Changes in Stone Tool Technology at Maya Hak Cab Pek

By

Emmanuel Macías

Special Thanks

to

Dr. Keith Prufer,

without whose guidance and support this work

would not have been possible

and to the members of my family,

who have been my lifeboat

on stormy seas

and to the ancient indigenous peoples of Mesoamerica

whose stories it would be my great honor to tell

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Abstract

Debitage analysis is an underutilized tool in lithic studies, and in the preceramic period of the lowland Maya region it has been given little attention in comparison to later periods. This study employed debitage analysis in an effort to understand stone tool technological organization during the Terminal Pleistocene and Early to Middle Holocene in southern Belize. Individual flake analysis was applied to a lithic assemblage from Maya Hak Cab Pek, a rockshelter in the Maya mountains with a 12,000-year history of human occupation. Attributes indicative of technological organization were recorded and plotted across several time periods. The results indicate that a shift from curated bifacial stone tool industries to expedient stone tool industries occurred between 10600 BP and 9200 BP. This change in technology is usually indicative of a shift from high residential mobility to low residential mobility (i.e., mobile hunter-gatherers shifting to permanent settlements). Further research is necessary to link these changes to proposed causal factors, such as climate change and agriculture.

Introduction

Stone tool artifacts and their waste-products (debitage), being more durable than organic or ceramic materials, are well-represented in pre-metallurgical archaeological assemblages. However, the focus in lithic studies is usually on formal tools, with debitage analysis relegated to a position of secondary importance (Parry 1987; Stemp 2021). This is particularly true within the Maya region, where studies have traditionally focused on ornate eccentrics produced by craftsmen of high skill, or on obsidian, which can be easily sourced and thus yield information on ancient trade routes (Hruby 2010). Debitage, however, comprises a large part of most lithic assemblages and can yield valuable information regarding tool production, raw material availability, tool use patterns, and mobility (Parry 1987; Andrefsky 2005; Stemp 2019). This study reports on a debitage assemblage from southern Belize, spanning the Terminal Pleistocene (12,500–11,700 BP), the Early Holocene (11,700–8200 BP), and part of the Middle Holocene (8200-4200 BP).

Rainfall in Belize is distributed unevenly throughout the year, with a distinct dry season that lasts for several months. During this time, evaporation rates are higher than precipitation rates; any potential rainfall evaporates before it reaches the ground. Despite this, the region receives over 4,000 mm of rainfall annually due to the intensity of the rainy season (Kennett et al. 2012; Ridley et al. 2015). The dissolution effects of this precipitation on the local limestone bedrock have created a karstic landscape characterized by sinkholes, subterranean caverns, and rockshelters. These features have been utilized by human inhabitants of the region for thousands of years and continue to influence local culture to the present day (Prufer and Kennett 2020).

In contrast to the current tropical conditions, paleoclimate data indicate that the first inhabitants of the region would have encountered conditions that were cooler and drier (Prufer et al. 2021). The landscape would have been characterized by scrub, grassland, and patchy forests rather than the dense closed canopies that currently predominate. Warmer and wetter conditions would begin to manifest by 11,000 BP and reach their peak by the Mid-Holocene (Prufer and Kennett 2020). This could be considered the origin of the neotropical environment as it exists today. It is against this backdrop of ecological change that we must consider the behavioral adaptations of people in the region, both in terms of food acquisition and mobility.

As detailed by Kennett et al. (2020), Southern Belize is home to several large prey animals, including deer, tapir, and peccary. Plant foods include edible tree fruits, nuts, seeds, and tubers. Rivers provide freshwater mollusks, crabs, and small fish. These food sources, however, are widely dispersed and subject to seasonal availability. Without the adoption of agriculture, the neotropics are therefore an unlikely place to observe high population densities. Stable isotope analysis of human bone indicates that individuals living from 9600 BP to 4700 BP did not rely on maize, which uses the C_4 photosynthetic pathway, as a significant food source. Rather, they depended primarily on plants and animals native to the neotropical forest, a trophic structure underpinned by the C_3 photosynthetic pathway. The earliest isotopic evidence for maize consumption by some individuals appears during the period from 4700-4000 BP. After that it would become a staple food for most individuals, comprising over 55% of their diets (Kennett et al. 2020).

Thousands of years prior to this observed dietary shift were technological changes that occurred in the stone tool industries of the region (Prufer et al. 2019; Stemp et al. 2016). The reason for these changes has been a matter of interest to Mesoamerican archeologists since they cannot be directly explained by the agricultural transition. Until recently, preceramic lithic chronologies for region have been absent from the archaeological literature, inasmuch as few Paleoindian sites have been discovered and preserved organic materials providing absolute dates are hard to come by. However, excavations at rockshelters in southern Belize have yielded reliable chronologies for the Late Pleistocene and Early Holocene (Prufer and Kennett 2020), as well as evidence of a bifacial stone tool technocomplex designated Lowe complex.

Bifacial stone tools are those that have been worked on both sides (including both projectile points and larger multi-purpose tools from which they are made) and represent a high degree of investment in terms of time, energy, and skill to produce (Andrefsky 2005; Odell 2004). The oldest bifacial tools that have been found in Central America are the fluted and waisted Clovis (named for their resemblance to the Clovis points of North America) and the stemmed Fishtail projectile points (which are widely found in South America); these have been found in Mexico, Guatemala, Costa Rica, and Panama in archaeological contexts as old as 13,000 BP (Prufer et al. 2019; Ranere and Cooke 2021). These technological traditions would eventually be replaced by Lowe complex projectile points. First described by MacNeish and Neckler (1983) and recently refined by Prufer et al. (2019), Lowe complex is a technological tradition of the Early Holocene in southern Mesoamerica, characterized by basally thinned, stemmed, and barbed bifaces. Bifaces are versatile tools, lending themselves well to the varied tasks that would be encountered in the dense neotropical forest. Survival in such an environment necessitates a broad-spectrum subsistence economy involving the processing of a wide variety of plant and animal materials. The chronology provided for this technological tradition spans a roughly 2,700-year period, from approximately 12,000 BP to 9,300 BP. Interestingly, formal bifacial tools are absent from the archaeological record in Mesoamerica after 9,000 BP and also in Panama after 7900 BP (Prufer et al. 2019; Ranere and Cooke 2021).

The abandonment of bifacial stone tool industries in tropical southern Mesoamerica and much of the Neotropics, followed by a continuation of informal or expedient tool industries, has been observed in many regions of North America (Parry and Kelly 1987). This has often been ascribed to changes in residential mobility. Curated technologies are linked to high mobility foraging for several reasons, the first of which is access to raw lithic materials. Not all materials are useful for making tools, and high-quality materials are preferable over low-quality materials. Groups with high residential mobility may find themselves far away from a quality lithic source for extended periods, and thus must transport materials that are sufficient to meet their needs. This brings us to the practical consideration of weight. Mobile foragers must economize on the quantity of lithic materials that they carry. The curation of bifacial tools allows both of these concerns to be addressed adequately. The bifaces themselves can serve as multi-purpose cutting or chopping tools, and can be resharpened or modified, while at the same time serving as a source of smaller flakes needed for more detailed work. (Parry and Kelly 1987; Andrefsky 2005). At the end of a biface's use-life, it will commonly take the form of a finely crafted projectile point, such as the aforementioned Lowe complex.

In contrast to curated tools like bifaces, expedient tools (also referred to as *ad hoc* or informal tools) are manufactured with a minimum investment of time and energy. Flakes suitable for common tasks, such as cutting and scraping, can be removed from a nodule or core with little to no preparation of the striking surface. (Andrefsky 2005). Even angular debris (those pieces of debitage which do not display traditional flake morphology) may have a utilizable edge, and thus become informal tools. Expedient tools are typically discarded rather than resharpened, simply because it is easier to create a new expedient tool than to resharpen a used one. This rather inefficient use of raw material implies reliable access to a lithic source, which in turn indicates a reduced degree of residential mobility (Parry and Kelly 1987).

To understand the importance of quality raw materials, it is necessary to understand how composition of lithic materials affects fracture mechanics during tool production, as well as the durability of the tool itself. The material most commonly encountered at pre-ceramic sites in Belize is chert, and for good reason: it has a fine-grained or "cryptocrystalline" quartz structure which makes it especially suitable for tools. Barring the occasional impurity, cherts tend to be isotropic (having a consistent composition throughout the material); this results in a high degree of predictability with regards to fracture. The cryptocrystalline silicate structure produces thin, sharp, strong edges that are well-suited to a variety of cutting, chopping, and scraping activities. Although geologists differentiate between a variety of silicate materials (flint, chalcedony, agate, jasper), their compositions and fracture mechanics are not different enough to be of concern to archaeologists (or the people who used them, for that matter). Thus, all of these varieties are commonly subsumed under the label of chert (Leudtke 1992).

The type of fracture seen in worked cryptocrystalline material such as chert is known as conchoidal fracture. Deliberate blows with a percussion instrument, or hammer, produce a smooth surface with a bulbous region, known as the bulb of percussion, beneath the point of impact, which is referred to as the striking platform (see Figure 1 below). Along with the bulb of percussion, other features such as ripples (concentric rings originating at the point of impact), lines of force (straight lines leading directly away from the platform), and the occasional erailleur scar (a concavity where a small chip has been detached) help to identify the ventral surface. The ventral surface is that which was previously attached to the core or nodule from which the flake was removed. It is from the bulb of percussion and the concentric ripples that the term conchoidal is derived, as these features can somewhat resemble the surface of a conch or scallop (Andrefksy 2005). Again, it is the predictable fracture patterns of chert that make it a valuable material for tool manufacture. It is also in part the relative of abundance of deliberately manufactured flakes that allows archaeologists to differentiate between lithic deposits that are indicative of human activity, and deposits produced by natural weathering (freeze/thaw cycles, rockfall, etc.).

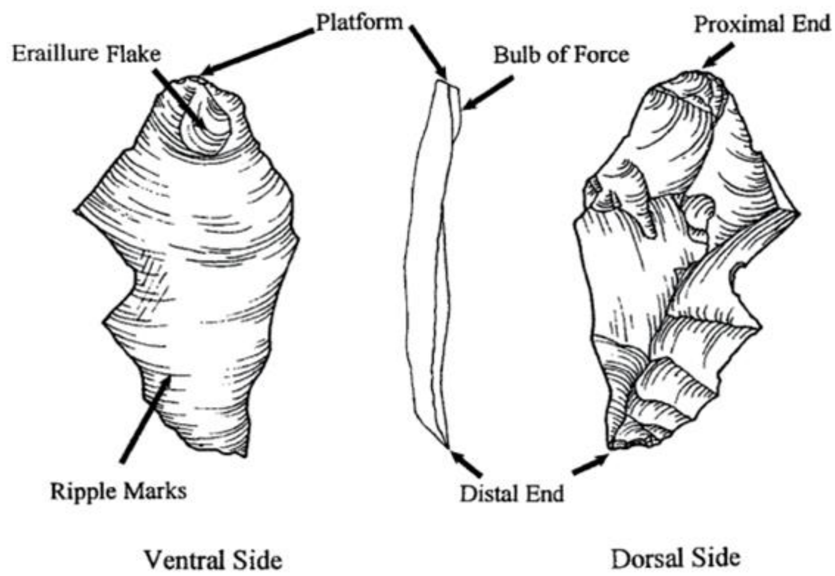

Figure 1. Complete flake showing common conchoidal morphology. (Figure 2.7 from Andrefsky 2005)

The lithic assemblage analyzed here comes from excavations at Maya Hak Cab Pek, one of two rockshelters situated in the Maya Mountains in the western part of southern Belize (Prufer and Kennett 2020; see Figure 2 below). The other rockshelter, Saki Tzul, is located some 1.5 km to the north and has similar archaeological assemblages (Prufer et al. 2021). In between these two sites is the Classic Period settlement of Ek Xux, and there are over 60 other major Classic Period population centers within 200 km. Archaeological excavations began at both Maya Hak Cab Pek and Saki Tzul in 1998, as part of the Maya Mountains Archaeological Project (Prufer 2002). Further excavations led by Dr. Keith Prufer have been ongoing since 2014 (Prufer and Kennett 2020). Numerous burials in these sites have provided the materials for the aforementioned dietary analyses concerning maize consumption. The Maya Mountains themselves are located within the Bladen Nature Reserve, a wilderness area within which archaeological sites are afforded protection from human disturbance (Kennett et al. 2020).

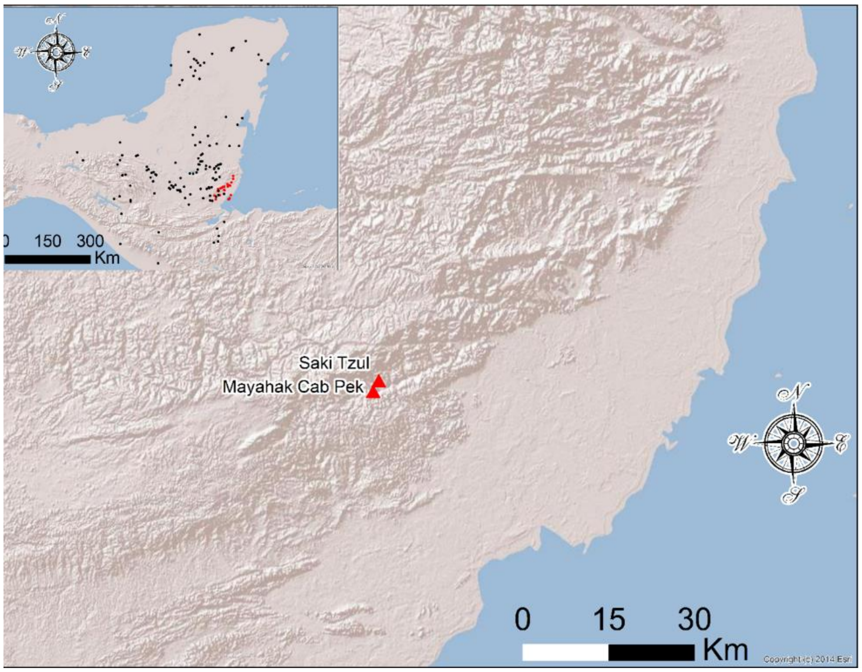

Figure 2. The locations of Maya Hak Cab Pek and Saki Tzul in the Maya Mountains of Southern Belize. (Image courtesy of Keith Prufer.)

Maya Hak Cab Pek is shielded by a limestone outcrop 20 meters in height, which creates a dry area 26 meters wide by 6 meters deep (approximately 150 m^2) (see Figure 3 below). The rockshelter is oriented SSE to NNW, with a southeast exposure. The ground surface has a slope towards the north that ranges from 6 degrees to as much as 14 degrees (Prufer 2014). Dry sediments, limited root activity, and an absence of fluvial activity have contributed to the excellent preservation of the stratigraphy, as well as organic materials suitable for carbon-14 dating. Unit 1 at Maya Hak Cab Pek was 2.5m x 2.5m and was excavated to a depth of 280 cm over the course of three field seasons (2014, 2016-2017) (Prufer et al. 2019). The lowest levels at Maya Hak Cab Pek indicate Paleoindian occupation as early as 12,000 BP, and the rockshelter continued to be used through the Terminal Classic (Prufer et al. 2019; Prufer and Kennett 2020).

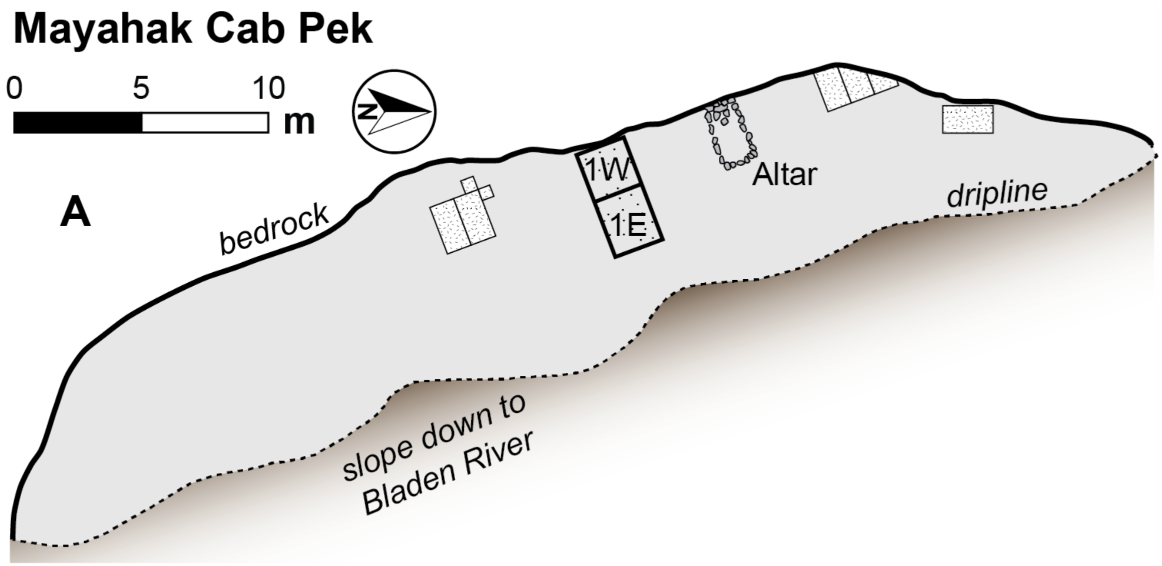

Figure 3. Plan view of the Maya Hak Cab Pek rockshelter. (Image courtesy of Keith Prufer.)

The age models for this study are based on work previously published by Prufer et al. (2019). The models are based on AMS dates (charcoal) and stratigraphic data, with depths adjusted from cm below datum to cm below surface (due to surface and basal slope of the excavation unit) (see Table 1 below). A Bayesian Poisson depth model was produced to represent the depositional sequence (see Figure 4 below). Two standard deviation errors are shown by the blue shading. Age models were generated in Oxcal v.4.4 (Ramsey 2009) using the Intal20 calibration curve (Reimer et al. 2020).

