

**USE-WEAR ANALYSIS OF THE CLOVIS BIFACE COLLECTION FROM THE
GAULT SITE IN CENTRAL TEXAS**

A Thesis

by

ASHLEY MICHELLE SMALLWOOD

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

December 2006

Major Subject: Anthropology

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Approved by:

Chair of Committee,	Michael Waters
Committee Members,	Harry Shafer
	John Edwards
Head of Department,	David Carlson

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ABSTRACT

Use-Wear Analysis of the Clovis Biface Collection from the Gault Site in Central Texas.

(December 2006)

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Chair of Advisory Committee: Dr. Michael R. Waters

Use-wear studies were undertaken to determine if the Clovis bifaces discovered at the Gault site in Central Texas were utilized implements or rather products of lithic raw material procurement. Those bifaces bearing microscopic traces indicative of use were studied in detail to determine the use-history of the tools. This thesis describes an experimental program aimed to build analogues for probable biface functions. A series of projectile impact studies, butchering experiments, and expedient-like tool use-activities were conducted to document the traces acquired on the tool surface from use. The experimental results are used to identify the utilized tools, demonstrate their functional purpose, and suggest the extent of tool use of the prehistoric biface assemblage.

DEDICATION

**In honor of my father
Philip R. Smallwood**

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Michael Waters, for providing me the opportunity to work with the Gault biface assemblage and the facilities to conduct my research. Further, I thank my committee member, Dr. Harry Shafer for his guidance and encouraging words throughout the process. It has been a rewarding experience working with these insightful members. I want to thank Dr. Charles Boyd and Dr. John Edwards for helping me build a strong experimental program. Their assistance was critical to the experimental component of this investigation. I appreciate Laurie Lind for her continuous support and endless optimism. I thank the Center for the Study of the First Americans and the North Star Archaeological Research Program for their funding and support. I also appreciate the help of Dr. Michael Collins at the Texas Archaeological Research Lab.

I owe a debt of gratitude to Jim Wiederhold, a scholar and a friend with the natural ability to guarantee quality craftsmanship and the learned skills to apply his talents to ethnoarchaeology. It was an honor to work with this patient man. I also want to thank Charlotte Pevny, my mentor, my friend, and my inspiration. I always knew I could do this because Charlotte would never let me forget. Love and horse guts. I thank William Dickens for chipping my experimental replicas and offering his advice as an expert lithic analyst. I am very grateful for the friendship and support of Cassady Yoder. She was a wonderful photographer in the strangest of situations.

My sister, Amber Smallwood, always sent her love with care packages and thoughtful calls. I wish to express my appreciation to Taras Pevny, Maria Parks, Katie Custer, and Eleanor Dahlin for their friendship and support. These wonderful friends have made graduate school a fun and fulfilling experience. I appreciate Robert Lassen's years of patience and support. From the beginning, he provided me with advice and laughter. I want to thank Andrew Roberts for dealing with me in all states of stress and always "being on my team." Finally, I want to thank my father for sparking an interest that would grow into a life-long pursuit. Thank you all.

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CHAPTER I

INTRODUCTION

The Gault Site

The Gault site was first recognized for its vast archaeological deposits in 1929 by University of Texas professor James E. Pearce. Pearce's excavations revealed extensive evidence of Archaic and Late Prehistoric occupations. For the next sixty years these rich cultural deposits were continually disturbed by artifact collectors. The site was revisited in 1991, when the Texas Archaeological Research Laboratory excavated several test units to assess the extent of Clovis occupation at Gault. Excavations began in 1991 under the direction of Dr. Michael Collins of TARL (Collins and Hester 1998). From 2000 to 2001, co-principal investigators Michael Waters and Harry Shafer of Texas A&M University directed excavations of an area known as the Lindsey Pit, comprised of 42 one by one meter units. These investigations have provided evidence of nearly continuous human occupation at the Gault site; representing Clovis, Folsom, Angostura, Archaic, and Late Prehistoric tool technologies. The abundant cultural material excavated from the site is a reflection of the favorable resources that attracted people to the setting for much of prehistory.

The general setting of the Gault site is the southernmost region of the Great Plains physiographic province of North America. The site setting is on the easternmost boundary of the Oak-Mesquite-Juniper Park/Woods (Frye et al. 1984). Gault is situated in the physiographic subregion known as the Lampasses Cut Plain of the Edwards

Plateau, which closely borders the Blackland Prairie to the east of the Balcones Escarpment (Amos and Gehlbach 1988). The subregion is characterized as an open-woodland of oaks, junipers, and mesquite trees and vegetation is intermixed with tall, medium, and short grasses, such as switchgrass, bluestems, and Indiangrass (Gould 1975). The Blackland Prairie to the east is almost completely absent of trees and shrubs and is dominated by a grass known as little bluestem (Risser et al. 1981). Gault's location in the Lampasses Cut Plain of the Edwards Plateau and its proximity to the Blackland Prairie place it in prime position to access the limestone uplands of the plateau and the contrasting landscape of the Blackland Prairie.

