

Regression Statistics	
Multiple R	0.45774426
R Square	0.20952981
Adjusted R Square	0.0966055
Standard Error	6.38623487
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	75.67425173	75.67425173	1.855488906	0.21535353
Residual	7	285.4879705	40.78399578		
Total	8	361.1622222			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	25.3916269	7.126269519	3.563102245	0.009181241	8.5407	42.2426
	0.11965465	0.08784163	1.362163319	0.21535353	-0.0881	0.3274

Figure C-11. Regression output: Blades – morphological length by morphological width.

Regression Statistics	
Multiple R	0.422335656
R Square	0.178367406
Adjusted R Square	0.060991322
Standard Error	7.322461258
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	81.47981673	81.47981673	1.519623071	0.2574677
Residual	7	375.3290722	53.61843888		
Total	8	456.8088889			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	7.406799051	4.946973013	1.497238621	0.177997057	-4.29093	19.10453
	1.675045914	1.358810132	1.232729926	0.257467731	-1.53803	4.88812

Figure C-12. Regression output: Blades – platform depth by platform width.

Regression Statistics	
Multiple R	0.3610657
R Square	0.1303684
Adjusted R Square	0.1013807
Standard Error	7.0133035
Observations	32

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	221.2094279	221.2094279	4.497367443	0.042325758
Residual	30	1475.59276	49.18642532		
Total	31	1696.802188			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	14.195764	1.912644576	7.422060729	2.85707E-08	10.2896	18.1019
	0.2116846	0.099818285	2.120699753	0.042325758	0.0078	0.4155

Figure C-13. Regression output: "Other" flakes – trajectory length by trajectory width.

Regression Statistics	
Multiple R	0.357776931
R Square	0.128004332
Adjusted R Square	0.09893781
Standard Error	6.135373548
Observations	32

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	165.7729303	165.77293	4.40384064	0.04438119
Residual	30	1129.284257	37.6428086		
Total	31	1295.057188			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	13.94805733	1.650683002	8.44987033	1.9798E-09	10.577	17.319
	0.169807286	0.08091714	2.09853297	0.04438119	0.005	0.335

Figure C-14. Regression output: "Other" flakes – morphological length by morphological width.

Regression Statistics	
Multiple R	0.8030297
R Square	0.6448567
Adjusted R Square	0.6330186
Standard Error	3.4350685
Observations	32

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	642.7641281	642.7641281	54.4729409	3.1907E-08
Residual	30	353.9908719	11.79969573		
Total	31	996.755			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	4.5439848	1.200525142	3.784997579	0.00068698	2.09219	6.99578
	2.1399168	0.289938891	7.380578629	3.1907E-08	1.54778	2.73205

Figure C-15. Regression output: "Other" flakes – platform depth by platform width.

APPENDIX D: SPATIAL ANALYSIS DATA TABLES

Table D-1. Flake type and count by elevation.