Table 1. Radiocarbon dates used in age model for MHCP. Depths used in the age model were adjusted from depth below datum to depth below surface to account for the uneven and slightly sloping surfaces of the rockshelter. Lab IDs are: PSUAMS Pennsylvania State University AMS ^{14}C Facility, UCIAMS Keck Carbon Cycle AMS Facility. (Prufer et al. 2019)

Site	Unit	Lab ID	Age	Error	Depth Below Surface
MHCP	1	PSUAMS 1197	4485	20	105
MHCP	1	UCIAMS 151867	4610	25	143
MHCP	1	PSUAMS 1200	4755	25	145
MHCP	1	UCIAMS 151871	5075	30	185
MHCP	1	UCIAMS 142100	5275	25	197
MHCP	1	PSUAMS 2658	7610	110	209
MHCP	1	UCIAMS 151872	7940	30	215
MHCP	1	PSUAMS 2656	8790	45	228
MHCP	1	UCIAMS 142101	10105	30	237
MHCP	1	PSUAMS 2655	10130	90	245

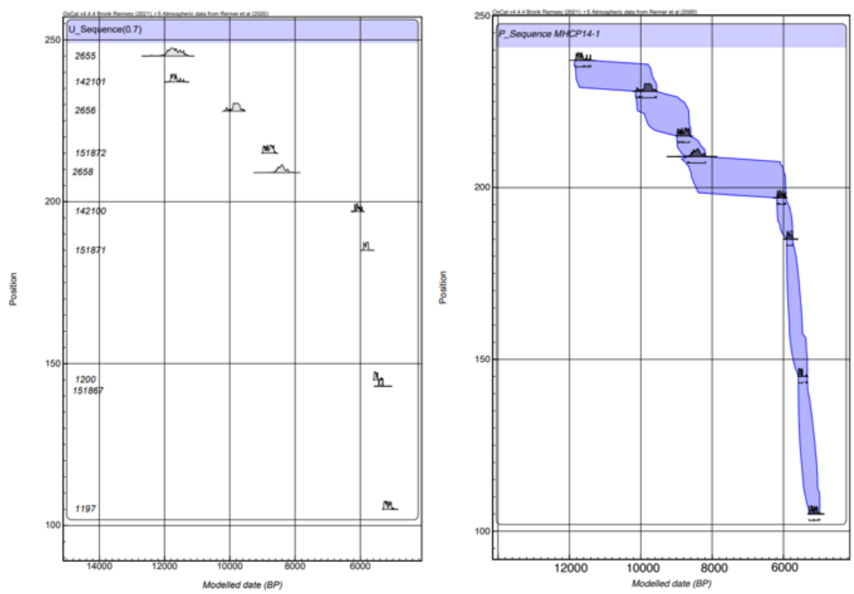

Figure 4. Time model (left) and Poisson depositional model (right) for MHCP Unit 1. Model data are in Table 1. (Images courtesy of Keith Prufer.)

The lithic assemblage from Maya Hak Cab Pek consists primarily of debitage in the form of angular debris and flakes/flake fragments. The most common materials are chert, chalcedony, limestone, and silicified limestone (limestone that has been infused with silicates and can have fracture properties similar to chert). There is an abundance of complete flakes and flake fragments, many of which bear signs of use-wear (see methods section). Cores and formal tools are present but were not the subject of this analysis. Obsidian was also part of the assemblage but had been previously separated for independent analysis. The chert and chalcedony displayed a wide range of colors, often forming ornate patterns within the material. Colors included various shades of gray, brown, and black, as well as white, amber, orange, deep red, and reddish-brown.

Methods and Materials

This study was conducted to investigate the possibility of a transition from curated stone tool industries to expedient ones during the Holocene, as well as changes in material type and use-wear over time. Individual flake analysis was performed on 2359 pieces of debitage from two adjacent excavation units. The analyzed portion of the assemblage represents seven excavation levels from Unit 1E (Levels 8-14) and ten excavation levels from Unit 1W (Levels 3-12). The age of the analyzed assemblage ranges from 12211 BP to 5440 BP.

The word debitage (from the French *débitage;* literally, "reduction to smaller objects") is typically used in lithic studies to refer to the waste products from knapping activities (Andrefsky 2005), and therefore excludes any pieces that have been used as tools. However, as pointed out by Stemp et al. (2021), it is impossible to differentiate between flakes that were intentionally produced as expedient tools, and flakes or angular debris that were produced incidentally (waste) and happened to have an edge that was suitable for a particular task. Based on this observation, all complete flakes, flake fragments, and angular debris were considered debitage for the purpose of this analysis (Stemp 2021).

The raw material of the debitage was identified by visual characterization based on color, observable fracture mechanics, surface texture, and translucence (Odell, 2004). Limestone was identified as occurring in various shades of gray, lacking in conchoidal fracture mechanics, having a rough surface texture, and no translucence. Silicified limestone was identified as occurring in various shades of gray, but having at least some observable features of conchoidal fracture, a smoother surface texture, and no translucence. Chert and chalcedony were both identified as occurring in a wide range of colors (even within the same piece), displaying obvious conchoidal fracture, and having smooth surface texture (with chalcedony being the smoother of the two). The presence of even slight translucence was the final factor in differentiating chalcedony from chert.

Initial categorization of debitage was done according to a system proposed by Sullivan and Rozen (1985) which uses "three dimensions of variability, each with two naturally dichotomous attributes." (See Figure 5 below.) The first is the presence a single anterior (ventral) surface, indicated by features such as a bulb of percussion, lines of force, ripples, and the occasional erailleur scar. Any piece of debitage lacking an identifiable anterior surface was classified as angular debris. The second dimension of variability is the point of applied force, most often represented by a striking platform. In instances where the striking platform is crushed or collapsed, the point of applied force can be inferred from the ripples and lines of force. Any piece of debitage with an identifiable anterior surface but a missing or unidentifiable point of applied force was classified as a distal or lateral flake fragment. The third dimension of variability is the integrity of the margins, indicated by intact feathered or hinged terminations. Any piece of debitage with an identifiable anterior surface and identifiable point of applied force but missing one or more of its margins (including stepped terminations), was classified as a proximal flake fragment (a "broken flake" in the Sullivan and Rozen terminology). Finally, any piece of debitage with an identifiable anterior surface, identifiable point of impact, and all margins intact was classified as a complete flake.

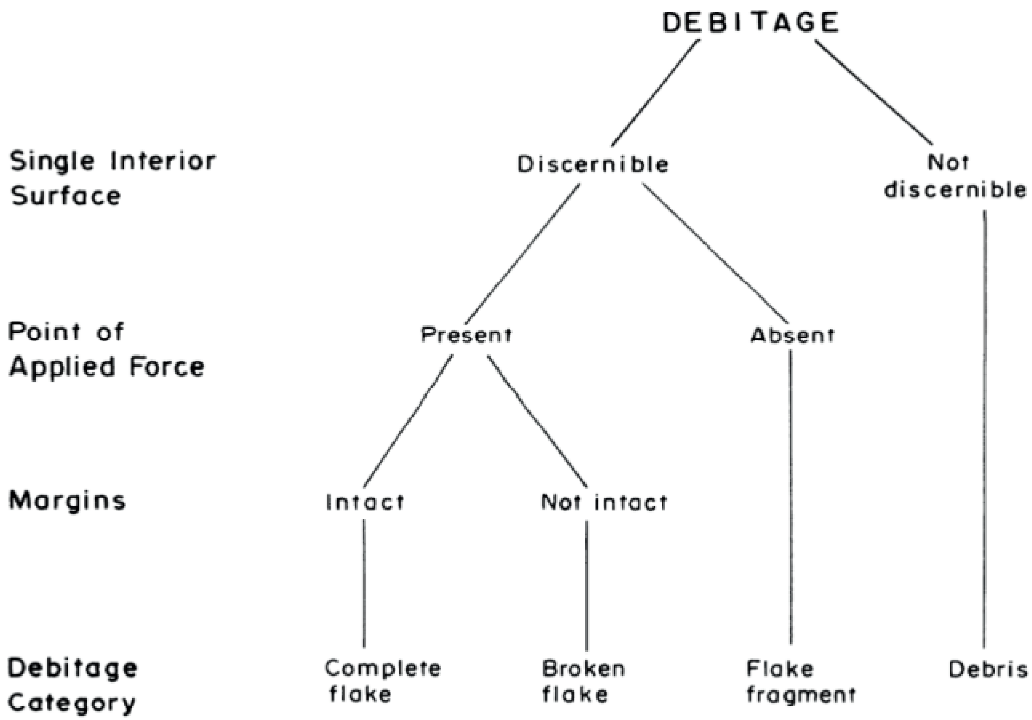

Figure 5. Sullivan and Rozen's attribute key for the classification of debitage. (After Sullivan and Rozen 1985.)

Measurements of complete flake dimensions (length, width, and height) were taken with digital calipers (Carbon Fiber Composites Digital Caliper, Zonaris) and measured in millimeters. Measurements of length were taken from the proximal end (platform) to distal end (termination); width was measured at the midpoint along the length of the flake; thickness was also measured at the midpoint along the length of the flake. Measurements of weight in grams were taken for all complete flakes, flake fragments, and angular debris using an electronic balance (Digital Pocket Scale).

Typological analysis using one or more characteristics of debitage can be used to assign each item to a category or group (Andrefsky 2005). A common application of typological analysis is to identify artifact categories that are indicative of specific stages in the manufacturing sequence; these are referred to as stage typologies (Sullivan and Rozen, 1985). The stage typology categories used this study were bifacial thinning flakes, trim flakes, cortical flakes, and flakes with cortical platforms.

Bifacial thinning flakes are the result of biface reduction, and therefore indicative of a curated stone tool industry (Andrefsky 2005). Bifacial thinning flakes are commonly identified based on flake morphology (spatulate shape, widening towards the distal end), platform characteristics (diminutive platform size; lipping is common, and indicative of soft-hammer percussion), and relative flake thickness (they are typically quite flat compared to primary reduction flakes) (Sullivan and Rozen, 1985). (See Figure 6 below.)

Curated lithic technologies, by their reductive nature, produce progressively smaller waste-flakes at each successive stage (Andrefsky 2005). Biface sharpening (as well as other formal tool maintenance) produces trim flakes that are characterized by small size and feathered edges, and thus represent the final stages of the lithic reduction trajectory. Trim flakes, due to their diminutive size, may lack a distinct striking platform or bulb of percussion. In this analysis, debitage was considered to represent a trim flake if the length and width dimensions were both under 20 mm, and the flake did not have blocky characteristics (McManamon 1984). (See Figure 6 below.)

Figure 6. An assortment of bifacial thinning flakes (left) and trim flakes (right). Ventral surface shown to display flake morphology and lipping.

Flakes with cortex on the dorsal surface are known as cortical flakes. They are produced in the early stages of lithic reduction, as cortical pieces are removed from a nodule or core (Andrefsky 2005). Although cortical flakes can be divided into subcategories based on percentage of cortex, there is some disagreement as to how to best characterize cortex (Sullivan and Rozen, 1985). Therefore, only absence or presence of cortex was documented for this analysis. Cortex was recorded for complete flakes, flake fragments, and angular debris. (See Figure 7 below.)

Platforms were classified as cortical or non-cortical, with cortical platforms representing the unmodified cortical surface of a nodule or core (Andrefsky 2005). Cortical attributes of platforms were recorded independently of cortex on the dorsal surface of flakes, as the two types of cortication can exist independently or concurrently. Platforms were also classified as lipped (possessing a projection at the base of the striking platform on the ventral surface of the flake) or non-lipped, with lipping considered indicative of soft-hammer percussion (Andrefsky 2005). Measurements of platform width and thickness (in millimeters) were also taken using digital calipers. (See Figure 7 below.)

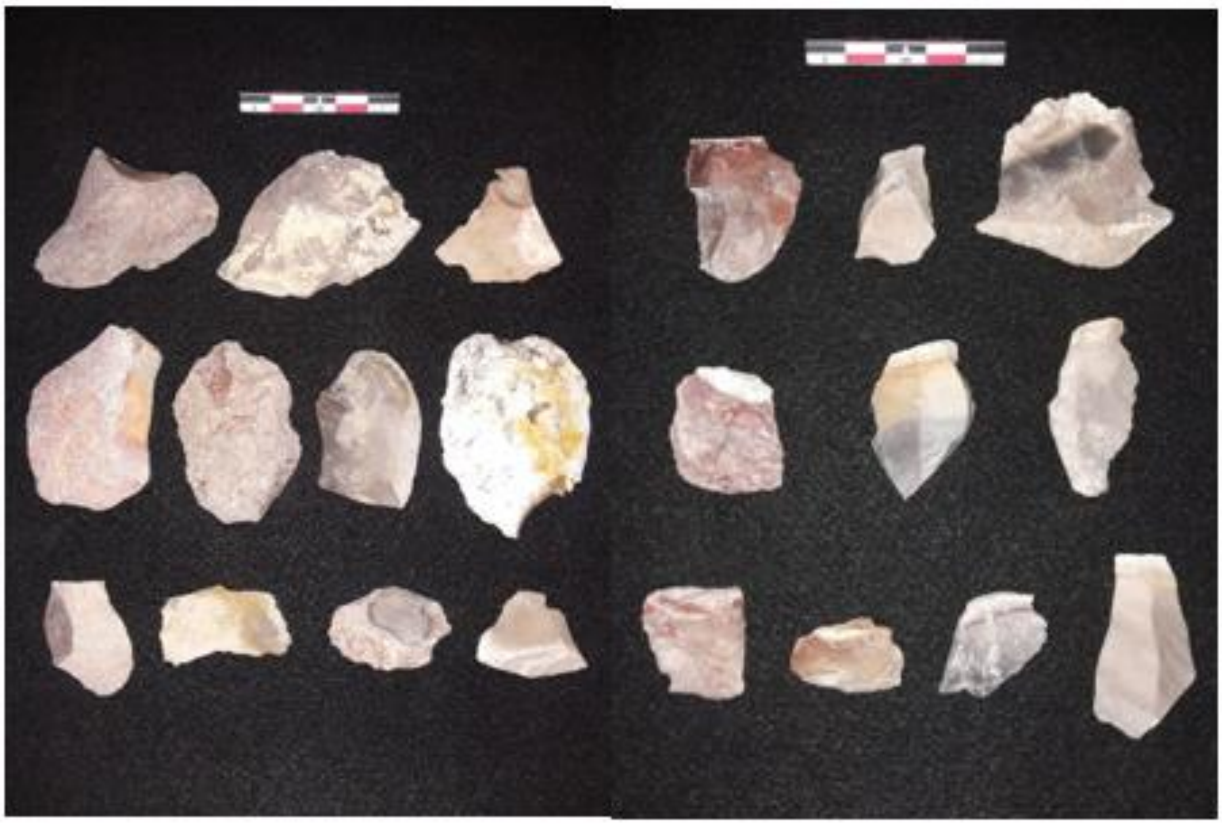

Figure 7. An assortment of cortical flakes (left) and flakes with cortical platforms (right). Dorsal surface shown to display cortex.

Use-wear analysis is employed in an attempt to determine how individual lithic artifacts were utilized (including both formal and informal tools). Use-wear analysis relies heavily on an understanding of the effects of utilization, and how the motions and materials change the tool itself. Replicative experiments are often conducted to develop the researcher's ability to recognize use-wear patterns and associate them with specific tasks and materials. However, these approaches have yielded varying degrees of reliability when tested empirically, and identifying the specific materials being worked is notoriously difficult (Andrefsky 2005; Odell 2004). In contrast, the absence or presence of use-wear is relatively easy to determine. Three types of use-wear were recorded for this analysis: edge damage (microflaking/fracturing, often associated with butchering activities), striations (linear abrasion or tiny scratches, often the result of cutting plant materials), and edge rounding/polish (associated with hide-scraping) (Odell 2004). Macroscopic identification of use-wear was performed with stereomicroscope at 10x to 50x magnification (Laboratory LED Zoom Stereo Binocular, VWR; Radnor, Pennsylvania). Length (in millimeters) and shape (concave, convex, or straight) of utilized edges was also recorded.

Statistical analyses were conducted in Microsoft Excel (Version 2202 Build 16.0.14931.20128). The *P* value threshold for statistical significance was 0.05 for all tests. The excavation levels of Unit 1E and Unit 1W together were grouped into four time periods for the initial statistical analysis: 12211-11488 BP, 11613-9263 BP, 9247-7197 BP, and 7176-5440 BP. The levels of Unit 1W were also grouped into six time periods and analyzed independently in an effort to achieve higher temporal resolution (as some levels of Unit 1E correspond to two levels of 1W). These time periods are: 12211-11488 BP, 11613-10661 BP, 10633-9263 BP, 9247-7197 BP, 7176-5959 BP, and 5931-5440 BP. (It should be noted that omitting the data from unit 1E only reduces the assemblage by about 25%, since the majority of the assemblage came from unit 1W). Abundance of thinning flakes, trim flakes, cortical flakes, and cortical platforms was calculated as a percentage of complete flakes for each time period. Linear regression was used to investigate the relationship between abundance of thinning flakes, trim flakes, cortical flakes, and cortical platforms. Average complete flake dimensions (length, width, thickness, and weight) were calculated for each time period. Two-sample T-tests were used to evaluate differences in complete flake dimensions between time periods. Proportion of utilized flakes was also calculated.

Results

Initial analysis used data from Units 1E and 1W, grouped into four time periods. For the time period from 12211-11488 BP, bifacial thinning flakes accounted for 11.1% of complete flakes. For 11613-9263 BP, bifacial thinning flakes accounted for 19.4% of complete flakes. For 9247-7197 BP, bifacial thinning flakes accounted for 0.7% of complete flakes. For 7176-5440 BP, bifacial thinning flakes accounted for 0.4% of complete flakes. (See Appendix Table 1 and Appendix Figure 1)

For the time period from 12211-11488, trim flakes accounted for 72.2% of complete flakes. For 11613-9263 BP, trim flakes accounted for 37.3% of complete flakes. For 9247-7197 BP, trim flakes accounted for 5.8% of complete flakes. For 7176-5440 BP, trim flakes accounted for 2.2 % of complete flakes. (See Appendix Table 2 and Appendix Figure 2)

For the time period from 12211-11488, cortical flakes accounted for 16.7% of complete flakes. For 11613-9263 BP, cortical flakes accounted for 10.5% of complete flakes. For 9247-7197 BP, cortical flakes accounted for 28.1% of complete flakes. For 7176-5440 BP, cortical flakes accounted for 29.7 % of complete flakes. (See Appendix Table 3 and Appendix Figure 3)

For the time period from 12211-11488, 5.6% of complete flakes had cortical platforms. For 11613-9263 BP, 5.7% of complete flakes had cortical platforms. For 9247-7197 BP, 9.4%

of complete flakes had cortical platforms. For 7176-5440 BP, 11.4% of complete flakes had cortical platforms. (See Appendix Table 4 and Appendix Figure 4)

Simple linear regression was used to test if the proportion of bifacial thinning flakes predicted the proportion of cortical flakes across four time periods. The fitted regression model was: $y = -0.9985x + 0.2912$. There was a strong negative correlation between the two variables ($R^2 = .9866$). It was found that the proportion of bifacial thinning flakes significantly predicted the proportion of cortical flakes for a given time period ($p = 0.006724$). (See Appendix Figure 5 and Appendix Table 5.)