The local geographic setting of the Gault locality reflects the appeal of the site and further suggests its importance to the hunter-gatherers of prehistory. The site is located in a small wooded valley near the headwaters of Buttermilk Creek, a creek that incises the limestone bedrock of the Lampasses Cut Plain and joins Salado Creek before it eventually drains into the Brazos River (Black 2002). Buttermilk Creek cuts into the local limestone bedrock known as Edwards Limestone and Comanche Peak Limestone of the Lower Cretaceous Fredericksburg Group (Barnes 1974). This fine-grained bedrock contains abundant outcrops of high-quality chert nodules. The site's location in this protective wooded valley near a reliable water source, the diverse floral and faunal community of the ecotone habitat, and the abundant outcrops of fine-quality Edward's chert are appeals that have contributed to the formation of the rich material record found within the Clovis components at Gault.

The Texas A&M University excavation block, adjacent to the Lindsey Pit, is an excavation area located on the southern margin of Buttermilk Creek. In this block, Clovis artifacts have been collected from two distinct stratigraphic units, unit 3a (a low-energy deposit of pond clay) and unit 3b (floodplain overbank deposits) (Luchsinger 2002). The Lindsey Pit contained over 74,000 pieces of debitage and over 1300 artifacts mostly from these Clovis components. The Clovis artifacts include blades, blade cores, core tablets, end scrapers, fluted points, and bifaces in all stages of manufacture. Nearly all of these lithic artifacts are made from the local chert found at the Gault quarry. This thesis is specifically concerned with the fifty-nine bifaces and biface fragments, two performs, and four projectile points that comprise the biface assemblage recovered from the A&M excavation area. Though this excavation block is only a narrow glimpse of the entire Gault site or possible sites not yet discovered in the plateau region, the biface assemblage has proven to be a valuable research tool on which to conduct a use-wear investigation and project aspects of Clovis hunter-gatherers' subsistence behavior.

Research Objectives

This thesis details the study of the Clovis age for traces of microscopic use-wear. This study was undertaken determine if the bifaces recovered from the Lindsey Pit were utilized tools or byproducts of manufacture. This information will allow us to understand the economic activities that took place at the site. A technological analysis of the collection, defining the manufacturing sequence and failures of each biface, has been conducted by Dickens (2005). My use-wear study is an attempt to obtain a more

complete understanding of the economic activities represented after manufacture, once the biface became a functional tool. Individual use-units or areas on the bifaces that possess evidence of utilization are reported. These descriptive units are considered together in terms of their relationship to the tool's function. To interpret the microwear observed on the Clovis bifaces, experimental tools were created and used on animal carcasses. The type and frequency of microwear and its patterning are used to interpret the function of the Clovis bifaces.

CHAPTER II

HISTORICAL REVIEW

Use-Wear Studies

Use-wear analysis began with the simple yet significant observation that flint implements accrued noticeable alterations from use (Curwen 1930). Partnered with technological advances, these descriptive investigations burgeoned to include questions of stone tool functionality (Semenov 1964). Scholars began to recognize that stone tools could contribute information beyond just a formal typological approach to actual explanations of tool origins and utility. These advancements necessitated the call for more standardized methods and experimentally controlled analogues (Tringham et al. 1974; Hayden 1979; Keeley 1974; Grace 1989; Levi Sala 1996). Scholars devoted their entire careers to establishing the methodological and theoretical foundations of use-wear studies (Odell 2004). Their efforts ensured that use-wear investigations would become an accepted and essential aspect of present-day lithic analyses. Now many scholars look to use-wear studies as the systematic link between material remains and the functionally complex behaviors of prehistoric peoples. This section provides a brief overview of the development of use-wear analysis. While many scholars have contributed exhaustive historical surveys that follow the specialization from its earliest foundations to present research (Olausson 1980; Grace 1996; Odell 2001), this section focuses on the key contributions to use-wear analyses.

Semenov's seminal work *Prehistoric Technology* (1964) encouraged analysts to move beyond the typological approach established by Bordes, to systematically investigate the functionality of stone tools. Semenov suggested that striations, or microscopic grooves on the working edges of stone tools, are the most important clues to understanding unknown tool functions because they "allow us to establish the kinematics of work" (Semenov 1964:4). Semenov's analysis was conducted primarily using binocular microscopy with magnifications reaching 180x, but when necessary, he utilized a monocular microscope for high power magnifications reaching up to 300x, 500x + (Semenov 1964:22). Traces of wear were presented in micro-photographs, a technique that would become standard procedure for future use-wear analysts. His extensive experimental program authorized Semenov to make unequivocal statements concerning the conditions and variables that influence the accumulation of wear traces, as well as the kinematic patterns expected for each basic working process (Semenov 1964:17). *Prehistoric Technology* inspired a return to use-wear studies and convinced analysts that a more systematic approach was in order.

Guided by the gathering momentum of *Prehistoric Technology*, researchers were ready to apply Semenov's kinematic approach to interpret stone tool functionality. However, they recognized that applying Semenov's principles would be impractical without first investigating the fundamental properties of use-wear and establishing a standardized theoretical framework. The first Conference on Lithic Use-Wear (CLUW) dealt with these vital issues and delivered a noteworthy publication in response. Hayden's (1979) *Lithic Usewear Analysis* is a comprehensive collection of papers that

investigates the complex variables that interact to produce use-wear. A chapter on fracture mechanics clarifies the fundamentals of macroscopic use-wear traces, while a chapter on abrasion, polish, and striations provides a necessary assessment of competing polishing theories.