Elevation * Flake Type							
Elevation (m)		Normal	Biface Thinning	Sequent Flake	Blade	Other	Grand Total
92.65-92.60	Count Percent (%)	68 81.9	9 10.8	6 7.2	0 0	0 0	83
92.60-92.55	Count Percent (%)	63 69.2	19 20.9	6 6.6	1 1.1	2 2.2	91
92.55-92.50	Count Percent (%)	54 65.9	16 19.5	12 14.6	0 0	0 0	82
92.50-92.45	Count Percent (%)	97 81.5	16 13.4	4 3.4	0 0	2 1.7	119
92.45-92.40	Count Percent (%)	78 81.3	10 10.4	6 6.3	0 0	2 2.1	96
92.40-92.35	Count Percent (%)	78 81.3	13 13.5	4 4.2	0 0	1 1.0	96
92.35-92.30	Count Percent (%)	65 78.3	9 10.8	7 8.4	0 0	2 2.4	83
92.30-92.25	Count Percent (%)	78 77.2	10 9.9	8 7.9	2 2.0	3 3.0	101
92.25-92.20	Count Percent (%)	55 90.2	2 3.3	3 4.9	0 0	1 1.6	61
92.20-92.15	Count Percent (%)	110 68.8	33 20.6	16 10.0	0 0	1 0.6	160
92.15-92.10	Count Percent (%)	152 74.9	26 12.8	19 9.4	1 0.5	5 2.5	203
92.10-92.05	Count Percent (%)	240 78.4	50 16.3	10 3.3	2 0.7	4 1.3	306
92.05-92.00	Count Percent (%)	218 75.7	49 17.0	17 5.9	2 0.7	2 0.7	288
92.00-91.95	Count Percent (%)	180 85.3	23 10.9	5 2.4	1 0.5	2 0.9	211
91.95-91.90	Count Percent (%)	68 75.6	17 18.9	5 5.6	0 0	0 0	90
91.90-91.85	Count Percent (%)	169 74.8	34 15.0	18 8.0	0 0	5 2.2	226
Below 91.85	Count Percent (%)	62 74.7	14 16.9	7 8.4	0 0	0 0	83
	Total Percent (%)	1835 77.1	350 14.7	153 6.4	9 0.4	32 1.3	2379

Table D-2. Average flake measures by elevation.

Elevations (m)	Averages of Trajectory Lengths (mm)	Averages of Trajectory Widths (mm)	Averages of Flake Weights (g)
92.65-92.60	16.6	15.6	2.3
92.60-92.55	17.0	15.9	1.7
92.55-92.50	16.8	16.5	1.7
92.50-92.45	15.4	14.5	1.4
92.45-92.40	14.5	14.1	1.2
92.40-92.35	15.7	15.6	1.3
92.35-92.30	18.8	18.1	2.7
92.30-92.25	16.6	15.9	2.3
92.25-92.20	12.2	12.5	0.5
92.20-92.15	17.1	17.1	2.5
92.15-92.10	17.3	16.4	1.9
92.10-92.05	18.2	16.5	1.7
92.05-92.00	17.7	16.8	2.0
92.00-91.95	16.9	16.1	1.4
91.95-91.90	18.2	17.7	1.6
91.90-91.85	17.3	16.1	1.2
Below 91.85	17.0	15.5	1.0
Grand Total	17.0	16.1	1.7

Table D-3. Count of flakes with thermal damage by elevation.

Elevation * Thermal Damage				
Elevation (m)		Not thermally damaged	Thermally damaged	Grand Total
92.65-92.60	Count Percent (%)	70 84.3	13 15.7	83
92.60-92.55	Count Percent (%)	84 92.3	7 7.7	91
92.55-92.50	Count Percent (%)	74 90.2	8 9.8	82
92.50-92.45	Count Percent (%)	98 82.4	21 17.6	119
92.45-92.40	Count Percent (%)	78 81.3	18 18.8	96
92.40-92.35	Count Percent (%)	90 98.3	6 6.3	96
92.35-92.30	Count Percent (%)	68 81.9	15 18.1	83
92.30-92.25	Count Percent (%)	94 93.1	7 6.9	101
92.25-92.20	Count Percent (%)	54 88.5	7 11.5	61
92.20-92.15	Count Percent (%)	137 85.6	23 14.4	160
92.15-92.10	Count Percent (%)	191 94.1	12 5.9	203
92.10-92.05	Count Percent (%)	230 75.2	76 24.8	306
92.05-92.00	Count Percent (%)	229 79.5	59 20.5	288
92.00-91.95	Count Percent (%)	168 79.6	43 20.4	211
91.95-91.90	Count Percent (%)	69 76.7	21 23.3	90
91.90-91.85	Count Percent (%)	167 73.9	59 26.1	226
Below 91.85	Count Percent (%)	57 68.7	26 31.3	83
	Total Percent (%)	1958 82.3	421 17.7	2379

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