Simple linear regression was used to test if the proportion of bifacial thinning flakes predicted the proportion of cortical platforms across four time periods. The fitted regression model was: $y = -0.2767x + 0.1017$. Although there was a negative correlation between the two variables ($R^2 = .7866$), it was found that the proportion of bifacial thinning flakes did not significantly predict the proportion of cortical platforms for a given time period ($p = 0.113102$). (See Appendix Figure 6 and Appendix Table 6.)

Simple linear regression was used to test if the proportion of trim flakes predicted the proportion of cortical flakes across four time periods. The fitted regression model was: $y = -0.21x + 0.274$. Although there was a weak negative correlation between the two variables ($R^2 = .5573$.), it was found that the proportion of trim flakes did not significantly predict the proportion of cortical flakes for a given time period ($p = 0.2535$). (See Appendix Figure 7 and Appendix Table 7.)

Simple linear regression was used to test if the proportion of trim flakes predicted the proportion of cortical platforms across four time periods. The fitted regression model was: y = -

0.077x + 0.1025. Although there was a negative correlation between the two variables (R^2 = .7784), it was found that the proportion of trim flakes did not significantly predict the proportion of cortical flakes for a given time period (p = 0.117726). (See Appendix Figure 8 and Appendix Table 8.)

Simple linear regression was used to test if the proportion of bifacial thinning flakes predicted the proportion of trim flakes across four time periods. The fitted regression model was: y = 2.4099x + 0.1035. Although there was a positive correlation between the two variables (R^2 = 0.4548), it was found that the proportion of bifacial thinning flakes did not significantly predict the proportion of trim flakes for a given time period (p = 0.325584). (See Appendix Figure 9 and Appendix Table 9)

Average complete flake dimensions for each of the four time periods are as follows. 12211-11488 BP: length 18.32 mm, width 5.73 mm, thickness 1.06 mm, weight 2.42 grams. 11613-9263 BP: length 21.3 mm, width 15.71 mm, thickness 3.28 mm, weight 3.7 grams. 9247-7197 BP: length 29.31 mm, width 25.23 mm, thickness 6.85 mm, weight 6.98 grams. 7176-5440 BP: length 27.29 mm, width 24.66, thickness 6.69 mm, weight 8.15 grams. (See Appendix Table 10 and Appendix Figures 10-13).

T-tests evaluating the difference in average complete flake length between the four time periods found no statistically significant difference between 9247-7197 BP and 7176-5440 BP, or between 12211-11488 BP and 11613-9263 BP. However, the difference in average complete flake length was found to be statistically significant between 11613-9263 BP and 9247-7197 BP. (See Appendix Tables 11-13.)

T-tests evaluating the difference in average complete flake width between the four time periods found no statistically significant difference between 9247-7197 BP and 7176-5440 BP, or between 12211-11488 BP and 11613-9263 BP. However, the difference in average complete flake width was found to be statistically significant between 11613-9263 BP and 9247-7197 BP. (See Appendix Tables 14-16.)

T-tests evaluating the difference in average complete flake thickness between the four time periods found no statistically significant difference between 9247-7197 BP and 7176-5440 BP, or between 12211-11488 BP and 11613-9263 BP. However, the difference in average complete flake thickness was found to be statistically significant between 11613-9263 BP and 9247-7197 BP. (See Appendix Tables 17-19.)

T-tests evaluating the difference in average complete flake weight between the four time periods found no statistically significant difference between 9247-7197 BP and 7176-5440 BP, or between 12211-11488 BP and 11613-9263 BP. However, the difference in average complete flake weight was found to be statistically significant between 11613-9263 BP and 9247-7197 BP. (See Appendix Tables 20-22.)

Flakes with edge damage were calculated as a percentage of complete flakes in four times periods. For the time period from 12211-11488 BP, edge-damaged flakes accounted for 0% of complete flakes. For 11613-9263 BP, edge-damaged flakes accounted for 13.4% of complete flakes. For 9247-7197 BP, edge-damaged flakes accounted for 15.8% of complete flakes. For 7176-5440 BP, edge-damaged flakes accounted for 23.8% of complete flakes. (See Appendix Table 23 and Appendix Figure 14)

Flakes with striations were calculated as a percentage of complete flakes in four time periods. For the time period from 12211-11488 BP, striated flakes accounted for 0% of complete flakes. For 11613-9263 BP, striated flakes accounted for 12.8% of complete flakes. For 9247-7197 BP, striated flakes accounted for 14.4% of complete flakes. For 7176-5440 BP, striated flakes accounted for 13.2% of complete flakes. (See Appendix Table 24 and Figure 15)

A secondary analysis was performed using data only from Unit 1W, grouped into six time periods. For the time period from 12211-11488 BP, bifacial thinning flakes accounted for 11.1% of complete flakes. For 11613-10661 BP, bifacial thinning flakes accounted for 18.7% of complete flakes. For 10633-9263 BP, bifacial thinning flakes accounted for 24.2% of complete flakes. For 9247-7197 BP, bifacial thinning flakes accounted for 7.4% of complete flakes. For 7176-5959 BP, bifacial thinning flakes accounted for 1.4% of complete flakes. For 5931-5440 BP, bifacial thinning flakes accounted for 0.0% of complete flakes. (See Figure 8 and Appendix Table 25)

For the time period from 12211-11488, trim flakes accounted for 72.2% of complete flakes. For 11613-10661 BP, trim flakes accounted for 54.2% of complete flakes. For 10633-9263a BP, trim flakes accounted for 29.5% of complete flakes. For 9247-7197 BP, trim flakes accounted for 6.6% of complete flakes. For 7176-5959 BP, trim flakes accounted for 4.1% of complete flakes. For 5931-5440 BP, trim flakes accounted for 4.1% of complete flakes. (See Figure 9 and Appendix Table 26)

For the time period from 12211-11488, cortical flakes accounted for 16.7% of complete flakes. For 11613-10661 BP, cortical flakes accounted for 10.2% of complete flakes. For 10633-9263 BP, cortical flakes accounted for 11.4% of complete flakes. For 9247-7197 BP, cortical flakes accounted for 28.9% of complete flakes. For 7176-5959 BP, cortical flakes accounted for 26.0% of complete flakes. For 5931-5440 BP, cortical flakes accounted for 29.8% of complete flakes. (See Figure 10 and Appendix Table 27)

For the time period from 12211-11488, 5.6% of complete flakes had cortical platforms. For 11613-10661 BP, 4.8% of complete flakes had cortical platforms. For 10633-9263 BP, 8.3% of complete flakes had cortical platforms. For 9247-7197 BP, 8.3% of complete flakes had cortical platforms. For 7176-5959 BP, 12.3% of complete flakes had cortical platforms. For 5931-5440 BP, 12.8% had cortical platforms. (See Figure 11 and Appendix Table 28)

Simple linear regression was used to test if the proportion of bifacial thinning flakes predicted the proportion of cortical flakes across six time periods. The fitted regression model was: $y = -0.8399x + 0.293$. There was a strong negative correlation between the two variables ($R^2 = .8277$). It was found that the proportion of bifacial thinning flakes significantly predicted the proportion of cortical flakes for a given time period ($p = 0.011837$). (See Figure 12 and Appendix Table 29)

Simple linear regression was used to test if the proportion of bifacial thinning flakes predicted the proportion of cortical platforms across six time periods. The fitted regression model was: $y = -0.2466x + 0.1126$. Although there was a weak negative correlation between the two variables ($R^2 = 0.5076$), it was found that the proportion of bifacial thinning flakes did not significantly predict the proportion of cortical flakes for a given time period ($p = .112107$). (See Appendix Figure 16 and Appendix Table 30)

Simple linear regression was used to test if the proportion of trim flakes predicted the proportion of cortical flakes across six time periods. The fitted regression model was: $y = -0.231x + 0.2697$. Although there was a weak negative correlation between the two variables (R^2

= 0.5974), it was found that the proportion of trim flakes did not significantly predict the proportion of cortical flakes for a given time period ($p = .071513$). (See Appendix Figure 17 and Appendix Table 31)

Simple linear regression was used to test if the proportion of trim flakes predicted the proportion of cortical platforms across six time periods. The fitted regression model was: $y = -0.0974x + 0.1141$. There was a negative correlation between the two variables ($R^2 = 0.7566$). It was found that the proportion of trim flakes significantly predicted the proportion of cortical platforms for a given time period ($p = .02431$). (See Appendix Figure 18 and Appendix Table 32)

Simple linear regression was used to test if the proportion of bifacial thinning flakes predicted the proportion of trim flakes across six time periods. The fitted regression model was: $y = 1.7365x + 0.1028$. Although there was a positive correlation between the two variables ($R^2 = 0.3262$), it was found that the proportion of bifacial thinning flakes did not significantly predict the proportion of trim flakes for a given time period ($p = 0.236413$). (See Appendix Figure 19 and Appendix Figure 33)

Average complete flake dimensions for each of the six time periods are as follows. 12211-11488 BP: length 18.32 mm, width 5.73 mm, thickness 1.06 mm, weight 2.4 grams. 11613-10661 BP: length 18.46 mm, width 11.12 mm, thickness 2.19 mm, weight 1.5 grams. 10633-9263 BP: length 25.57 mm, width 22.59 mm, thickness 4.97 mm, weight 6.17 grams. 9247-7197 BP: length 28.66 mm, width 23.17, thickness 6.95 mm, weight 7.4 grams. 7176-5959 BP: length 27.43 mm, width 23.17 mm, thickness 6.24 mm, weight 7.14 grams. 5931-5440 BP: length 28.8 mm, width 27.4 mm, thickness 7.39 mm, weight 9.99 grams. (See Figures 13-16 and Appendix Table 34)

T-tests evaluating the difference in average complete flake length between the six time periods found no statistically significant difference between 12211-11488 BP and 11613-10661 BP; between 9247-7197 BP and 7176-5959 BP; or between 7176-5959 BP and 5931-5440 BP. However, the difference in average complete flake length was found to be statistically significant between 11613-10661 BP and 10633-9263 BP, as well as between 10633-9263 BP and 9247-7197 BP (see Appendix Tables 35-39).

T-tests evaluating the difference in average complete flake width between the six time periods found no statistically significant difference between 12211-11488 BP and 11613-10661 BP, or between 9247-7197 BP and 7176-5959 BP. However, the difference in average complete flake width was found to be statistically significant between 11613-10661 BP and 10633-9263 BP; between 10633-9263 BP and 9247-7197 BP; and between 7176-5959 BP and 5931-5440 BP (see Appendix Tables 40-44).

T-tests evaluating the difference in average complete flake thickness between the six time periods found no statistically significant difference between 12211-11488 BP and 11613-10661 BP; between 9247-7197 BP and 7176-5959 BP; or between 7176-5959 BP and 5931-5440 BP. However, the difference in average complete flake thickness was found to be statistically significant between 11613-10661 BP and 10633-9263 BP, as well as between 10633-9263 BP and 9247-7197 BP (see Appendix Tables 45-49).

T-tests evaluating the difference in average complete flake weight between the six time periods found no statistically significant difference between 12211-11488 BP and 11613-10661 BP; between 10633-9263 BP and 9247-7197 BP; between 9247-7197 BP and 7176-5959 BP; or between 7176-5959 BP and 5931-5440 BP. However, the difference in average complete flake weight was found to be statistically significant between 11613-10661 BP and 10633-9263 BP (see Appendix Tables 50-54).

Flakes with edge damage were calculated as a percentage of complete flakes in six times periods. For the time period from 12211-11488 BP, edge-damaged flakes accounted for 0% of complete flakes. For 11613-10661 BP, edge-damaged flakes accounted for 6.0% of complete flakes. For 10633-9263 BP, edge-damaged flakes accounted for 18.9% of complete flakes. For 9247-7197 BP, edge damaged flakes accounted for 15.7% of complete flakes. For 7176-5959 BP, edge-damaged flakes accounted for 26.0% of complete flakes. For 5931-5440 BP, edge-damaged flakes accounted for 17.0% of complete flakes. (See Appendix Table 55 and Appendix Figure 20)

Flakes with striations were calculated as a percentage of complete flakes in six times periods. For the time period from 12211-11488 BP, striated flakes accounted for 0% of complete flakes. For 11613-10661 BP, striated flakes accounted for 8.4% of complete flakes. For 10633-9263 BP, striated flakes accounted for 18.2% of complete flakes. For 9247-7197 BP, striated flakes accounted for 13.2% of complete flakes. For 7176-5959 BP, striated flakes accounted for 15.0% of complete flakes. For 5931-5440 BP, striated flakes accounted for 7.8% of complete flakes. (See Appendix Table 56 and Appendix Figure 21)

Discussion

The results of the analysis clearly indicate a change in the proportion of bifacial thinning flakes over time (see Figure 8 and Appendix Table 25), with earlier periods having higher proportions (peaking at 10633-9263 BP) and later periods have markedly lower proportions. The change in proportion of trim flakes is also striking (see Figure 9 and Appendix Table 26), with proportions clearly declining and becoming notably low after about 9200 BP. As both bifacial thinning flakes and trim flakes are associated with curated stone tool industries, these patterns indicate a shift away from curation and towards expedient tool production.

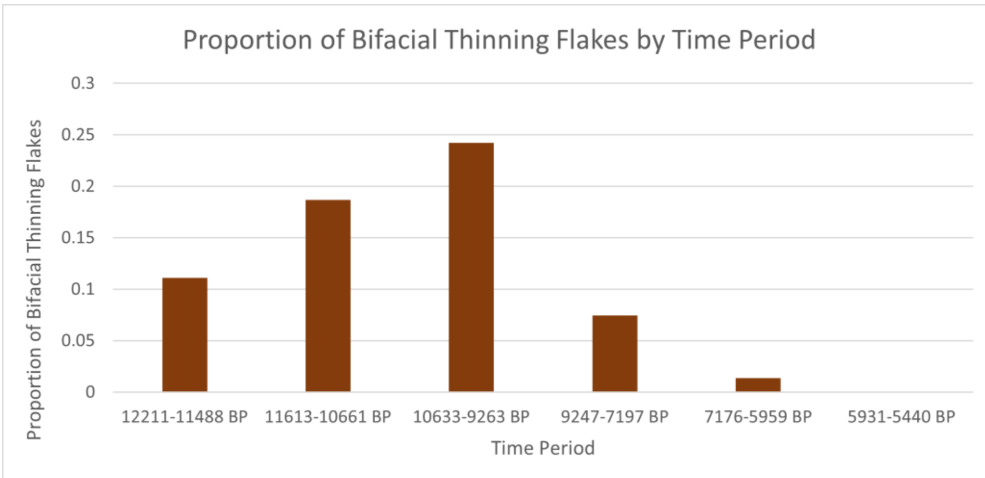

Figure 8. Bifacial thinning flakes as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

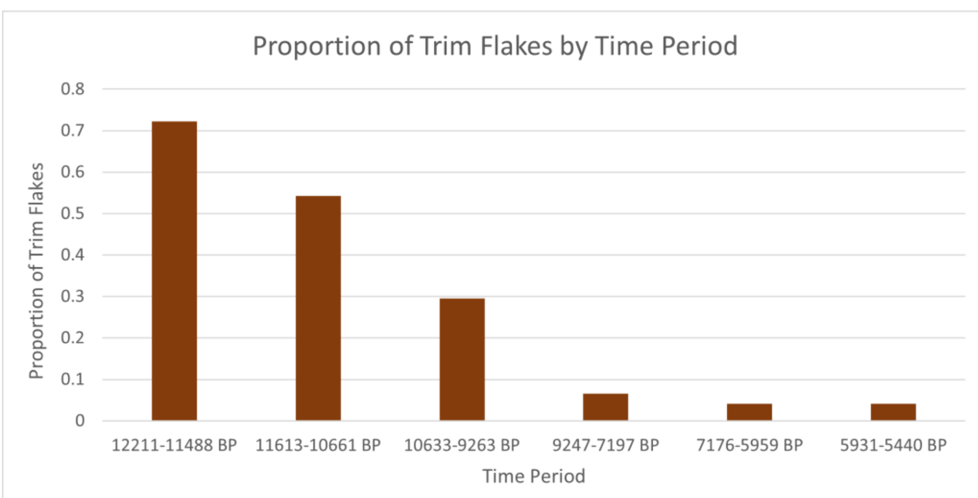

Figure 9. Trim flakes as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

Considering the proportion of cortical flakes (see Figure 10 and Appendix Figure 27), we see quite the opposite pattern, with cortical flakes being less abundant in earlier periods and becoming more abundant after 9200 BP. Cortical platforms demonstrate a somewhat more gradual upward trend over time (see Figure 11 and Appendix Figure 28), yet the change is clearly visible. Since both cortical flakes and cortical platforms are associated with expedient stone tool technologies, these patterns also indicate a shift away from curation.

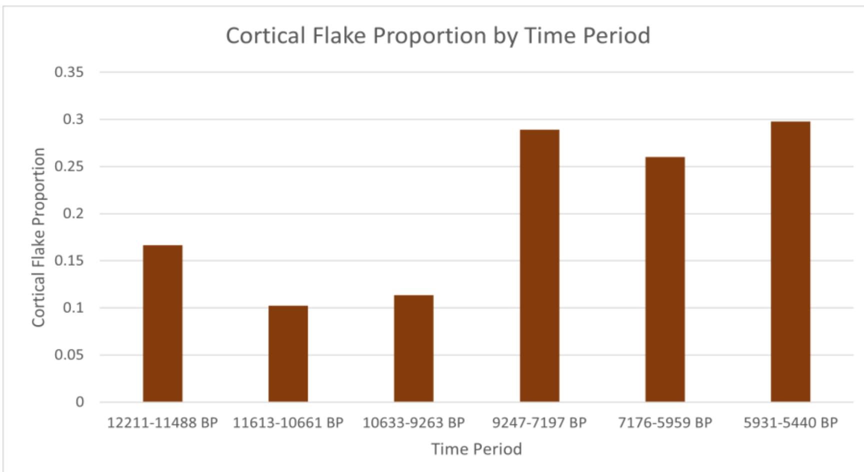

Figure 10. Cortical flakes as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

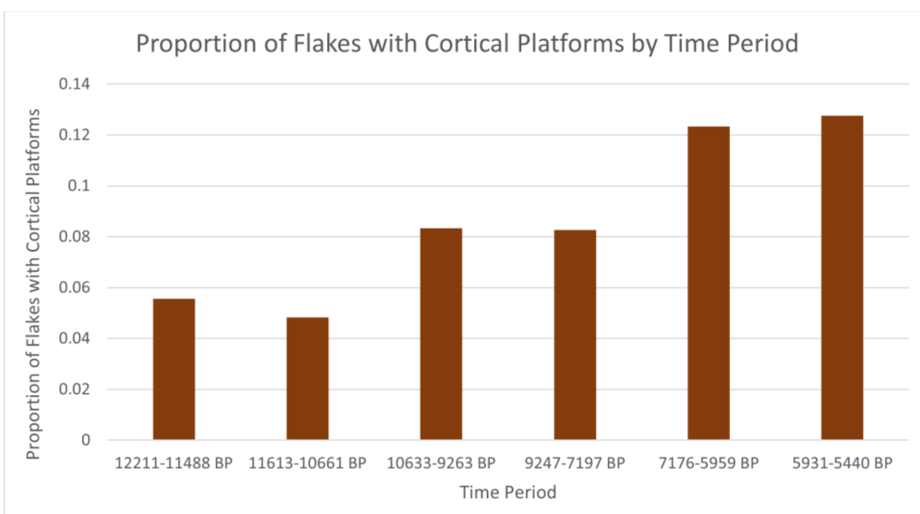

Figure 11 . Flakes with cortical platforms as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

With these complementary lines of evidence in mind we can consider the regression analyses. Bifacial thinning flake proportion turned out to be a strong predictor of cortical flake proportion in both the first and second analysis (see Figure 12, Appendix Figure 5, and Appendix Tables 5 and 29).