Although Keeley had many articles that predate the CLUW (Keeley and Newcomer 1977), he presented a synthesis of his major work in 1980. Keeley's publication *Experimental Determination of Stone Tool Uses* is a continuation of Semenov's enthusiasm for systematic methods and experimental programs. The work is a summary of the author's use-wear investigations conducted between 1972 and 1977 to assess the functionality of a collection of British Lower Paleolithic implements (Keeley 1980: xi). Keeley's most impressive microphotographs were captured by means of a binocular incident-light microscope with high optical magnification capabilities up to 400x. Like Semenov, Keeley stresses the importance of controlled experimental studies that test "a variety of uses on a variety of worked materials" (Keeley 1980:4). The author employs replicas fabricated from English chalk flint to simulate use-activities on materials such as wood, bone, meat, hide, and antler. While Semenov focused on the formation and interpretation of striations caused from use, Keeley's focus is the microwear polishes that have, according to Keeley, "distinctive appearances and are, indeed, distinguishable from one another" (1980:83). Keeley employs his distinct polish descriptions to interpret the actual material on which archaeological implements were used to gain a better understanding about ancient economics (Keeley 1974: 323). Despite the very subjective nature of his descriptions, (ie. "greasy luster" and "melted

snow” microphotography) many researchers are attracted to Keeley’s method and polish categories due to the potential detail it contributes to use-wear analyses (Keeley 1980:53-56). The author’s work gathered support for the high-power approach to use-wear analysis and spurred a polemic debate against those researchers practicing Odell’s low-power approach and those following Keeley’s own methods. Keeley’s nearly dogmatic endorsement of interpreting microwear on archaeological implements against a framework of experiments and his utilization of high magnifications under incident light microscopes are his most significant contributions to use-wear studies.

Keeley’s methodological bias for the high-power approach in use-wear studies convinced many researchers to adopt the technique. Odell, however, remained a steadfast proponent for use-wear techniques employing low-power microscopes. The author dedicates his research to reinforcing the capacity of the low-power approach and established the methodological foundations for use-wear analysts employing lower magnifications of 10x to 100x. Odell recognizes the instructive elements of macro-damage, therefore he assesses stone tool functionality by classifying the shape of flake scars, the size of scars, and the extent and distribution of scarring on the modified edge (Odell 1975:232). Odell does not accept the high-power approach as the only effective technique, and argues “there is a certain element of not seeing the forest for the trees” (Odell 1975:229-230). In response to Keeley’s and Newcomer’s article (1977) featured in *Journal of Archaeological Science*, in which they conduct blind tests to determine tool functions and contact materials, Odell strives to prove the comparable reliability of low-power investigations. The author openly criticizes the high-power approach to use-wear

analysis for the considerable cost of equipment, the excessive time expended during analysis, and the lack of versatility with raw material types other than flint (Odell and Odell-Vereecken 1980:89). His blind tests prove that the low-power approach to use-wear analysis is an effective technique and in accordance with Odell's own words, there is more than one way to skin a cat (Odell and Odell-Vereecken 1980:88).

Keeley's conclusion that different contact materials produce distinct microwear polishes was accepted uncritically by some researchers, but others such as Grace expressed fundamental doubts. Grace rejects the idea that polish is material specific and instead suggests that his model, polish development as a continuum, presents a more logical approach for microwear analysts (Grace 1989). In response to Keeley's subjective manner of describing material polishes, Grace dedicated his efforts and thesis published in B.A.R. to developing a more standardized and scientifically repeatable system of polish classification. Grace's "multi-dimensional approach to functional analysis" systematically quantifies what he considers to be the crucial variables that effect microwear polishes through the use of image processing and mathematical comparisons (Grace 1989). Grace recognizes that the assessment of use-wear should be evaluated based on the correlation of many factors, including the morphology of the working edge, the edge-damage present, the orientation of striations, and the extent and location of polish. According to Grace it is the correlation or "agreement of all the variables" that leads to accurate conclusions of tool functionality (Grace 1989). Grace's "Functional Analysis of Stone Tool expert system computer" is an impressive effort to standardize vocabulary, systematize methods, and streamline analysis time (Grace

1989). Despite the great potential, his computer system was not adopted by other use-wear analysts. Grace's efforts did, however, confirm the critical need for an overhaul in use-wear studies to more standardized methods and repeatable interpretations.

While some researchers dedicated their work to debating the crucial indicators of use-wear or to distinguishing microwear polishes produced by various contact materials, Levi Sala returned to the root of the problem to re-examine the fundamental processes responsible for polish formation. Her Ph.D dissertation *A Study of Microscopic Polish on Flint Implements* published in B.A.R. is a very noteworthy report that tackles the critical issues overlooked or merely mentioned by many analysts (Levi Sala 1996). Levi Sala approached use-wear studies with a skepticism that compelled her to reevaluate several accepted methods of research and meticulously investigate processes that may lead to misinterpretations of 'polish' (Levi Sala 1996:vii). Levi Sala's experimental program not only included an extensive investigation of the standard use-activities, but she also explored the effects of water on polish formation, the role of abrasives, and the negative effects of post-depositional processes on stone tools. The author tests the applicability of the polish mechanism promoted by Anderson (1980:184) known as the silica gel model. According to the silica gel model, during use-activities extremely high localized heat and friction combined with the presence of water cause the stone tool surface to dissolve or melt and redeposit as a solidified gel. Anderson suggests that this additive polish is a surface build-up consisting of the worked material (ie. plant, bone, antler) and the dissolved flint surface (Anderson 1980:189). Levi Sala recognized the inherent problems in this model, and through comprehensive experimentation the author