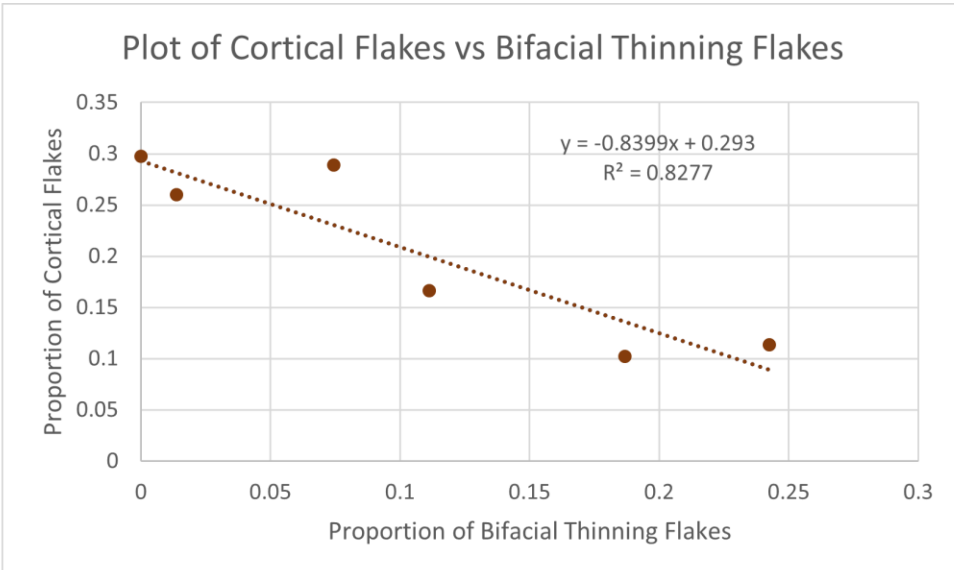

Figure 12. A simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of cortical flakes across six time periods. Includes data only from Unit 1W.

Trim flake proportion turned out to be a strong predictor of cortical platform proportion, but only in the second analysis using six time periods (see Appendix Figure 18 and Appendix Table 32). Although the other regressions did not reach statistical significance, the trendlines do display the inverse relationship between indicators of curation and indicators of expedient technology that we would expect to see. Bifacial thinning flake proportion turned out not to be strong predictor of trim flake proportion (see Appendix Figures 9 and 19, and Appendix Tables 9 and 33), although there was a weak positive correlation. We can conclude from this that although both bifacial thinning flakes and trim flakes are both indicative of high curation (with thinning flakes being the more reliable of the two proxies), the two are not inextricably linked.

Having observed the changes that indicate a shift towards expedient technology, we turn to the analysis of complete flake dimensions to determine at what point in time these changes were most substantial. Average complete flake dimensions can be taken at face value to represent stages in production simply because lithic technology is a reductive process; but more specifically, average complete flake dimensions are highly influenced by the proportion of bifacial thinning flakes and trim flakes, which are smaller than primary reduction flakes. Thus, average complete flake dimensions provide us with a continuous variable that incorporates multiple proxies for stages of production. In terms of cultural behaviors, an increase average flake dimensions would therefore indicate decreased investment in curated stone tool technologies and imply a reduced degree of mobility.

The T-tests in the initial analysis, using four time periods and data from both units, demonstrated a statistically significant change in average complete flake length, width, thickness, and weight between 11613-9263 BP and 9247-7197 BP (see Appendix Figures 10-13). The fact that all four attributes would change significantly at the same time indicates a substantial shift in technology occurring around 9200 BP.

The T-tests in the second analysis, using six time periods and data from Unit 1W, allow us to observe these changes with slightly better resolution (see Figures 13-16). There is in fact a statistically significant change in average complete flake length, width, and thickness at two different points: between 11613-10661 BP and 10633-9263 BP, as well as between 10633-9263 BP and 9247-7197 BP. The change in average complete flake width only reached statistical significance between 11613-10661 BP and 10633-9263 BP. These data suggest that the shift towards expedient technology did not happen strictly after 9200 BP, but had started as early as 10600 BP. This is roughly the time period in which a warmer and wetter climate would begin to manifest in the region (Prufer and Kennett 2020).

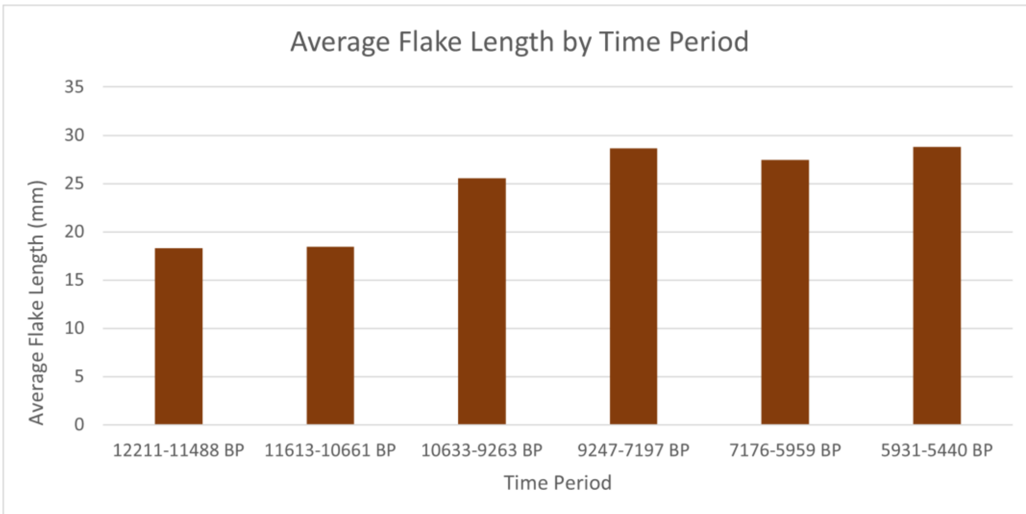

Figure 13. Average complete flake length by six time periods. Includes data only from Unit 1W. The difference in average complete flake length was found to be statistically significant between 11613-10661 BP and 10633-9263 BP, as well as between 10633-9263 BP and 9247-7197 BP (see Appendix Tables 35-39).

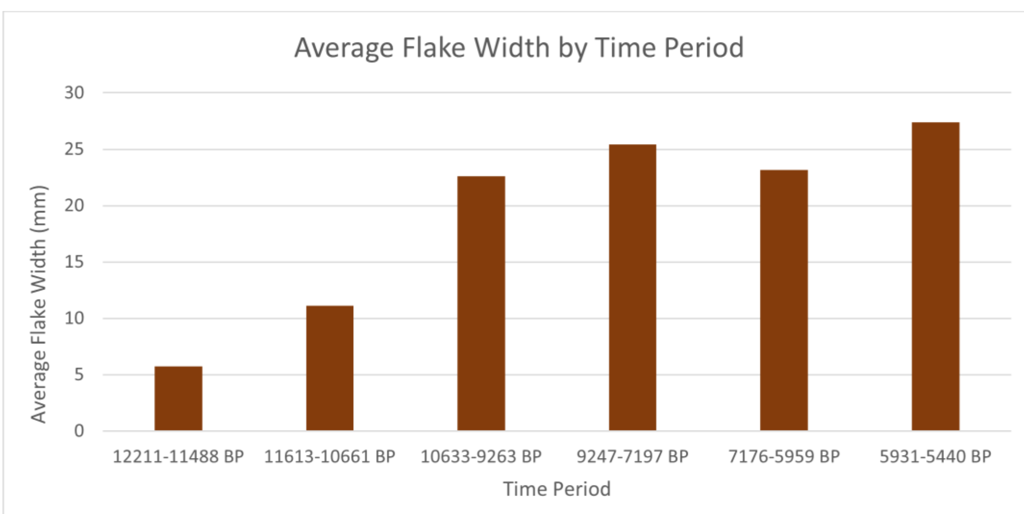

Figure 14. Average complete flake width by six time periods. Includes data only from Unit 1W. The difference in average complete flake width was found to be statistically significant between 11613-10661 BP and 10633-9263 BP; between 10633-9263 BP and 9247-7197; and between 7176-5959 BP and 5931-5440 BP (see Appendix Tables 40-44).

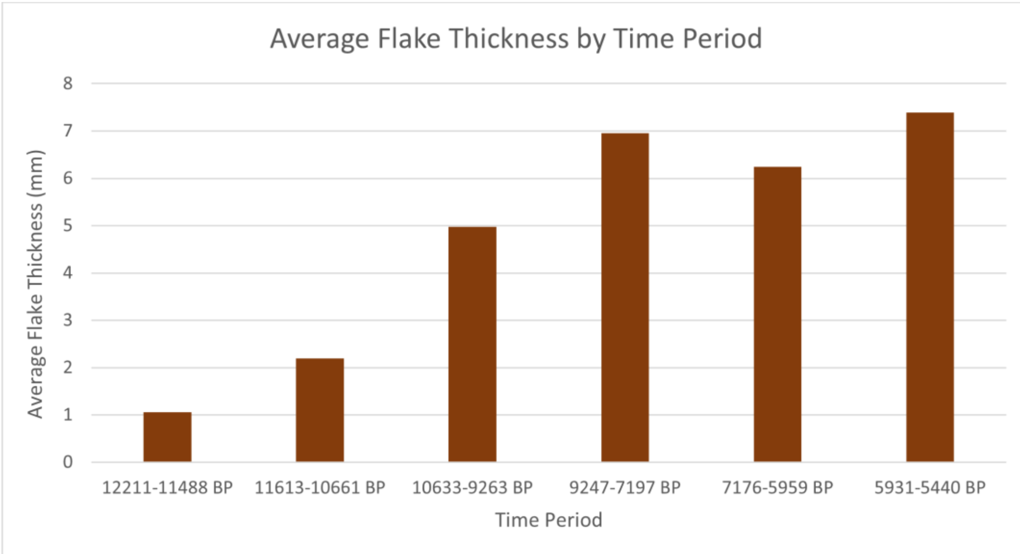

Figure 15. Average complete flake thickness by six time periods. Includes data only from Unit 1W. The difference in average complete flake thickness was found to be statistically significant between 11613-10661 BP and 10633-9263 BP, as well as between 10633-9263 BP and 9247-7197 BP (see Appendix Tables 45-49).

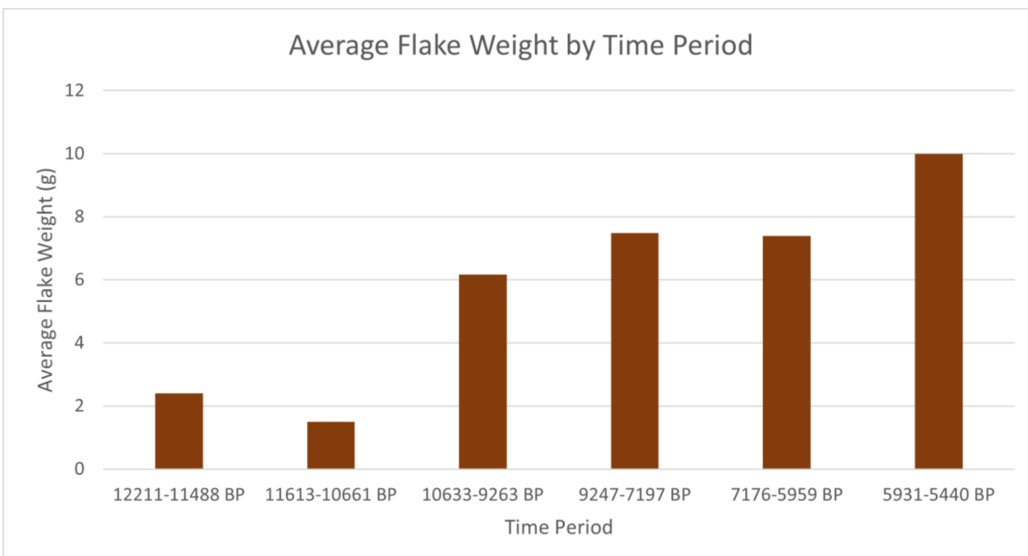

Figure 16. Average complete flake weight by six time periods. Includes data only from Unit 1W. The difference in average complete flake width was found to be statistically significant between 11613-10661 BP and 10633-9263 BP (see Appendix Tables 50-54).

These results corroborate the findings of Dennehy's (2021) dissertation, in which he examined proportions of cortex, degrees of striking platform preparation, and prevalence of bifacial and retouched artifacts from sites in Belize (the aforementioned Maya Hak Cab Pek and Saki Tzul, as well as a third site called Tzib'te Yux). His analysis indicated high levels of stone tool curation during the Late Pleistocene and Early Holocene, followed by a rapid abandonment of bifacial technologies and a transition to expedient technologies (Dennehy 2021). These results also coincide with the disappearance of the Lowe complex tradition from Mesoamerica after 9,300 BP (Prufer et al. 2019). It is also worth noting that this phenomenon parallels the disappearance of bifacial points and bifacial thinning flakes in Panama after 7900 BP (Ranere and Cooke 2021). The technological transition to expedient technology seems to have occurred in nearby regions with only a small degree of temporal variation.

As noted by Parry and Kelly (1987), the shift from curated bifacial stone industries to "an almost exclusive use of informal tools" has been observed across North America in diverse regions. From the Eastern Woodlands of the United States (circa A.D. 500) to the Great Plains (circa A.D. 300) and the Southwest (beginning in the late Archaic and peaking around A.D. 600), this change has been identified through the analysis of numerous proxies. These proxies have included proportion of tools with facial retouch, proportion of bifacial thinning flakes, proportion of flakes with faceted platforms, proportion of flakes with abraded platforms, and proportion of non-standardized cores. Parry and Kelly point out that the technological change observed in these regions should not be conflated with technological progress; the transition to expedient technologies is in fact a step backwards in terms of technological sophistication, trading a highly skilled craft for an unskilled one (Parry and Kelly 1987).

Given the ubiquitous nature of this phenomenon, many efforts have been made to identify a universal causal factor. The explanation offered by Parry and Kelly, which has gained widespread acceptance over several decades, is a decrease in residential mobility. In each area and time period where the shift to expedient technology occurs, it is highly correlated with the establishment of large permanent settlements. These settlements are characterized by numerous houses arranged in a formal pattern, usually around a central point; this is referred to as a nucleated village (Parry and Kelly 1987). As yet, no such villages or settlements have been discovered in southern Belize dating to the Early Holocene. If the residents of such villages relied heavily on organic building materials, it is highly unlikely that any portion of a settlement could remain intact in the humid environment of the tropics. Even limestone structures are likely to have eroded beyond recognition over such a vast expanse of time.

Other variables have been investigated as causal or correlational factors. Dennehy's analysis explored the relationship between indicators of technological change and proxies of climate change and found no correlation between the two phenomena (Dennehy 2021). Parry and Kelly made similar observations regarding the technological change in various regions of North America:

> *"Topography, climate, and vegetation also varied considerably among the different regions where the shift occurred, and it does not appear to represent a response to a particular set of local environmental conditions."* (Parry and Kelly, 1987)

They also reject agriculture as the driving force behind these technological changes since horticulture (including Maize cultivation) had already been adopted in most of these regions. They note however that the technological shift "does correlate with the first emphasis on maize as a major staple in the diet of each area" (Parry and Kelly, 1987). The same cannot be said of southern Belize, since isotopic data indicate that maize did not become a major staple and surplus food source until after 4000 BP (Kennett et al. 2020).

Recent work by Kennett et al. (2022) has demonstrated that a south-to-north human migration occurred in southern Belize sometime between 7,300 BP and 5,600 BP, in the period after the observed stone tool transition. Genetic analysis of human skeletal remains from Maya Hak Cab Pek and Saki Tzul, which have been dated to 9,600-7,300 BP, indicate that the original populations inhabiting southern Belize were only distantly related to modern populations. In contrast, genetic analysis of later human remains (after 5,600 BP) show a strong relatedness to modern Maya populations and bear genetic markers of ancestry from South America. However, no skeletal remains have been found that represent the intervening years, from 7,300-5,600 BC, making it impossible to pinpoint when this population influx began (Kennett et al. 2022). Indeed, we must consider the possibility that the two populations may have coexisted for considerable period of time.

Considering the edge-damage and striation data (see Appendix Tables 23-24 and 55-56; and Appendix Figures 14-15 and 20-21), there are no strong trends that we can observe across the various time periods (note the small sample size for the earliest time period). We can simply assume that a variety of activities were being performed in these rockshelters throughout its long history of occupation, regardless of the lithic industry being implemented. Future studies of debitage assemblages such as this one could include experiments in replicating stone tools with similar materials, as well as performing tasks to replicate use-wear patterns. Extensive experience in use-wear replication is necessary to develop the researcher's ability to associate use-wear patterns with specific motions and materials. This approach was successfully demonstrated by Anthony Ranere in his studies of preceramic lithic tools from Panama (Ranere 1978).

The changes in stone tool technology in southern Belize during the Terminal Pleistocene and Early Holocene are now supported by multiple lines of evidence. The work that remains is to document these changes with a higher degree of resolution, and to determine the causal factors. Excavations of other rockshelters in the Maya Mountains may provide additional opportunities for lithic analysis and chronological developments and thus contribute to the construction of more fine-grained chronologies. Furthermore, although the shift to expedient technologies can be taken as an indication of reduced residential mobility, more data from other proxies is needed to assess degrees of sedentism in the region. The early adoption of cultivars, especially maize, could provide a missing piece of the puzzle. An early influx of human populations from the south could provide another. If evidence of such events is to be found, then our understanding of this time period hinges on the acquisition of additional skeletal materials, which only further excavation can provide.

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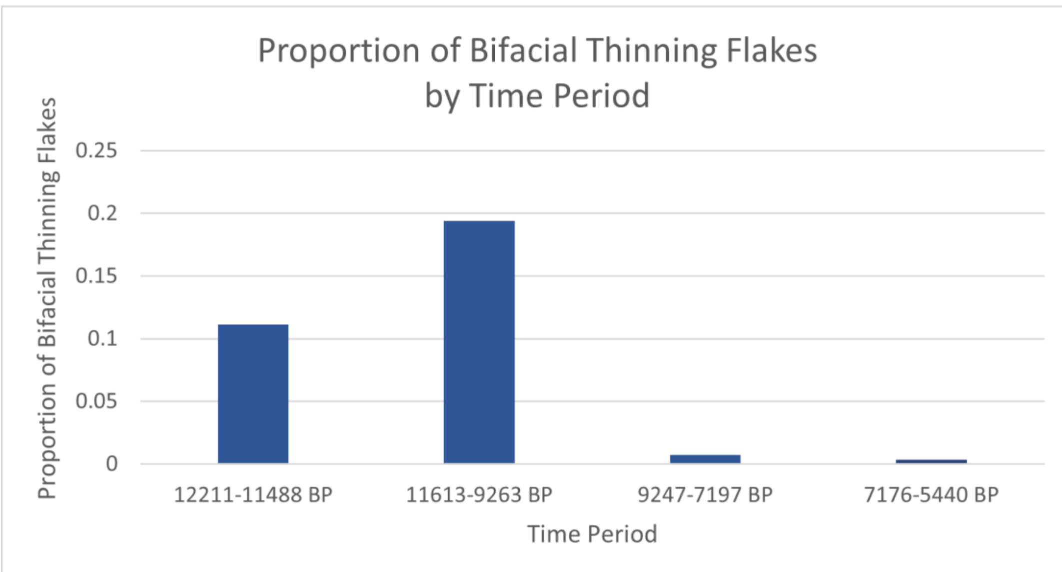
Appendix: Tables and Figures

Appendix Table 1. Complete flake count, bifacial thinning flake count, and bifacial thinning flakes as a proportion of complete flakes, by four time periods. Includes data from Units 1E and 1W.

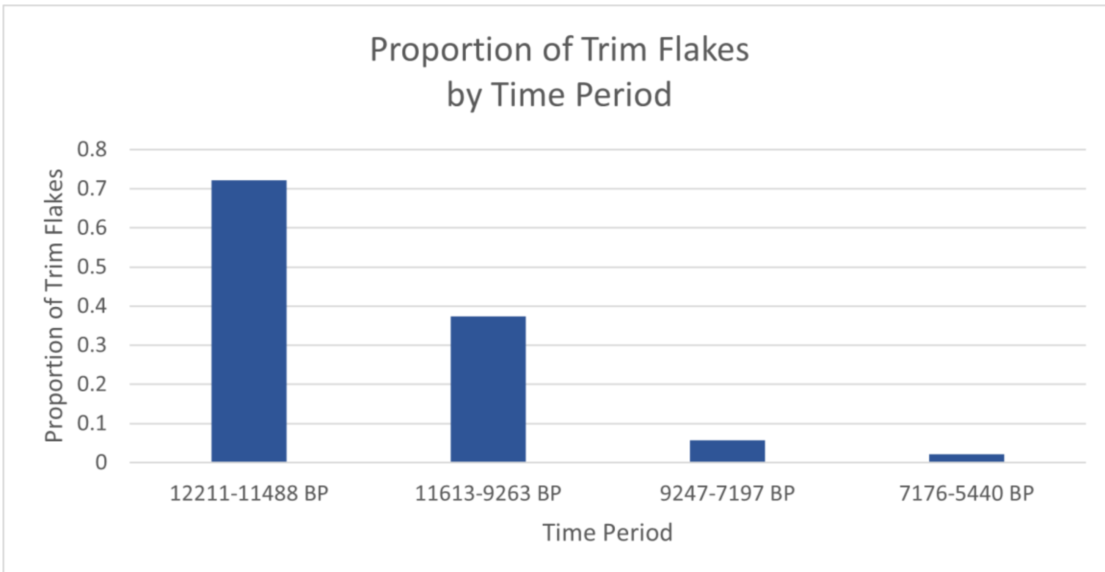
Time Period	12211-11488 BP	11613-9263 BP	9247-7197 BP	7176-5440 BP
Complete Flake Count	18	351	139	273
Bifacial Thinning Flake Count	2	68	11	1
Thinning Flake Proportion	0.111111111	0.193732194	0.007194245	0.003663004



Appendix Figure 1. Bifacial thinning flakes as a proportion of complete flakes, by four time periods. Includes data from Units 1E and 1W.

Appendix Table 2. Complete flake count, trim flake count, and trim flakes as a proportion of complete flakes, by four time periods. Includes data from Units 1E and 1W.

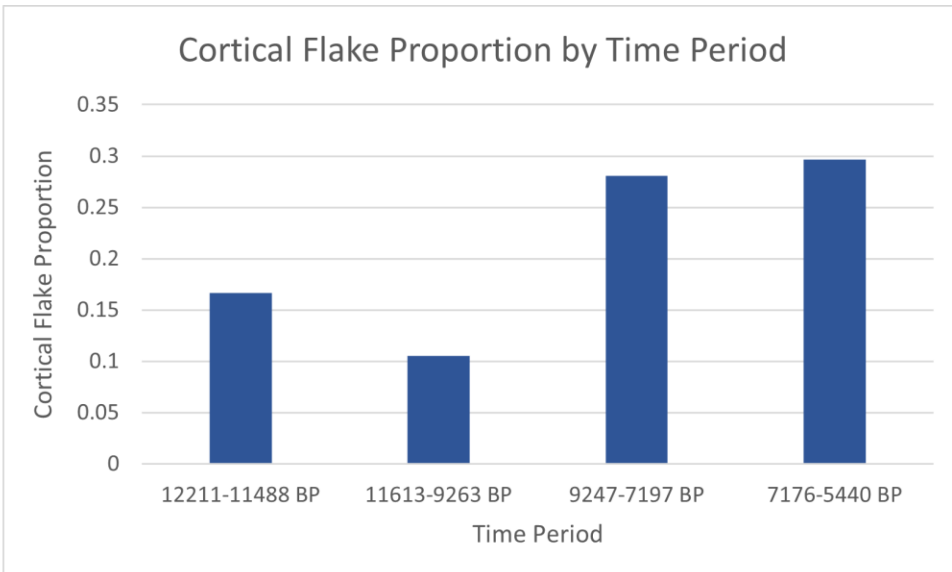
Time Period	12211-11488 BP	11613-9263 BP	9247-7197 BP	7176-5440 BP
Complete Flake Count	18	351	139	273
Trim Flake Count	13	131	8	6
Trim Flake Proportion	0.722222222	0.373219373	0.057553957	0.021978022



Appendix Figure 2. Trim flakes as a proportion of complete flakes, by four time periods. Includes data from Units 1E and 1W.

Appendix Table 3. Complete flake count, cortical flake count, and cortical flakes as a proportion of complete flakes, by four time periods. Includes data from Units 1E and 1W.

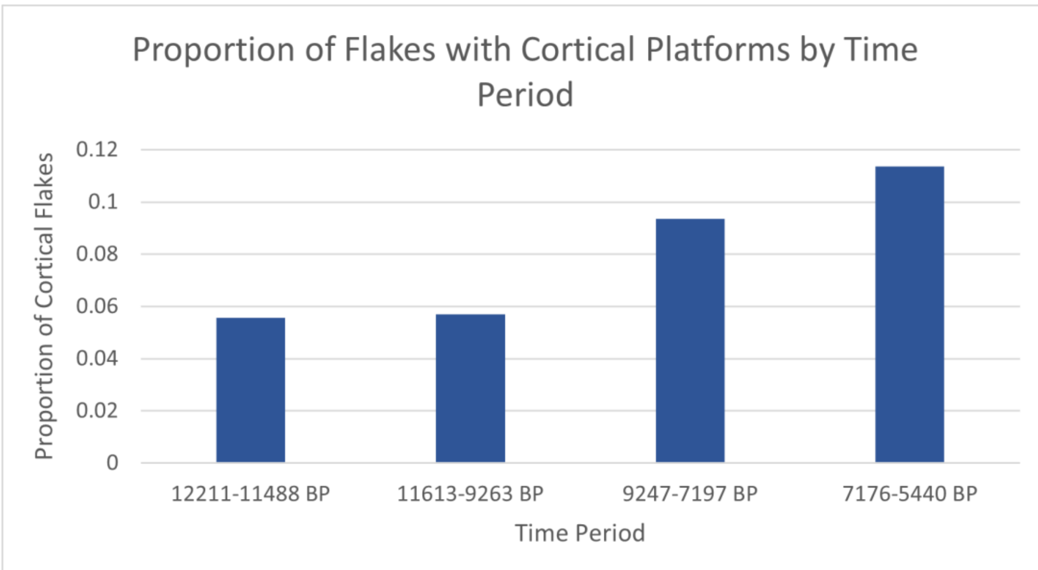
Time Period	12211-11488 BP	11613-9263 BP	9247-7197 BP	7176-5440 BP
Complete Flake Count	18	351	139	273
Cortical Flake Count	3	37	39	81
Cortical Flake Proportion	0.166666667	0.105413105	0.28057554	0.296703297



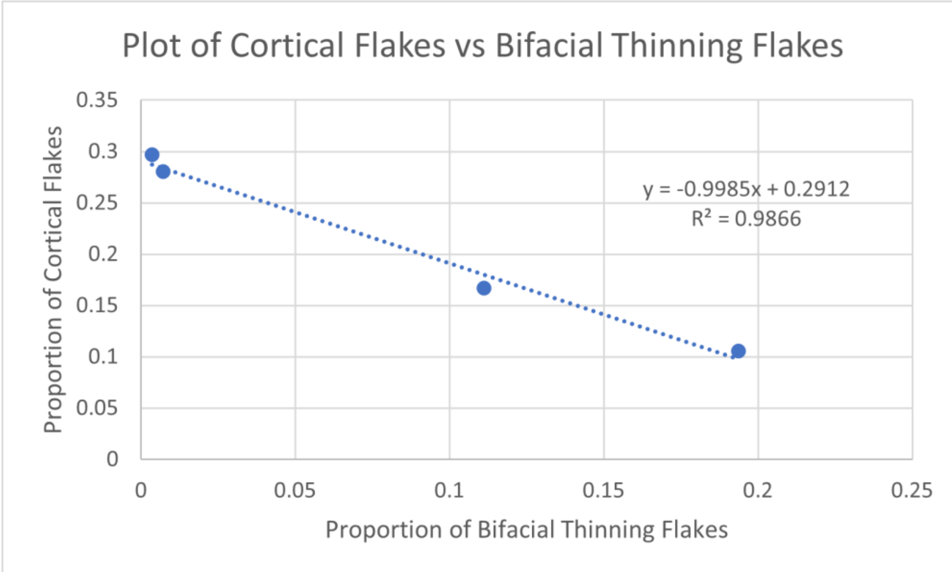
Appendix Figure 3. Cortical flakes as a proportion of complete flakes, by four time periods. Includes data from Units 1E and 1W.

Appendix Table 4. Complete flake count, cortical platform count, and proportion of flakes with cortical platforms, by four time periods. Includes data from Units 1E and 1W.

Time Period	12211-11488 BP	11613-9263 BP	9247-7197 BP	7176-5440 BP
Complete Flake Count	18	351	139	273
Cortical Platform Count	1	20	13	31
Proportion of Flakes with Cortical Platforms	0.055555556	0.056980057	0.09352518	0.113553114



Appendix Figure 4. Proportion of complete flakes with cortical platforms, by four time periods. Includes data from Units 1E and 1W.



Appendix Figure 5. A simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of cortical flakes across four time periods. Includes data from Units 1E and 1W.

Appendix Table 5. Summary output for the simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of cortical flakes in each time period.

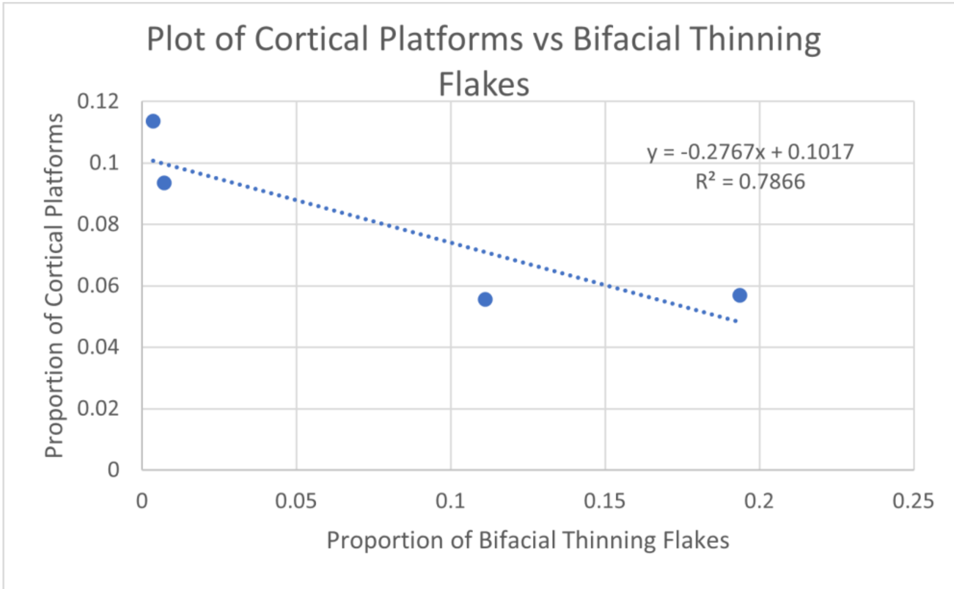
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.993275813
R Square	0.98659684
Adjusted R Square	0.97989526
Standard Error	0.013019249
Observations	4

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	1	0.024954	0.024954	147.2185	0.006724
Residual	2	0.000339	0.00017		
Total	3	0.025293			

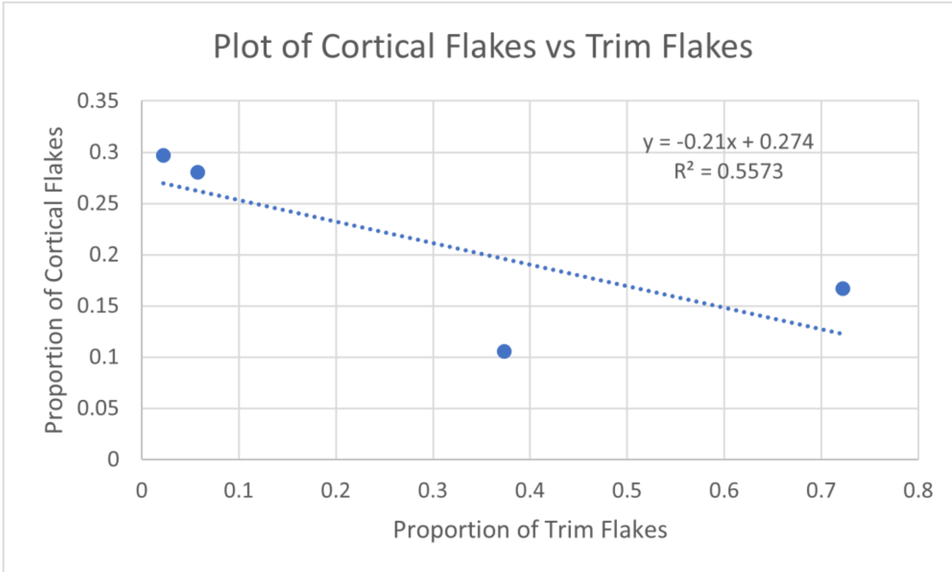
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.291150166	0.009196	31.66082	0.000996	0.251583	0.330717	0.251583	0.330717
Thinning Flake Proportion	-0.998547679	0.082298	-12.1334	0.006724	-1.35265	-0.64445	-1.35265	-0.64445



Appendix Figure 6. A simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of cortical platforms across four time periods. Includes data from Units 1E and 1W.

Appendix Table 6. Summary output for the simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of cortical platforms in each time period.

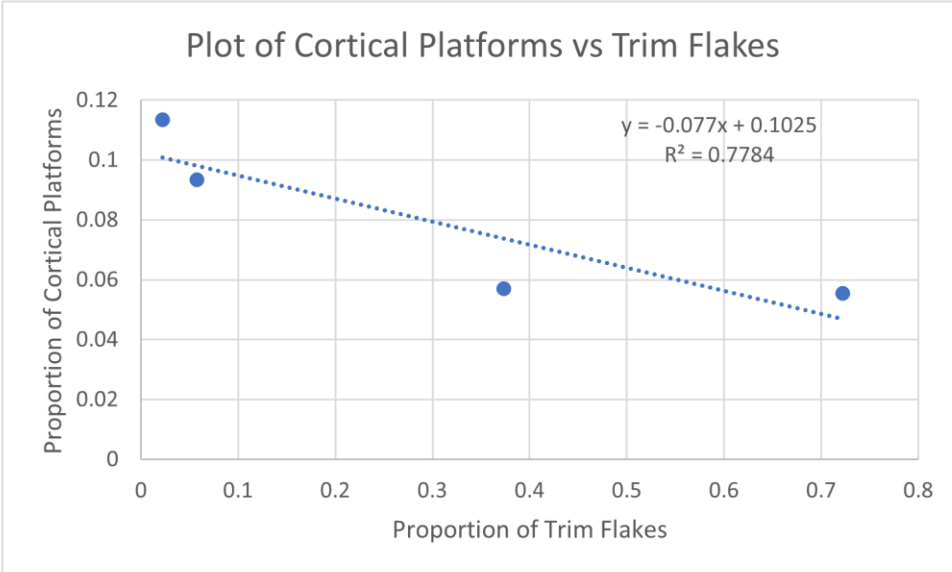
SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.886897891							
R Square	0.78658787							
Adjusted R Square	0.679881805							
Standard Error	0.016123037							
Observations	4							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression	1	0.001916	0.001916	7.371539	0.113102			
Residual	2	0.00052	0.00026					
Total	3	0.002436						
	Coefficients	*andard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.101742987	0.011388	8.934055	0.012298	0.052743	0.150743	0.052743	0.150743
Thinning Flake Proportion	-0.276711715	0.101917	-2.71506	0.113102	-0.71523	0.161804	-0.71523	0.161804



Appendix Figure 7. A simple linear regression testing whether the proportion of trim flakes predicts the proportion of cortical flakes across four time periods. Includes data from Units 1E and 1W.