demonstrated that in the absence of water polishing still takes place. She logically points out that the high flash temperatures necessary to melt the flint surface cannot occur without first evaporating the water that supposedly promotes the reactivity and secondly charring the worked material itself (Levi Sala 1996:67). Based on evidence from her research program, Levi Sala defines polish as the product of “smoothing of the flint surface through a combination of plastic deformation and removal of disparities” (Levi Sala 1996:67). Levi Sala’s untimely death ended a promising pursuit to understand polish formation and the effects of post-depositional processes on stone artifacts. However, her work remains a stimulating testament of the importance of controlled experimentation in the future of use-wear studies.

Use-Wear Studies on Clovis Projectile Points

The function and use-life of fluted projectile points is often assumed by researchers, but has rarely been confirmed with microscopic use-wear analysis. To date, only two use-wear studies have been conducted on Clovis projectile point assemblages.

Kay (1996) completed a high-power microscopic analysis of the four Clovis projectile points recovered from the Colby site, a mammoth kill and butchery site in Wyoming. Kay compares wear traces on the Colby points with two replicas utilized in killing and butchering experiments conducted by George Frison on wounded African elephants in Zimbabwe. With the experimental results as his foundation, Kay describes the diagnostic projectile wear patterns on two of the Colby points and evidence of point recycling and heavy-duty butchering on the remaining two specimens. Kay admits to

the drawbacks of small sample sizes in both experimental and archaeological assemblages, but assures a carefully controlled sample can provide valuable results. Further, the nature of the experimental program made it impossible for Kay to microscopically photo-document locations on the replica tool surface prior to use. His analysis, however, remains an informative study of the tool functionality of Clovis projectile points.

Hudler (2003: 263) reports the use-wear analysis of selected artifacts from the Pavo Real Site, a Paleoindian and Archaic camp and workshop in south-central Texas. The study analyzes a total nine Clovis bifaces, one of which is a projectile point preform fragment. One biface fragment acquired possible evidence of use as a tool, but according to Hudler, the evidence is questionable. The only other potential utilized tool is a bifacially modified flake fragment that seems to have been utilized on a moderately hard material; the author suggests the contact material was an animal product. Hudler does not have his own experimental program as a basis, but refers to the work of other researchers for analogues. This descriptive analysis serves as a necessary exercise, but unfortunately does not provide any microscopic evidence for understanding Clovis projectile point functionality.

Consequently, there is the potential and need for a more comprehensive use-wear analysis, and the assemblage recovered from the Lindsey Pit at the Gault site offers the critical opportunity to investigate tool functionality on a large assemblage of Clovis bifacial tools.

CHAPTER III

METHODS

This chapter is an explanation of the indicators used to assess use-wear evidence, the cleaning procedures applied to the replicas and artifacts, the equipment utilized in the examination, and the approach taken for the microscopic analysis.

Use-Wear Criteria

All functional interpretations in this study are based on the evaluation of three key variables of use-wear traces. The first criterion is the type of wear that altered the tool's surface such as polish, linear indicators including polish streaks and striations, and microflaking. The second use-wear criterion is an assessment of the intensity of the polish traces on the stone surface, this is based on Grace's (1989: Figure 55) schematic model of polish development. Then the wear type and intensity are considered for the final use-wear criterion, the kinematic relationship between the tool and the contact material.

Wear Types

Each of these wear types has a very distinct formation process and therefore illustrates different mechanisms affecting the stone surface. The wear types used to determine if an artifact is a utilized tool are as follows:

1. Polish: Levi Sala's (1996) explanation of the mechanism of polish to be the most applicable to what was observed on the experimental replicas and the Gault biface collection. Polishing is referred to in this investigation as a shape-altering and smoothing of the chert surface through the combination of tensile stress and the mechanical removal of asperities on the microtopography. Therefore, anything that can be removed from a tool's surface by cleaning is not by any means the product of polishing.
2. Linear indicator: This term generally refers to any microscopic evidence of motion on a tool's surface. These traces reveal an implement's use-trajectory and serve as signatures of different tool functions. Linear indicators have been identified in the form of linearly distributed polish streaks and striations. A polish streak is a linearly constricted area on the tool's surface that has been polished. A streak's orientation to the center axis, may it be perpendicular to or parallel with the center axis, is an indication of a tool's use-trajectory. Striations are microscopic furrows incised in the tool's surface (Ahler 1979:314). As a stone tool contacts the worked material chert particles are dislodged from the tool's microtopography and are moved along the tool's own surface creating microscopic furrows or striations indicative of the use-trajectory. In some instances, the dislodged chert particle is pushed across the stone surface to form a polished furrow and remains embedded in the tool's surface at the end of that furrow. Levi Sala (1996:68) refers to this form of striation as a "comet tail pit" and suggests that their formation illustrates one mechanism of polishing. According to Semenov (1964) the orientation of striations helps establish the

kinematics of the tool's work. Based on experimentation Kay (1996) recognizes distinct striation directional trends for projectile usage and butchering, among other tasks. According to his observations, striations that are oriented parallel to the long-axis indicate impact and those perpendicular or oblique to the long-axis indicate a cutting motion. The experimental program in this thesis has also produced the same striation patterns and further confirms that striation orientation is an indicator of a tool's use-trajectory.