Appendix Table 7. Summary output for the simple linear regression testing whether the proportion of trim flakes predicts the proportion of cortical flakes in each time period.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.74650023							
R Square	0.557262593							
Adjusted R Squ	0.33589389							
Standard Error	0.074826501							
Observations	4							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression	1	0.014095	0.014095	2.51735	0.2535			
Residual	2	0.011198	0.005599					
Total	3	0.025293						
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.274031011	0.053959	5.078491	0.036655	0.041864	0.506198	0.041864	0.506198
Trim Flakes	-0.21001786	0.132368	-1.58662	0.2535	-0.77955	0.359517	-0.77955	0.359517



Appendix Figure 8. A simple linear regression testing whether the proportion of trim flakes predicts the proportion of cortical platforms across four time periods. Includes data from Units 1E and 1W.

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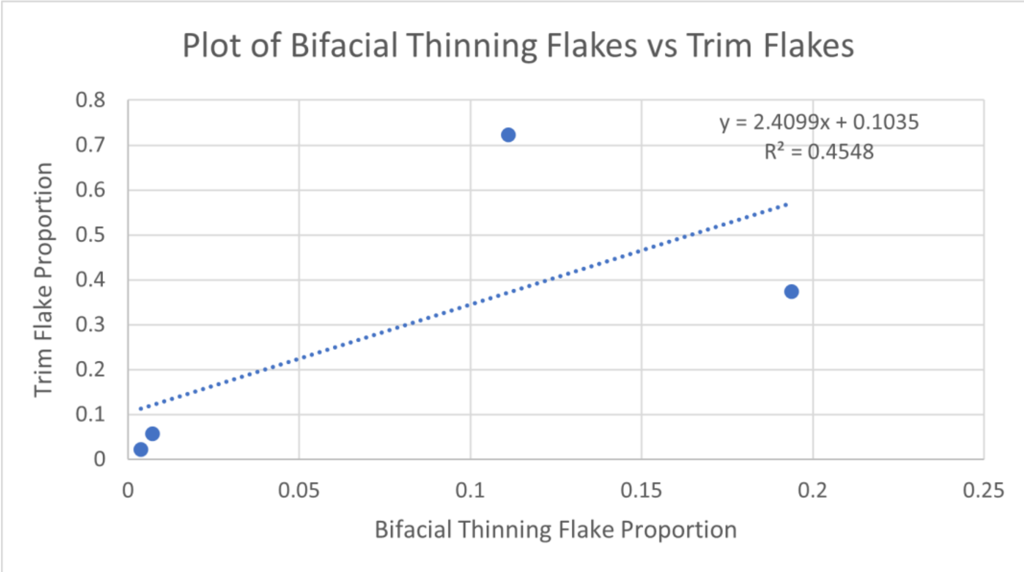
Appendix Table 8. Summary output for the simple linear regression testing whether the proportion of trim flakes predicts the proportion of cortical platforms in each time period.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.882274305							
R Square	0.778407948							
Adjusted R Squ	0.667611923							
Standard Error	0.016429124							
Observations	4							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression	1	0.001896	0.001896	7.025594	0.117726			
Residual	2	0.00054	0.00027					
Total	3	0.002436						
	Coefficients	*andard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Ipper 95.0%*
Intercept	0.102531832	0.011847	8.654356	0.01309	0.051556	0.153507	0.051556	0.153507
Trim Flakes	-0.077034433	0.029063	-2.65058	0.117726	-0.20208	0.048014	-0.20208	0.048014



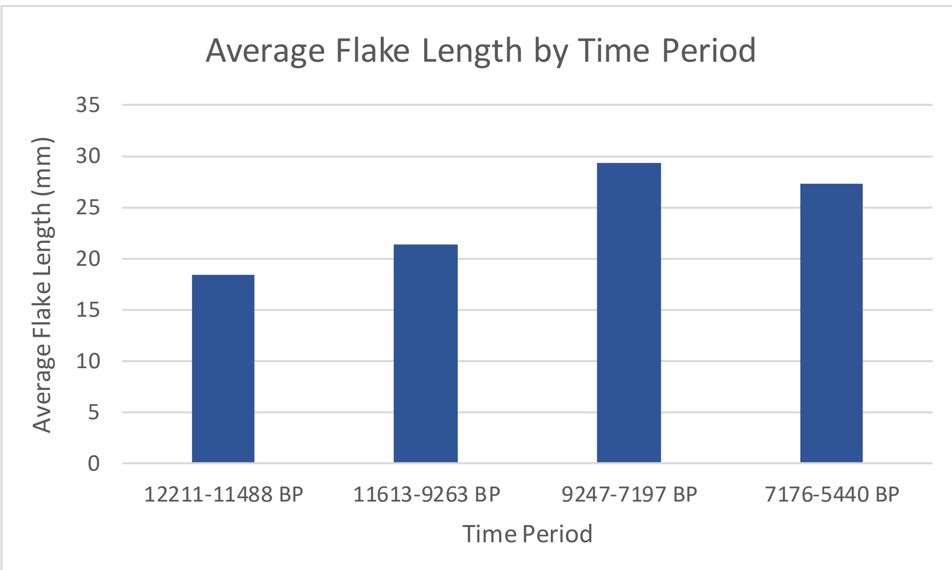
Appendix Figure 9. A simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of trim flakes across four time periods. Includes data from Units 1E and 1W.

Appendix Table 9. Summary output for the simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of trim flakes in each time period.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.6744163							
R Square	0.45483734							
Adjusted R Square	0.18225601							
Standard Error	0.2951339							
Observations	4							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.145344366	0.145344	1.66863	0.325583704			
Residual	2	0.174208039	0.087104					
Total	3	0.319552405						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.10354096	0.208462579	0.496688	0.668631	-0.793401123	1.000483	-0.7934	1.000483
Bifacial Thinning Fla	2.40990942	1.865609376	1.291755	0.325584	-5.61715986	10.43698	-5.61716	10.43698

Appendix Table 10. Average complete flake dimensions for each of four time periods. Includes data from Units 1E and 1W.

Time Period	12211-11488 BP	11613-9263 BP	9247-7197 BP	7176-5440 BP
Average Length (mm)	18.32	21.3	29.31	27.29
Average Width (mm)	5.73	15.71	25.23	24.66
Average Thickness (mm)	1.06	3.28	6.85	6.69
Average Weight (grams)	2.42	3.7	6.98	8.15



Appendix Figure 10. Average complete flake length by four time periods. Includes data from Units 1E and 1W. The difference in average complete flake length was found to be statistically significant between 11613-9263 BP and 9247-7197 BP (see Tables 10-12).

Appendix Table 11. T-test comparing average complete flake length between 9247-7197 BP and 7176-5440 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

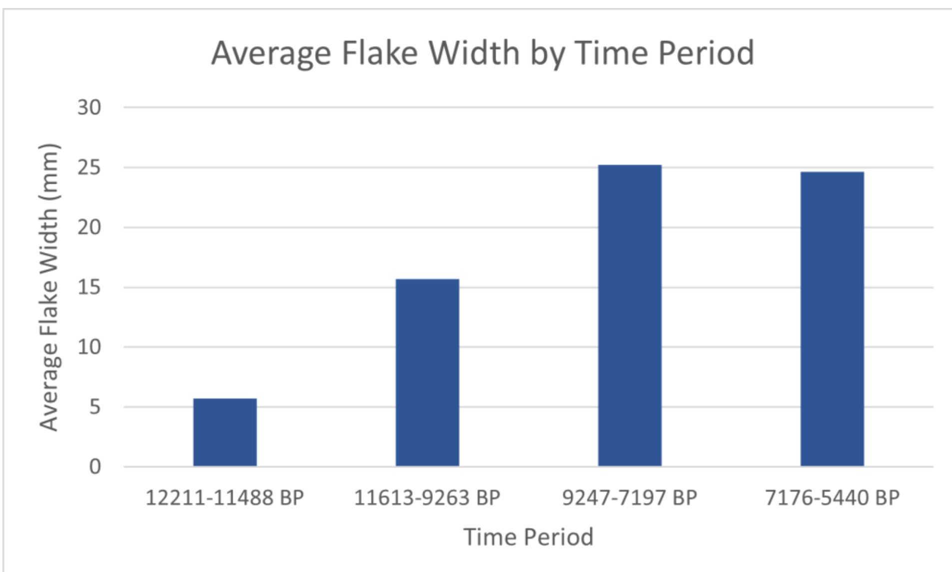
t-Test: Two-Sample Assuming Equal Variances		
	7176-5440 BP	*9247-7197 BP*
Mean	27.90073529	28.81021898
Variance	244.7908482	154.4343066
Observations	272	137
Pooled Variance	214.5979989	
Hypothesized Mean Difference	0	
df	407	
t Stat	-0.592604793	
P(T<=t) one-tail	0.276887384	
t Critical one-tail	1.64860612	
P(T<=t) two-tail	0.553774769	
t Critical two-tail	1.965809738	

Appendix Table 12. T-test comparing average complete flake length between 11613-9263 BP and 9247-7197 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

t-Test: Two-Sample Assuming Equal Variances		
	9247-7197 BP	*11613-9263 BP*
Mean	28.81021898	21.05142857
Variance	154.4343066	132.9429063
Observations	137	350
Pooled Variance	138.9693608	
Hypothesized Mean Difference	0	
df	485	
t Stat	6.530768891	
P(T<=t) one-tail	8.27384E-11	
t Critical one-tail	1.648001465	
P(T<=t) two-tail	1.65477E-10	
t Critical two-tail	1.964867287	

Appendix Table 13. T-test comparing average complete flake length between 12211-11488 BP and 11613-9263 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	11613-9263 BP	*12211-11488 BP*
Mean	21.05142857	18.38888889
Variance	132.9429063	93.42810458
Observations	350	18
Pooled Variance	131.1075193	
Hypothesized Mean Difference	0	
df	366	
t Stat	0.962118697	
P(T<=t) one-tail	0.168312594	
t Critical one-tail	1.649027553	
P(T<=t) two-tail	0.336625188	
t Critical two-tail	1.966466722	



Appendix Figure 11. Average complete flake width by four time periods. Includes data from Units 1E and 1W. The difference in average complete flake width was found to be statistically significant between 11613-9263 BP and 9247-7197 BP (see Tables 13-15).

Appendix Table 14. T-test comparing average complete flake width between 9247-7197 BP and 7176-5440 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

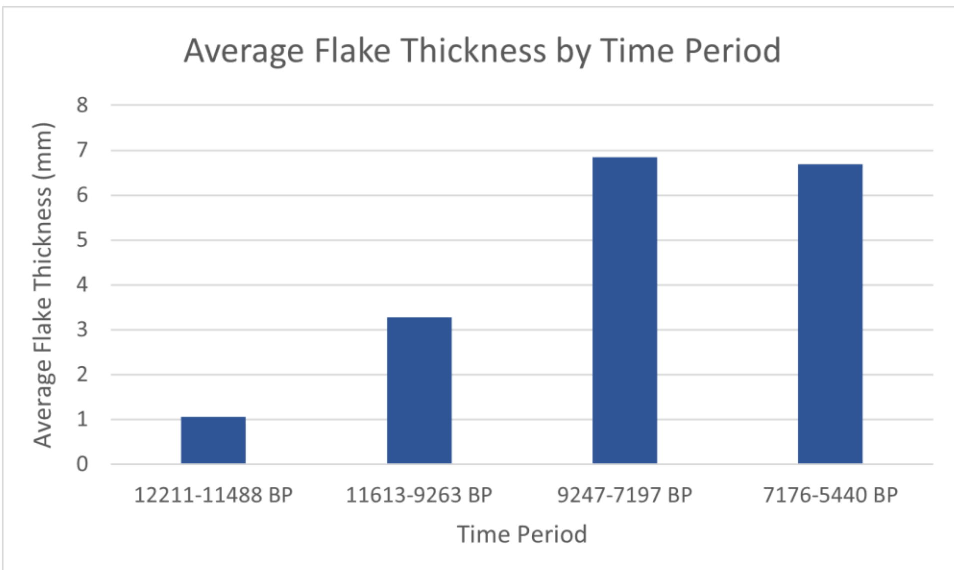
t-Test: Two-Sample Assuming Equal Variances		
	7176-5440 BP	9247-7197 BP
Mean	24.87625	25.29565217
Variance	163.6301542	138.3969153
Observations	272	138
Pooled Variance	155.1572283	
Hypothesized Mean Difference	0	
df	408	
t Stat	-0.3221638	
P(T<=t) one-tail	0.373746807	
t Critical one-tail	1.648596901	
P(T<=t) two-tail	0.747493614	
t Critical two-tail	1.965795368	

Appendix Table 15. T-test comparing average complete flake width between 11613-9263 BP and 9247-7197 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

t-Test: Two-Sample Assuming Equal Variances		
	9247-7197 BP	*11613-9263 BP*
Mean	25.29565217	19.49279202
Variance	138.3969153	162.5443962
Observations	138	351
Pooled Variance	155.7513677	
Hypothesized Mean Difference	0	
df	487	
t Stat	4.627696211	
P(T<=t) one-tail	2.37364E-06	
t Critical one-tail	1.647988513	
P(T<=t) two-tail	4.74728E-06	
t Critical two-tail	1.964847101	

Appendix Table 16. T-test comparing average complete flake width between 12211-11488 BP and 11613-9263 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	11613-9263 BP	*12211-11488 BP*
Mean	19.49279202	18.38888889
Variance	162.5443962	93.42810458
Observations	351	18
Pooled Variance	159.3428241	
Hypothesized Mean Difference	0	
df	367	
t Stat	0.361860633	
P(T<=t) one-tail	0.358832218	
t Critical one-tail	1.649016151	
P(T<=t) two-tail	0.717664435	
t Critical two-tail	1.966448946	



Appendix Figure 12. Average complete flake thickness by four time periods. Includes data from Units 1E and 1W. The difference in average complete flake thickness was found to be statistically significant between 11613-9263 BP and 9247-7197 BP (see Tables 16-18).

Appendix Table 17. T-test comparing average complete flake thickness between 9247-7197 BP and 7176-5440 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

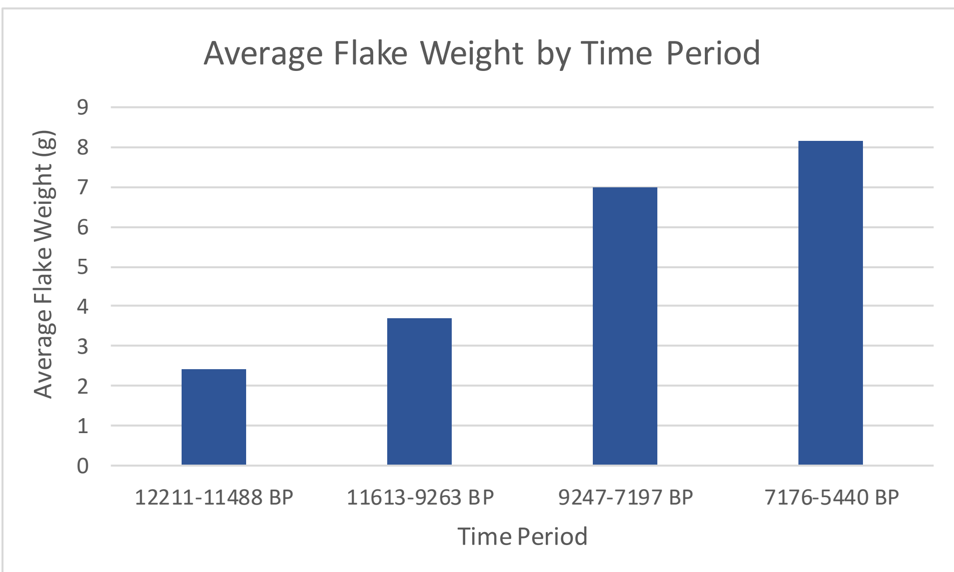
t-Test: Two-Sample Assuming Equal Variances		
	7176-5440 BP	*9247-7197 BP*
Mean	6.702867647	6.889130435
Variance	22.25850023	64.53907807
Observations	272	138
Pooled Variance	36.45565505	
Hypothesized Mean Difference	0	
df	408	
t Stat	-0.295172377	
P(T<=t) one-tail	0.384006174	
t Critical one-tail	1.648596901	
P(T<=t) two-tail	0.768012349	
t Critical two-tail	1.965795368	

Appendix Table 18. T-test comparing average complete flake thickness between 11613-9263 BP and 9247-7197 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

t-Test: Two-Sample Assuming Unequal Variances		
	9247-7197 BP	*11613-9263 BP*
Mean	6.889130435	3.93048433
Variance	64.53907807	12.02892519
Observations	138	351
Hypothesized Mean Difference	0	
df	157	
t Stat	4.176043256	
P(T<=t) one-tail	2.45197E-05	
t Critical one-tail	1.654617035	
P(T<=t) two-tail	4.90395E-05	
t Critical two-tail	1.975189163	

Appendix Table 19. T-test comparing average complete flake thickness between 12211-11488 BP and 11613-9263 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	11613-9263 BP	*12211-11488 BP*
Mean	3.93048433	2.932777778
Variance	12.02892519	7.615103595
Observations	351	18
Pooled Variance	11.82447024	
Hypothesized Mean Difference	0	
df	367	
t Stat	1.200573093	
P(T<=t) one-tail	0.115345588	
t Critical one-tail	1.649016151	
P(T<=t) two-tail	0.230691177	
t Critical two-tail	1.966448946	



Appendix Figure 13. Average complete flake weight by four time periods. Includes data from Units 1E and 1W. The difference in average complete flake weight was found to be statistically significant between 11613-9263 BP and 9247-7197 BP (see Tables 19-21).

Appendix Table 20. T-test comparing average complete flake weight between 9247-7197 BP and 7176-5440 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	7176-5440 BP	*9247-7197 BP*
Mean	8.562307692	7.042877698
Variance	164.2778634	85.79592209
Observations	273	139
Pooled Variance	137.8619905	
Hypothesized Mean Difference	0	
df	410	
t Stat	1.241934063	
P(T<=t) one-tail	0.10748542	
t Critical one-tail	1.6485786	
P(T<=t) two-tail	0.214970839	
t Critical two-tail	1.96576684	

Appendix Table 21. T-test comparing average complete flake weight between 11613-9263 BP and 9247-7197 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

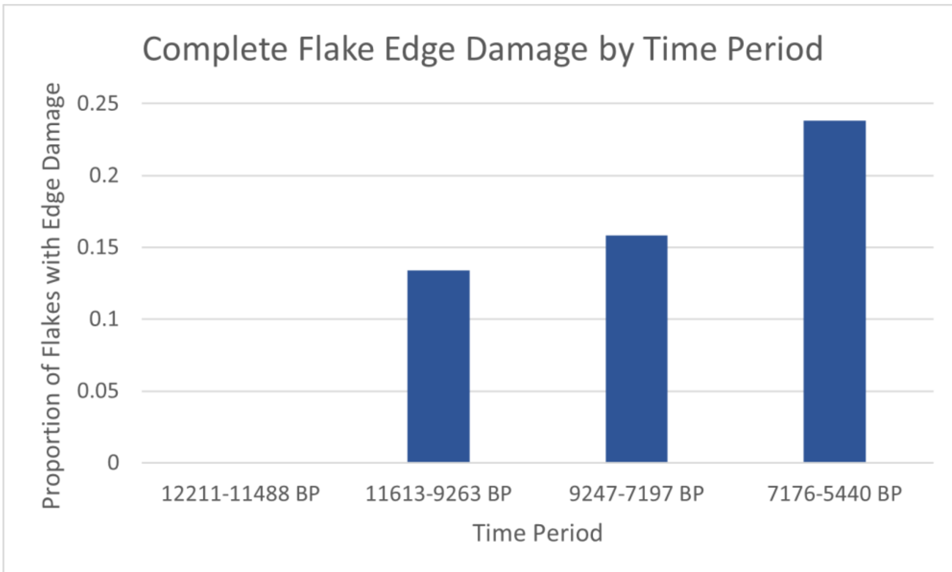
t-Test: Two-Sample Assuming Equal Variances		
	9247-7197 BP	*11613-9263 BP*
Mean	7.042877698	3.613589744
Variance	85.79592209	77.73661736
Observations	139	351
Pooled Variance	80.01568304	
Hypothesized Mean Difference	0	
df	488	
t Stat	3.825421671	
P(T<=t) one-tail	7.37445E-05	
t Critical one-tail	1.647982077	
P(T<=t) two-tail	0.000147489	
t Critical two-tail	1.96483707	

Appendix Table 22. T-test comparing average complete flake weight between 12211-11488 BP and 11613-9263 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Unequal Variances		
	11613-9263 BP	*12211-11488 BP*
Mean	3.613589744	1.978333333
Variance	77.73661736	11.51905
Observations	351	18
Hypothesized Mean Difference	0	
df	31	
t Stat	1.761889308	
P(T<=t) one-tail	0.04397406	
t Critical one-tail	1.695518783	
P(T<=t) two-tail	0.087948121	
t Critical two-tail	2.039513446	

Appendix Table 23. Complete flake count, edge-damaged flake count, and edge-damaged flake proportion, by four time periods. Includes data from Units 1E and 1W.

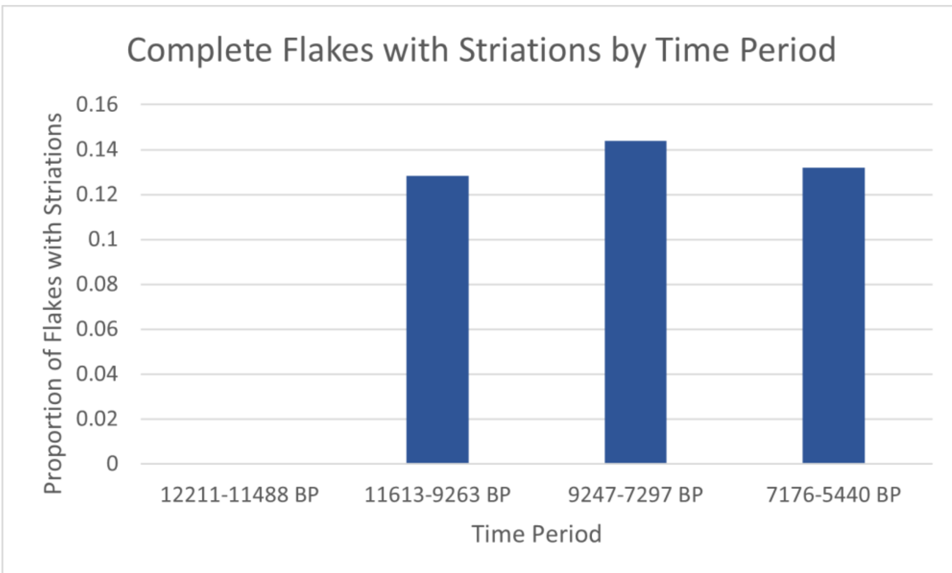
Time Period	12211-11488 BP	11613-9263 BP	9247-7197 BP	7176-5440 BP
Complete Flake Count	18	351	139	273
Edge Damaged Flakes	0	47	22	65
Edge Damaged Flake Proportion	0	0.133903134	0.158273381	0.238095238



Appendix Figure 14. Edge-damaged flakes as a proportion of complete flakes, by four time periods. Includes data from Units 1E and 1W.

Appendix Table 24. Complete flake count, striated flake count, and striated flake proportion, by four time periods. Includes data from Units 1E and 1W.

	12211-11488 BP	11613-9263 BP	9247-7297 BP	7176-5440 BP
Complete Flakes	18	351	139	273
Striated Flakes	0	45	20	36
Striated Flake Proportion	0	0.128205128	0.143884892	0.131868132



Appendix Figure 15. Striated flakes as a proportion of complete flakes, by four time periods. Includes data from Units 1E and 1W.

Appendix Table 25. Complete flake count, bifacial thinning flake count, and bifacial thinning flakes as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

Time Period	12211-11488 BP	11613-10661 BP	10633-9263 BP	9247-7197 BP	7176-5959 BP	5931-5440 BP
Complete Flake Count	18	166	132	121	73	141
Bifacial Thinning Flake Count	2	31	32	9	1	0
Thinning Flake Proportion	0.111111111	0.186746988	0.242424242	0.074380165	0.01369863	0

Appendix Table 26. Complete flake count, trim flake count, and trim flakes as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

Time Period	12211-11488 BP	11613-10661 BP	10633-9263 BP	9247-7197 BP	7176-5959 BP	5931-5440 BP
Complete Flake Count	18	166	132	121	73	141
Trim Flake Count	13	90	39	8	3	2
Trim Flake Proportion	0.722222222	0.542168675	0.295454545	0.066115702	0.04109589	0.04109589

Appendix Table 27. Complete flake count, cortical flake count, and cortical flakes as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

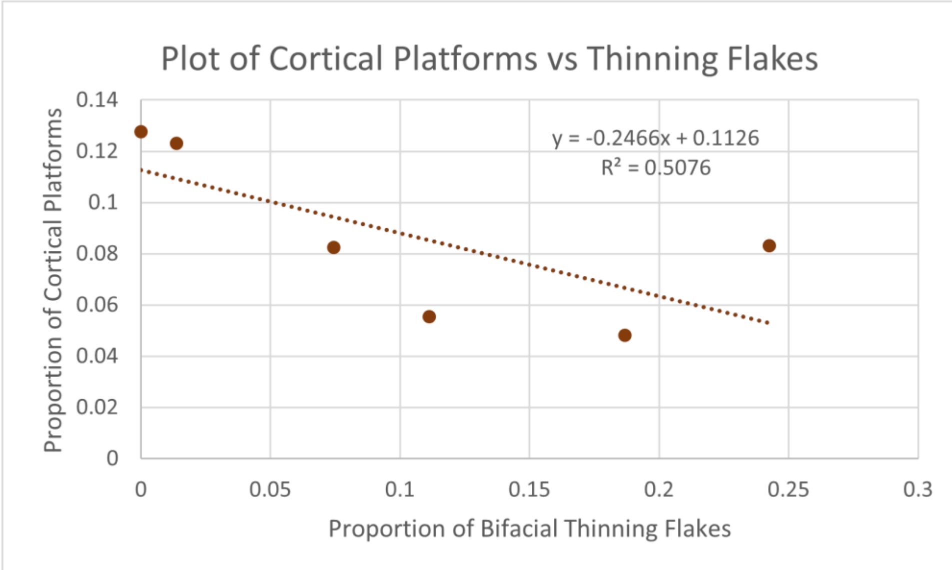
Time Period	12211-11488 BP	11613-10661 BP	10633-9263 BP	9247-7197 BP	7176-5959 BP	5931-5440 BP
Complete Flake Count	18	166	132	121	73	141
Cortical Flake Count	3	17	15	35	19	42
Cortical Flake Proportion	0.166666667	0.102409639	0.113636364	0.289256198	0.260273973	0.29787234

Appendix Table 28. Complete flake count, cortical platform count, and flakes with cortical platforms as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

Time Period	12211-11488 BP	11613-10661 BP	10633-9263 BP	9247-7197 BP	7176-5959 BP	5931-5440 BP
Complete Flake Count	18	166	132	121	73	141
Cortical Platform Count	1	8	11	10	9	18
Proportion of Flakes with Cortical Platforms	0.055555556	0.048192771	0.083333333	0.082644628	0.123287671	0.127659574

Appendix Table 29. Summary output for the simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of cortical flakes in each time period.

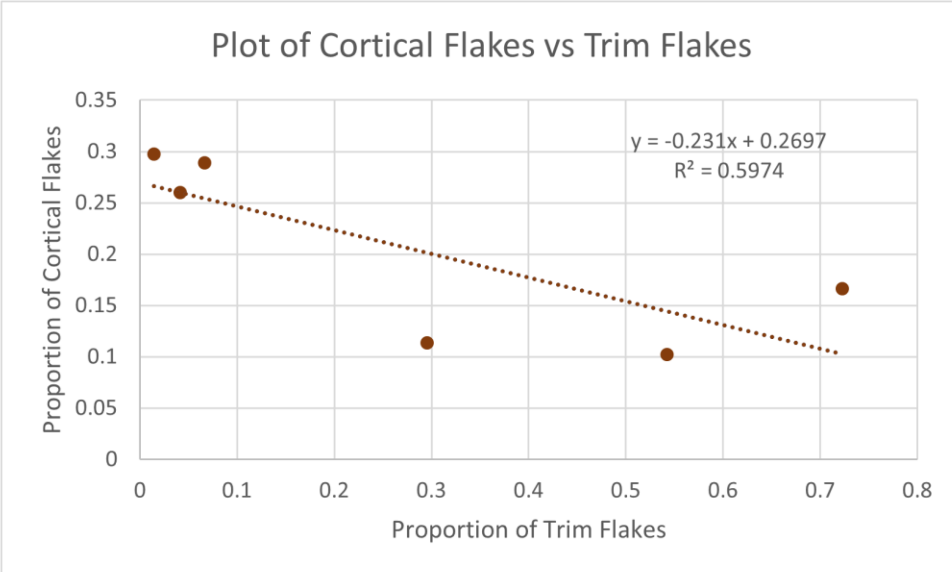
SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.909798686							
R Square	0.827733649							
Adjusted R Square	0.784667061							
Standard Error	0.04104648							
Observations	6							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression	1	0.032382	0.032382	19.21986	0.011837			
Residual	4	0.006739	0.001685					
Total	5	0.039121						
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.292979478	0.026141	11.20763	0.000361	0.2204	0.365559	0.2204	0.365559
Thinning Flake Proportion	-0.839901865	0.191581	-4.38405	0.011837	-1.37182	-0.30799	-1.37182	-0.30799



Appendix Figure 16. A simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of cortical platforms across six time periods. Includes data only from Unit 1W.

Appendix Table 30. Summary output for the simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of cortical platforms in each time period.

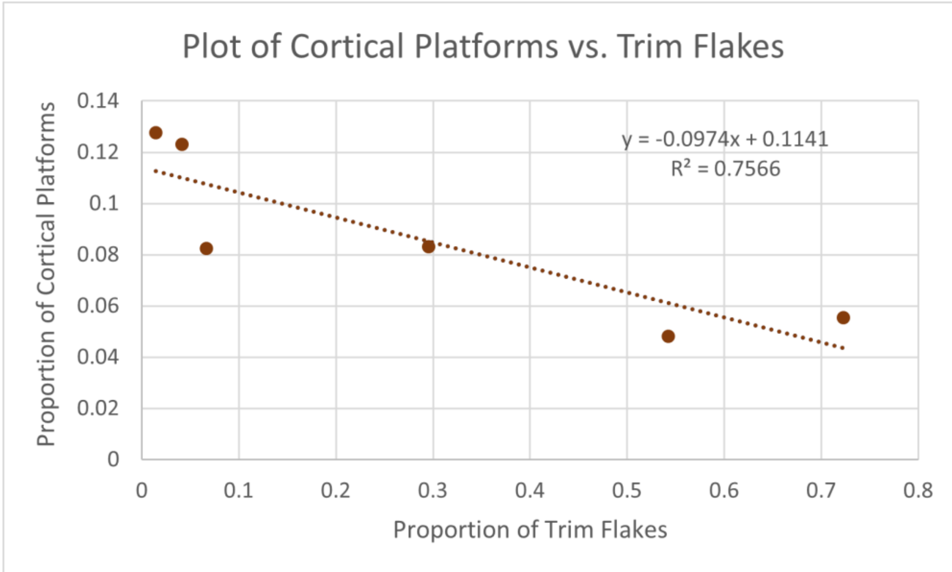
SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.712494625							
R Square	0.50764859							
Adjusted R Square	0.384560738							
Standard Error	0.026011497							
Observations	6							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression	1	0.00279	0.00279	4.124279	0.112107			
Residual	4	0.002706	0.000677					
Total	5	0.005497						
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.112600036	0.016566	6.797134	0.002447	0.066606	0.158594	0.066606	0.158594
Thinning Flake Proportion	-0.246556752	0.121407	-2.03083	0.112107	-0.58364	0.090522	-0.58364	0.090522



Appendix Figure 17. A simple linear regression testing whether the proportion of trim flakes predicts the proportion of cortical flakes across six time periods. Includes data only from Unit 1W.

Appendix Table 31. Summary output for the simple linear regression testing whether the proportion of trim flakes predicts the proportion of cortical flakes in each time period.

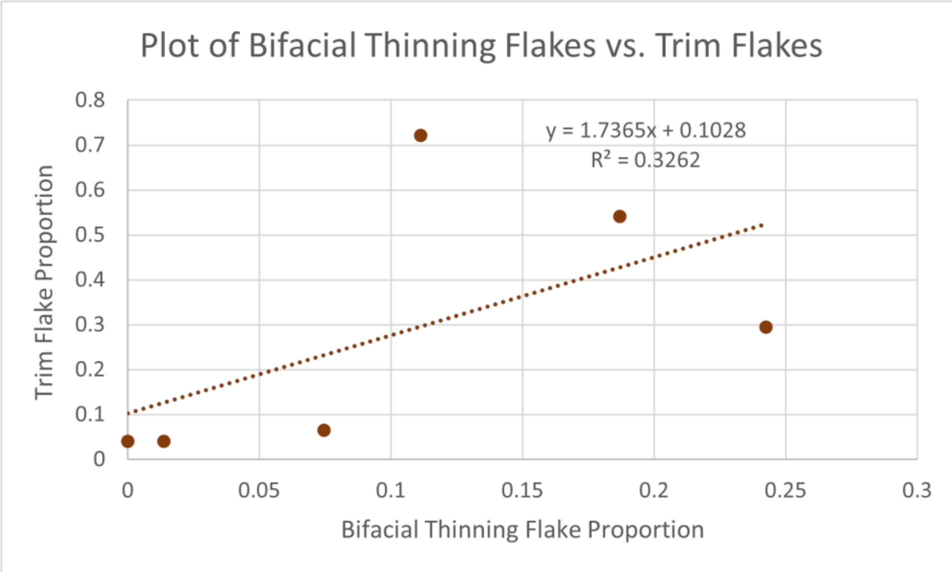
SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.772887769							
R Square	0.597355504							
Adjusted R Sq	0.49669438							
Standard Erro	0.062753301							
Observations	6							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression	1	0.023369	0.023369	5.934322	0.071513			
Residual	4	0.015752	0.003938					
Total	5	0.039121						
	Coefficients	*andard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.269742162	0.036908	7.308412	0.001864	0.167268	0.372216	0.167268	0.372216
Trim Flakes	-0.230982762	0.094819	-2.43605	0.071513	-0.49424	0.032276	-0.49424	0.032276



Appendix Figure 18. A simple linear regression testing whether the proportion of trim flakes predicts the proportion of cortical platforms across six time periods. Includes data only from Unit 1W.

Appendix Table 32. Summary output for the simple linear regression testing whether the proportion of trim flakes predicts the proportion of cortical platforms in each time period.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.869840816							
R Square	0.756623045							
Adjusted R Squar	0.695778806							
Standard Error	0.018288054							
Observations	6							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression	1	0.004159	0.004159	12.43541	0.02431			
Residual	4	0.001338	0.000334					
Total	5	0.005497						
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.114083397	0.010756	10.60634	0.000447	0.08422	0.143947	0.08422	0.143947
Trim Flakes	-0.097443973	0.027633	-3.52639	0.02431	-0.17416	-0.02072	-0.17416	-0.02072



Appendix Figure 19. A simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of trim flakes across six time periods. Includes data only from Unit 1W.

Appendix Table 33. Summary output for the simple linear regression testing whether the proportion of bifacial thinning flakes predicts the proportion of trim flakes in each time period.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.57117							
R Square	0.3262352							
Adjusted R Square	0.157794							
Standard Error	0.2673369							
Observations	6							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression	1	0.13842	0.13842	1.93679	0.236413			
Residual	4	0.285876	0.071469					
Total	5	0.424296						
	Coefficients	*andard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.1028328	0.170257	0.603984	0.578436	-0.36988	0.575543	-0.36988	0.575543
Bifacial Thinning Flakes	1.7365116	1.247775	1.391686	0.236413	-1.72787	5.200892	-1.72787	5.200892

Appendix Table 34. Average complete flake dimensions for each of six time periods. Includes data only from Unit 1W.