3. Microflaking: The removal or chipping of microscopic stone flakes that result in negative flake scars on the stone's surface. Microflaking can be an intentional modification to prepare a tool edge for manufacture or the unintentional result of tool use (Ahler 1979: 305).

Polish Intensity

The second criterion is a measure of polish as evidence of a tool's utilization. The intensity of polish on a tool's surface is based on a model which ranks polish development with designations from least polished A to the most developed wear denoted as category D (Grace 1989: Figure 55). An A designation refers to polish elements that are clearly isolated from one another on the stone surface, while A+ represents a polish that has larger polish elements but these elements are not yet linking up. Polish elements are linked in Grace's category B polish, but the majority of the tool surface remains unpolished. A B+ polish has more linked up polish elements to create a 1:1 ratio of polish to unpolished surfaces on the tool. A tool with a category C polish

has developed a polish that is clearly linked up and the tool's surface is almost completely covered by that polish. Finally, Grace's category D represents a tool that has developed a polish that is linearly distributed on the stone surface. This polish development model is applied to interpret both the general distribution of wear on the entire tool, as well as different degrees of wear intensity in distinct regions on the tool's surface. For instance, if the left lateral edge of a biface has acquired a category D polish while the right lateral has a category A polish intensity, this indicates that the tool's left lateral surface came in contact with a worked material more often than the right lateral edge.

Kinematic Relationship

A tool's wear type and polish intensity are then considered in terms of the kinematic relationship between the tool and the contact material. The distribution of wear elements and the intensity of these elements are strong indications of the tool's use-activity. According to Ahler (1979:316) wear patterns differentially distribute along with the tool's relative motion or use-trajectory. This investigation applies Ahler's categories of wear pattern distributions to directly assess the kinematic relationship of the biface to the worked material and indirectly determine the tool's function.

According to Ahler's model, a tool with a random distribution of wear traces does not have any distinct patterns of wear and the degree or intensity of wear is consistent on the entire tool. Longitudinal asymmetry indicates that the tool has an increased number of wear elements or an increased wear intensity in areas that are distributed parallel to a

long axis of the tool. This pattern illustrates the use-trajectory of the tool in relation to the contact material, may it be parallel or perpendicular to the tool's center axis. A tool with a facial asymmetry has an observable difference in wear intensity or frequency from one tool face relative to the opposite face. Bilateral asymmetry refers to a tool with increased wear frequency or intensity on one half of the tool, either left or right of the center axis, and often indicates the edge that has preformed the most work. A tool with marginal asymmetry exhibits a change in wear intensity or frequency with respect to propinquity to the tool edge. This distribution can represent an activity that focuses work directly on the tool edge or maintains an angle that causes wear off the edge.

Cleaning Procedures

The cleaning of stone tools for microscopic examination is a methodological issue that has not been fully resolved and standardized among use-wear analysts. Keeley (1980:10-12) recommends that all specimens, especially experimental specimens, should be chemically cleaned in the laboratory prior to examination. His procedure entails wiping specimens with white spirits or methylated spirits. This is followed by gently rubbing, and in some cases soaking, stone tools in a solution of hot water and ammonia-based household detergent. The specimen is then immersed in solutions of HCl and NaOH to remove any extraneous mineral and organic deposits that remain on the surface of the stone tool. Finally, Keeley (1980:10-12) suggests that if an archaeological specimen exhibits mineral deposits despite the previous cleaning methods, a hot solution of HCl can be poured directly on the pre-warmed implement. In reaction to Keeley's

publication, many researchers have investigated the cleaning methods necessary for microscopic analysis and have indicated the critical need for another approach. While Keeley's method is thorough, many analysts have criticized the use of caustic chemical detergents due to harsh effects on stone tool surfaces. Grace (1989) and Levi Sala (1996:18) found biological cleaning agents efficiently removed extraneous deposits without altering polished surfaces. Levi Sala (1996:18) conducted a cleaning investigation that initially treated tools with biological detergent then immersed the same pieces into the NaOH solution suggested by the Keeley method. She discovered no visible changes caused by the NaOH treatment and determined the biological detergent the effective cleaner and the NaOH treatment to be an unnecessary technique. She further cautions that alkaline solutions can even lead to patination on stone tool surfaces. Kay (1996:321; 1998:746) strongly advises against the use of potentially destructive chemical cleaning agents on archaeological specimens, and instead, advocates a milder treatment of occasionally wiping pieces with methyl alcohol. The work of several researchers (Briuer 1976; Shafer and Holloway 1979; Hyland et al. 1990) indicates that certain environmental and post-depositional conditions provide an adequate environment for the preservation of plant and animal residues on lithic artifacts. Organic residues can potentially disclose a tool's contact material and lead to more accurate interpretations of the uses for the prehistoric tools.

In agreement with Kay's methodologies, the Gault bifaces were not subjected to potentially harmful chemical detergents, but instead were thoroughly wiped with alcohol

via a cotton ball (Kay 1996:321; 1998:746). This treatment was carried out regularly throughout the analysis, especially after handling the artifact.