Time Period	12211-11488 BP	11613-10661 BP	10633-9263 BP	9247-7197 BP	7176-5959 BP	5931-5440 BP
Average Length (mm)	18.32	18.46	25.57	28.66	27.43	28.8
Average Width (mm)	5.73	11.12	22.59	25.41	23.17	27.4
Average Thickness (mm)	1.06	2.19	4.97	6.95	6.24	7.39
Average Weight (grams)	2.4	1.5	6.17	7.4	7.14	9.99

Appendix Table 35. T-test comparing average complete flake length between 7176-5959 BP and 5931-5440 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	5931-5440 BP	*7176-5959 BP*
Mean	30.25	26.68493151
Variance	229.8866906	211.7743531
Observations	140	73
Pooled Variance	223.7061774	
Hypothesized Mean Difference	0	
df	211	
t Stat	1.651066387	
P(T<=t) one-tail	0.050106289	
t Critical one-tail	1.652107286	
P(T<=t) two-tail	0.100212579	
t Critical two-tail	1.971270646	

Appendix Table 36. T-test comparing average complete flake length between 9247-7197 BP and 7176-5959 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	7176-5959 BP	*9247-7197 BP*
Mean	26.68493151	28.45378151
Variance	211.7743531	155.6397949
Observations	73	119
Pooled Variance	176.911838	
Hypothesized Mean Difference	0	
df	190	
t Stat	-0.894534009	
P(T<=t) one-tail	0.186084002	
t Critical one-tail	1.652912949	
P(T<=t) two-tail	0.372168005	
t Critical two-tail	1.972528182	

Appendix Table 37. T-test comparing average complete flake length between 10633-9263 BP and 9247-7197 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

t-Test: Two-Sample Assuming Equal Variances		
	9247-7197 BP	*10633-9263 BP*
Mean	28.45378151	25.06060606
Variance	155.6397949	150.3779783
Observations	119	132
Pooled Variance	152.8715299	
Hypothesized Mean Difference	0	
df	249	
t Stat	2.171033856	
P(T<=t) one-tail	0.015436771	
t Critical one-tail	1.650996152	
P(T<=t) two-tail	0.030873542	
t Critical two-tail	1.969536868	

Appendix Table 38. T-test comparing average complete flake length between 11613-10661 BP and 10633-9263 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

t-Test: Two-Sample Assuming Equal Variances		
	10633-9263 BP	*11613-10661 BP*
Mean	25.06060606	18.38181818
Variance	150.3779783	108.1643016
Observations	132	165
Pooled Variance	126.910036	
Hypothesized Mean Difference	0	
df	295	
t Stat	5.076920699	
P(T<=t) one-tail	3.40332E-07	
t Critical one-tail	1.650035304	
P(T<=t) two-tail	6.80664E-07	
t Critical two-tail	1.968038115	

Appendix Table 39. T-test comparing average complete flake length between 12211-11488 BP and 11613-10661 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	11613-10661 BP	*12211-11488 BP*
Mean	18.38181818	18.38888889
Variance	108.1643016	93.42810458
Observations	165	18
Pooled Variance	106.7802389	
Hypothesized Mean Difference	0	
df	181	
t Stat	-0.002756577	
P(T<=t) one-tail	0.498901804	
t Critical one-tail	1.653315758	
P(T<=t) two-tail	0.997803609	
t Critical two-tail	1.973157042	

Appendix Table 40. T-test comparing average complete flake width between 7176-5959 BP and 5931-5440 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

t-Test: Two-Sample Assuming Equal Variances		
	5931-5440 BP	*7176-5959 BP*
Mean	27.65514286	23.47534247
Variance	129.0622208	141.3249391
Observations	140	73
Pooled Variance	133.2466555	
Hypothesized Mean Difference	0	
df	211	
t Stat	2.508205004	
P(T<=t) one-tail	0.006443731	
t Critical one-tail	1.652107286	
P(T<=t) two-tail	0.012887462	
t Critical two-tail	1.971270646	

Appendix Table 41. T-test comparing average complete flake width between 9247-7197 BP and 7176-5959 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	7176-5959 BP	*9247-7197 BP*
Mean	23.47534247	25.22833333
Variance	141.3249391	143.118014
Observations	73	120
Pooled Variance	142.4420905	
Hypothesized Mean Difference	0	
df	191	
t Stat	-0.989541204	
P(T<=t) one-tail	0.161825167	
t Critical one-tail	1.652870547	
P(T<=t) two-tail	0.323650334	
t Critical two-tail	1.97246199	

Appendix Table 42. T-test comparing average complete flake width between 10633-9263 BP and 9247-7197 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

t-Test: Two-Sample Assuming Equal Variances		
	9247-7197 BP	*10633-9263 BP*
Mean	25.22833333	22.39522727
Variance	143.118014	115.1544877
Observations	120	132
Pooled Variance	128.4651262	
Hypothesized Mean Difference	0	
df	250	
t Stat	1.981743888	
P(T<=t) one-tail	0.024301605	
t Critical one-tail	1.65097149	
P(T<=t) two-tail	0.04860321	
t Critical two-tail	1.969498393	

Appendix Table 43. T-test comparing average complete flake width between 11613-10661 BP and 10633-9263 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

t-Test: Two-Sample Assuming Equal Variances		
	10633-9263 BP	*11613-10661 BP*
Mean	22.39522727	16.9686747
Variance	115.1544877	209.9954976
Observations	132	166
Pooled Variance	168.0219426	
Hypothesized Mean Difference	0	
df	296	
t Stat	3.589830076	
P(T<=t) one-tail	0.000193595	
t Critical one-tail	1.650017743	
P(T<=t) two-tail	0.000387189	
t Critical two-tail	1.968010728	

Appendix Table 44. T-test comparing average complete flake width between 12211-11488 BP and 11613-10661 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	11613-10661 BP	*12211-11488 BP*
Mean	16.9686747	15.75555556
Variance	209.9954976	55.80849673
Observations	166	18
Pooled Variance	195.5934151	
Hypothesized Mean Difference	0	
df	182	
t Stat	0.349548728	
P(T<=t) one-tail	0.363540761	
t Critical one-tail	1.653269024	
P(T<=t) two-tail	0.727081522	
t Critical two-tail	1.973084077	

Appendix Table 45. T-test comparing average complete flake thickness between 7176-5959 BP and 5931-5440 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	5931-5440 BP	*7176-5959 BP*
Mean	7.437857143	6.228767123
Variance	17.15618243	30.9198554
Observations	140	73
Pooled Variance	21.85279121	
Hypothesized Mean Difference	0	
df	211	
t Stat	1.791599053	
P(T<=t) one-tail	0.03731512	
t Critical one-tail	1.652107286	
P(T<=t) two-tail	0.074630239	
t Critical two-tail	1.971270646	

Appendix Table 46. T-test comparing average complete flake thickness between 9247-7197 BP and 7176-5959 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	7176-5959 BP	*9247-7197 BP*
Mean	6.228767123	6.979166667
Variance	30.9198554	73.12065476
Observations	73	120
Pooled Variance	57.21250003	
Hypothesized Mean Difference	0	
df	191	
t Stat	-0.668375461	
P(T<=t) one-tail	0.252350437	
t Critical one-tail	1.652870547	
P(T<=t) two-tail	0.504700874	
t Critical two-tail	1.97246199	

Appendix Table 47. T-test comparing average complete flake thickness between 10633-9263 BP and 9247-7197 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

t-Test: Two-Sample Assuming Equal Variances		
	9247-7197 BP	*10633-9263 BP*
Mean	6.979166667	4.971212121
Variance	73.12065476	18.3771802
Observations	120	132
Pooled Variance	44.43507409	
Hypothesized Mean Difference	0	
df	250	
t Stat	2.388186512	
P(T<=t) one-tail	0.008837374	
t Critical one-tail	1.65097149	
P(T<=t) two-tail	0.017674747	
t Critical two-tail	1.969498393	

Appendix Table 48. T-test comparing average complete flake thickness between 11613-10661 BP and 10633-9263 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

t-Test: Two-Sample Assuming Equal Variances		
	10633-9263 BP	*11613-10661 BP*
Mean	4.971212121	3.118072289
Variance	18.3771802	6.473247171
Observations	132	166
Pooled Variance	11.74154186	
Hypothesized Mean Difference	0	
df	296	
t Stat	4.637442132	
P(T<=t) one-tail	2.65003E-06	
t Critical one-tail	1.650017743	
P(T<=t) two-tail	5.30006E-06	
t Critical two-tail	1.968010728	

Appendix Table 49. T-test comparing average complete flake thickness between 12211-11488 BP and 11613-10661 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	11613-10661 BP	*12211-11488 BP*
Mean	3.118072289	2.932777778
Variance	6.473247171	7.615103595
Observations	166	18
Pooled Variance	6.579904089	
Hypothesized Mean Difference	0	
df	182	
t Stat	0.291094606	
P(T<=t) one-tail	0.385655218	
t Critical one-tail	1.653269024	
P(T<=t) two-tail	0.771310437	
t Critical two-tail	1.973084077	

Appendix Table 50. T-test comparing average complete flake weight between 7176-5959 BP and 5931-5440 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	5131-5440 BP	*7176-5959 BP*
Mean	9.596099291	7.884109589
Variance	166.5327654	253.096269
Observations	141	73
Pooled Variance	195.9316911	
Hypothesized Mean Difference	0	
df	212	
t Stat	0.848228585	
P(T<=t) one-tail	0.198633683	
t Critical one-tail	1.65207292	
P(T<=t) two-tail	0.397267365	
t Critical two-tail	1.971217013	

Appendix Table 51. T-test comparing average complete flake weight between 9247-7197 BP and 7176-5959 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	7176-5959 BP	*9247-7197 BP*
Mean	7.884109589	7.06446281
Variance	253.096269	93.47948825
Observations	73	121
Pooled Variance	153.335781	
Hypothesized Mean Difference	0	
df	192	
t Stat	0.446640635	
P(T<=t) one-tail	0.327818956	
t Critical one-tail	1.652828589	
P(T<=t) two-tail	0.655637912	
t Critical two-tail	1.972396491	

Appendix Table 52. T-test comparing average complete flake weight between 10633-9263 BP and 9247-7197 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	9247-7197 BP	*10633-9263 BP*
Mean	7.06446281	5.488181818
Variance	93.47948825	136.1403616
Observations	121	132
Pooled Variance	115.7447249	
Hypothesized Mean Difference	0	
df	251	
t Stat	1.16413253	
P(T<=t) one-tail	0.122737821	
t Critical one-tail	1.650947025	
P(T<=t) two-tail	0.245475642	
t Critical two-tail	1.969460227	

Appendix Table 53. T-test comparing average complete flake weight between 11613-10661 BP and 10633-9263 BP. Null hypothesis rejected; there is a statistically significant difference between the two groups.

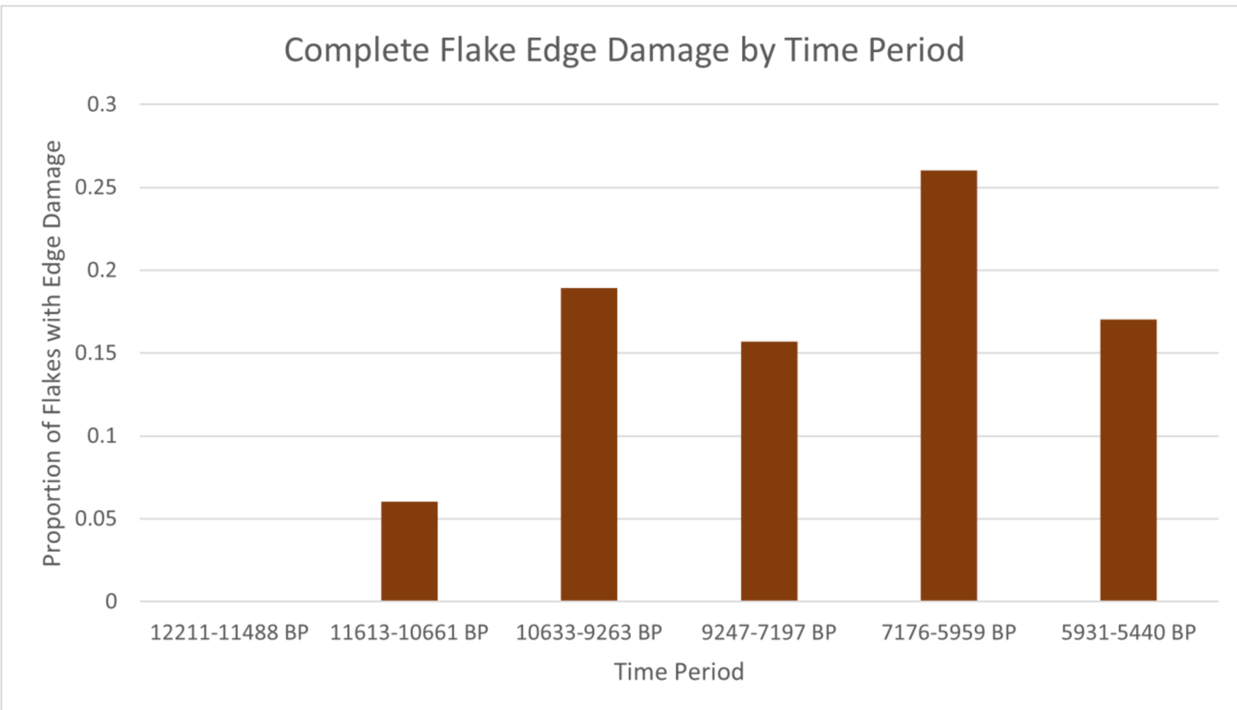
t-Test: Two-Sample Assuming Equal Variances		
	10633-9263 BP	*11613-10661 BP*
Mean	5.488181818	2.256566265
Variance	136.1403616	34.80569541
Observations	132	166
Pooled Variance	79.65313212	
Hypothesized Mean Difference	0	
df	296	
t Stat	3.104925173	
P(T<=t) one-tail	0.00104377	
t Critical one-tail	1.650017743	
P(T<=t) two-tail	0.002087541	
t Critical two-tail	1.968010728	

Appendix Table 54. T-test comparing average complete flake weight between 12211-11488 BP and 11613-10661 BP. Failed to reject null hypothesis; the difference between the means of each group was not statistically significant.

t-Test: Two-Sample Assuming Equal Variances		
	11613-10661 BP	*12211-11488 BP*
Mean	2.256566265	1.978333333
Variance	34.80569541	11.51905
Observations	166	18
Pooled Variance	32.63056919	
Hypothesized Mean Difference	0	
df	182	
t Stat	0.196280697	
P(T<=t) one-tail	0.422304731	
t Critical one-tail	1.653269024	
P(T<=t) two-tail	0.844609461	
t Critical two-tail	1.973084077	

Appendix Table 55. Complete flake count, edge-damaged flake count, and edge-damaged flakes as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

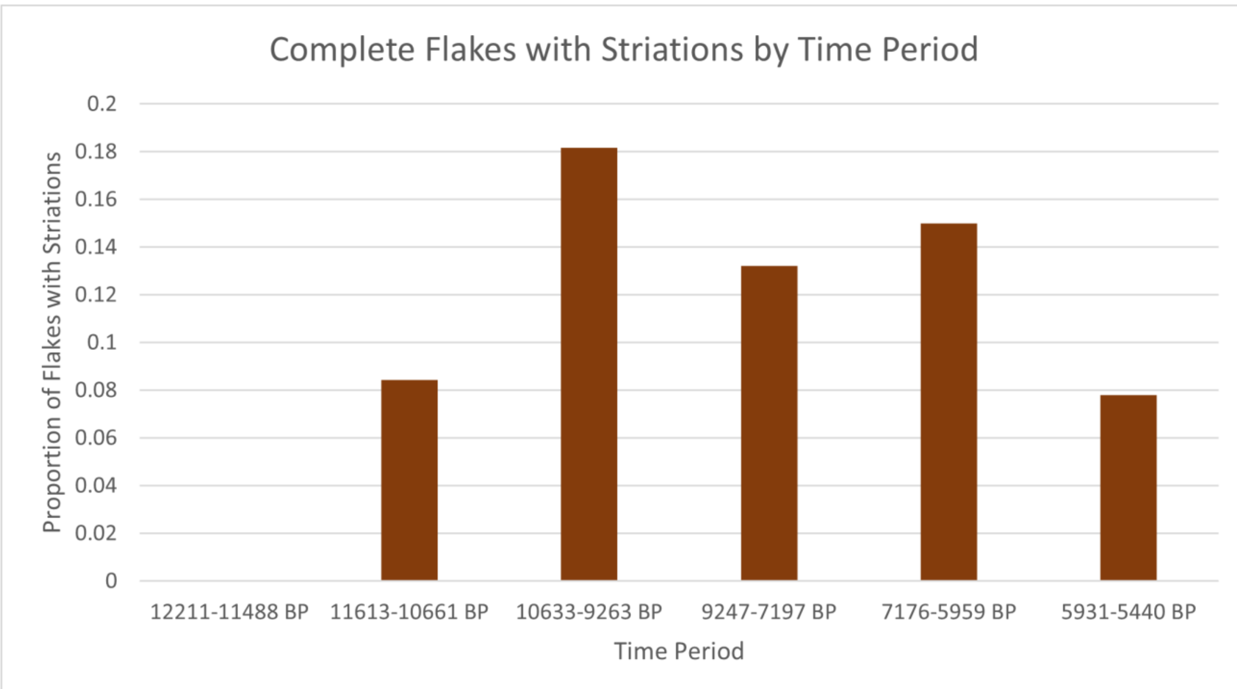
Time Period	12211-11488 BP	11613-10661 BP	10633-9263 BP	9247-7197 BP	7176-5959 BP	5931-5440 BP
Complete Flake Count	18	166	132	121	73	141
Edge Damaged Flakes	0	10	25	19	19	24
Edge Damaged Flake Proportion	0	0.060240964	0.189393939	0.157024793	0.260273973	0.170212766



Appendix Figure 20. Edge-damaged flakes as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

Appendix Table 56. Complete flake count, striated flake count, and striated flakes as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.

Time Period	12211-11488 BP	11613-10661 BP	10633-9263 BP	9247-7197 BP	7176-5959 BP	5931-5440 BP
Complete Flake Count	18	166	132	121	73	141
Striated Flakes	0	14	24	16	11	11
Striated Flake Proportion	0	0.084337349	0.181818182	0.132231405	0.15	0.078014184



Appendix Figure 21. Striated flakes as a proportion of complete flakes, by six time periods. Includes data only from Unit 1W.