For the experimental replicas more thorough cleaning procedures were necessary. All bifaces and points were subjected to an initial phase of cleaning, referred to as Phase 1. Phase 1 cleaning entailed a gentle washing with water and a mild detergent. Prior to microscopic analysis the tools were also wiped with a cotton ball soaked in alcohol. Alcohol is a safe cleaner that adequately removed hand oils unintentionally added during analysis. After the Phase 1 cleaning, the replicas' surfaces were photo-documented to record use-wear traces or the distribution of any residues on the tools' surface. If a residue, usually in the form of animal grease, was present on an experimental tool the specimen was subjected to additional cleaning. For the second phase of cleaning the tool's surface was washed with an emulsifying detergent and warm water. The emulsifier chosen is a biological ammonia-free detergent with solvents to absorb more grease than common detergents without negatively affecting the crypto-crystalline surface of the tools. Once residues were removed the replicas were re-analyzed and photo-documented for use-wear traces.

Equipment

All specimens, the Gault biface collection and experimental pieces, were analyzed and recorded at macroscopic and microscopic levels. Each of the bifaces was photographed using a Canon EOS Digital Rebel camera. Smaller bifaces required that

the camera was fitted with a Sigma APO Macro 180mm f/3.5 EX lens, while a Canon EFS 18-55mm f/3.5-5.6 EX lens was used to photograph the larger bifaces.

Use-wear analyses were conducted using two Leica microscopes with magnifications representative of both the “low-power” and “high-power” approaches. The “low-power” use-wear investigation was carried out with a motorized Leica MZ 12.5 stereomicroscope equipped with a 1.6x objective and 10x oculars. The motorized coarse and fine grained adjustments provided me with images ranging from 12.8x to 100.8x magnifications. Illumination was provided by a KL 1500 LCD cold light source with flexible glass-fiber light guides with continuous electronic and mechanical dimming.

The “high-power” analysis was conducted on a Leica DMLA compound microscope with magnifications of 100x, 200x, and 500x. This microscope offered automated functions that change objectives, adjust illumination, focus, and control xy axis stage movement.

Images were captured using a CoolSNAP-Pro digital kit from Media Cybernetics with fast digital preview speed of 20 MHz digitization. This camera could be attached to both the stereoscopic and compound microscopes. The images viewed with the Cool SNAP-Pro camera were directly acquired with Image Pro and In-focus 1-60 software. This software was equipped with a Scope-Pro plug-in that allowed me to view a specimen on the computer screen rather than always placing my eyes to the oculars. More importantly, this digital setup allowed for a more comprehensive view of the specimens' microtopography with a remarkable depth of field. This software allows the

analyst to determine the vertical distance by focusing and setting the camera on the lowest then highest points of the desired microtopography. Then based on this vertical distance, the analyst chooses the number of images to be taken within the limits. After the images are captured they are played back in a sequence on the computer screen. The sequence of partially in-focus images is then stacked to become a single clear, sharp image with an extended depth of field. Images taken with this software allow the analyst to capture wear traces in a realistic context. A single photo can convey changes in color, surface reflection, and texture along an artifact's edge to demonstrate to the reader the intensity of polish development. The speed and efficiency of this digital software captured images from several locations on each artifact and helped to build a thorough use-wear investigation of the Gault bifaces.

Biface Selection for Use-wear Analysis

The principal goal for the analysis of the Gault biface collection was to identify which, if any of the bifaces demonstrated evidence of wear from use. The bifaces were studied by Dickens (2005) to establish material type, tool morphology, and manufacturing techniques. The use-wear study was carried out with a two-fold approach, a low-power analysis of all 65 bifaces and biface fragments followed by a high-power analysis of a narrowed sample.

First, each biface in its entirety was thoroughly scanned at low power magnifications under the stereoscopic microscope. Break patterns and optically bright areas were documented. The areas that assessed to be possible evidence of use were

photo-documented and locations were recorded on detailed drawings. After all of the 65 bifaces were analyzed at low power, the images were assessed for the need of further analysis. Specimens that exhibited possible areas of use formed a subsample of 17 bifaces. Each biface in this subsample was reexamined utilizing the compound microscope. In this re-examination process the high power analysis was not limited to the previously identified areas of possible use. This precaution was taken to ensure that all wear traces were identified. All evidence was photo-documented at magnifications of 100X, 200X, and 500X. Any areas of use that were discovered at high power magnifications but not originally documented on the stereoscope were returned to for lower magnification photos to complete the sequence of images.

CHAPTER IV

EXPERIMENTAL PROGRAM

Methods for Experimental Analogues

Building applicable analogues with experimental replicas is an essential element of a use-wear study on archaeological specimens. Experiments were designed to simulate functionally diagnostic wear traces similar to those observed on the Gault biface collection and gain an understanding of the extent of use required to create such wear traces.

Eight experimental stone tools were chipped from chert collected near Ft. Hood, Texas. Two of these replicas were larger bifaces left in early stages of manufacture and the remaining six replicas were crafted into finished Clovis projectile points. Before use, the metric attributes of the tools were recorded (see Table 1 below).

Table 1. Experimental biface and foreshaft metric data. Measurements in centimeters.

Biface #	Biface Metric Data			Fore-shaft Metric Data Fore-shaft #	Length	Diameter	Total Length of Point and Fore-shaft
	Length	Width	Thick-ness				
BUR4	14.1	10.2	2.5	n/a			
BUR8	15.0	9	2.5	n/a			
BUR17	8.8	3.1	0.3	FO3	23.0	2.4	27.6
BUR18	9.0	3.1	0.3	FO2	21.4	2.5	27.3
BUR19	7.5	3.2	0.3	FO4	15.5	2.4	22.0
BUR20	9.9	3.7	0.3	FO1	22.5	2.4	28.0
BUR21	8.0	3.5	0.3	FA2	14.2	2.3	19.3
BUR24	10.1	3.5	0.3	FA1	21.8	2.0	26.2

Documentation of the experimental specimens was designed to be consistent with procedures utilized on the Gault bifaces. All experimental points were photographed to capture the original tool morphology. The points were analyzed under the compound microscope to note any irregularities on the point prior to use. Areas of potential use were identified based on pre-determined tool function, tool morphology, and flake removals. These areas included flake scars with protruding arises and/or higher surfaces on lateral edges and point faces. Microscopic images of these areas of potential use were captured at each point's tip, lateral edges, and base. The compound images recorded the original texture of the material and microflaking patterns created with manufacture. The areas of potential use were also documented on the low power stereoscopic microscope to record macroscopic flake patterns and material characteristics. These images would serve as the necessary "before" photos for later comparisons after use.

Projectile Impact Study

The goals of the impact experiments and analysis were first to confirm that there exist characteristic wear patterns indicative of projectile impact. The second concern was to monitor the development of such wear traces. Replica points BUR17, BUR18, BUR20, BUR21, and BUR24 were chosen to investigate the wear patterns created by projectile impact with animal hide, tissue, and bone. The equipment and activity were modeled after the methods described by Huckell (1982), therefore the focus of the impact experiments was to create impact wear caused by thrusting spears into large

animals. In each experimental series a given projectile point only performed one thrust into the animal. This method was employed to assess the development of wear patterns with each stabbing. Locations on the stone tool surface were photo-documented prior to experimentation and relocated after each series to assess if any wear had developed from the round of impact. All of the points remained hafted to a foreshaft during analysis in order to be equipped for the subsequent impact experiments.

Building Experimental Analogues for Projectile Impact Study

Five foreshafts were crafted out of post-oak saplings and deer antler (Table 1). The three foreshafts crafted from the oak saplings FO1, FO2, and FO3 were debarked and rounded (Figure1, Figure 2, Figure3). A custom cut wedged section with a depth of 3.5- 4.0 cm was removed from one foreshaft end and fitted to tightly hold its specified projectile point. The opposite ends of the oak foreshafts were crafted with of a rounded tapered end measuring 8-10 cm in length and 1 cm in diameter. This thin taper ended with an abrupt return to the maximum foreshaft diameter of 2.4- 2.5 cm. This created a shoulder that would allow thrusting force to be absorbed into the mainshaft and divert tension away from the foreshaft. Asphaltum was the chosen glue for FO1, FO2, and FO3. Hot asphaltum was dripped into the wedge haft and the heated points were placed and secured in their intended position. Any holes between the point and wedge were filled in with additional asphaltum to make certain that the point would not move in the haft. The mounted points were then bound into the foreshafts with a layer of sinew dipped in a thin solution of hide glue and water.

Two of the foreshafts were crafted from deer antler tine to observe haft wear caused by a point's movement in and contact with the foreshaft (Figure 4, Figure 5). Two portions of deer antler were chosen to be crafted into foreshafts FA1 and FA2, but one of these tines (FA1) required altering before use. The natural tapered end of the tine suggested its potential use as a foreshaft, in that it was pre-designed to fit into a mainshaft, but the overall curve of the tine would obviously be ineffective for thrusting. In order to use the curved antler tine as an efficient foreshaft, the antler needed to be straightened. Many studies (Semenov 1964:199) indicate that boiling makes antler easier to cut. These results indirectly suggested that boiling may also make antler more conducive to shaping and straightening. FA1 was submerged into boiling water for 1 to 1.5 hours. After this treatment, force was applied and the tine was straightened to become a serviceable foreshaft. The cut end of FA1 was sanded down to create a bevel that would fit into the flute of its specified projectile point. To further ensure that the point would stay secure to the beveled foreshaft, a thin shim of antler measuring 11 cm in length and 2 cm in width was created and bound to the foreshaft with sinew to hold the point. The two pieces tapered together smoothly and were bound entirely.



Figure 1. Experimental Point BUR17 in Foreshaft (scale: 3:4).



Figure 2. Experimental Point BUR18 in Foreshaft (scale: 3:4).



Figure 3. Experimental Point BUR20 in Foreshaft (scale: 3:4).

The shorter antler foreshaft, FA2, was designed to mount the point slightly different. Instead of a beveled rod design used in FA1, this foreshaft was designed similar to the wooden foreshafts. A custom fit wedge was cut into one end of the antler so that the point could be tightly mounted in the haft. The end section of the tine measuring 5.8 cm was rounded and ground down to a maximum diameter of 1 cm. This taper led up to a shoulder where the tine resumed its original 2.5 cm diameter and continued to the wedge up to a shoulder where the tine resumed its original 2.5 cm diameter and continued to the wedge that held the point. Hide glue was the chosen mastic to secure the points in hafts FA1 and FA2. A thicker solution of hide glue and water was heated and brushed on the surface of the antler foreshaft and into the flute of the points. The points were mounted in place and then bound securely to the foreshafts with sinew dipped in a thin solution of hide glue and water.



Figure 4. Experimental Point BUR21 in Foreshaft (scale: 3:4).



Figure 5. Experimental Point BUR24 in Foreshaft (scale: 3:4).

Three mainshafts were crafted from a post oak, a slash pine, and a bois d'arc sapling (see Table 2 below). First, the saplings were cut to serviceable lengths, debarked and dethorned to become mainshafts. A tapered hole was then drilled into the center of the cut end of each shaft. The holes were custom fit so the taper tightly held the foreshafts. The oak mainshaft was designed to accept BUR20 mounted in FO1 and BUR18 mounted in FO2. The pine mainshaft was crafted to accommodate BUR17 held by FO3. Finally the bois d'arc mainshaft was tapered to fit BUR 24 mounted in FA1 and BUR 21 mounted in FA2. The hollowed, tapered portion of the mainshaft was thinned down to create space for a single layer of sinew and softened raw hide binding, with the exception of the bois d'arc mainshaft that was only wrapped with a single layer of sinew. The area where the mainshafts met the foreshafts was carefully thinned and shaped so that the foreshafts led smoothly into the mainshafts. This precaution was taken in order to ensure that penetration would not stop abruptly at this juncture.

Table 2. Experimental mainshaft metric data. Measurements taken in centimeters.

Mainshaft Material	Length	Maximum Diameter	Points Fitted for Mainshaft
Boisd'arc	175.5	2.2	BUR21 and BUR24
Oak	159.0	4.5	BUR20 and BUR18
Pine	185.0	4.8	BUR17

The series of impact experiments were conducted on deceased horses donated for research purposes. The dead animals were laid on their sides with the chest facing the researchers and the ribcage exposed. A ladder allowed the individual thrusting the spears the height above and enough distance from the animal to aim and apply force to the thrust. For each thrust, the mainshaft was held to ensure that the lateral edges of the point were oriented where the narrowest axis entered the animal. This orientation allowed the point to slip between the ribs and penetrate the heart or lungs. In each series, the individual replica points penetrated the animal with only a single thrust, in-and-out once. The first series of experiments were conducted on a deceased 7 years old female horse weighing 517.1 kg (1140 lbs.). The second series of the projectile impact experiments were performed on a gelding weighing approximately 362.87 kg. (800 lbs.). The third and final series of the experimental impact study was conducted on a 10 year old mare weighing 381.02 kg (840 lbs).

Projectile Impact Study Results

Experimental Point BUR21

Series 1

BUR21, designed to fit the bois d'arc mainshaft, performed very well and successfully penetrated the heart of the animal. The small antler foreshaft FA2 and thin bois d'arc mainshaft both penetrated into the animal with a total depth of 28.2 cm. The

small diameter of the mainshaft (2.2 cm) enabled the implement to continue penetrating the carcass beyond the previously troublesome mainshaft-foreshaft joint. When the spear was pulled out of the carcass the antler foreshaft remained lodged in the animal and could only be recovered after the horse was disarticulated. BUR21 was not damaged from impact and was utilized in the next impact series.

BUR21 exhibited a polish distribution distinctive of its use as a projectile. Use-wear evidence was recorded at the predetermined location 1, as well as a new use-unit referred to as location 2. The natural upward cline that initiates at the tip of the experimental point places location 1 on the raised face of the first longitudinally-oriented aris. The higher location was abrasively polished from impact while the lower locations within flake scars maintain the point's original texture (Figure 6: 1-200x before; 1-200x after series 1). The tip of BUR21 was an upward facing facet, with a plane flat enough to view and photo-document the extreme distal end without removing the point from the foreshaft. This facet was abrasively polished and rounded by the single thrust (Figure 7: 2-100x after series 1; 2-200x after series 1; 2-500x after series 1). The polish was longitudinally distributed along the center axis, beginning at the point's tip and grading off into a diffuse polish at approximately 3.5 cm from the tip (Figure 6: 3-200x after series 1).

Series 2

In the second series BUR21 directly hit the seventh rib in the anterior portion of the animal. The direct impact with the rib caused the foreshaft to break at its juncture

with the mainshaft, but did not break the point itself. BUR21 only penetrated 8 cm to pierce the hide before shattering rib bone. The impact rendered this point too damaged for further use.

After Series 2, location 1 was modified by the use-activity and a new area of use referred to as location 3 was detected. The direct impact with bone removed an upward facing facet on the point's tip leaving the area rounded. Evidence of wear was most apparent from the newly rounded tip back along the center axis of the point. After the first series, location 1 exhibited polished surfaces only in the distal-most portion of the aris after the first series. After Series 2, the entire ridge was texturally altered (Figure 6: 1-200x after series 2). BUR21 also exhibited wear on the ventral face of the point. Location 3, a ridge where two lateral flake scars meet at the point's center axis, was polished and left with fewer asperities on the ridge's microtopography (Figure 6: 3-500x after series 2). BUR21 did exhibit isolated use-units of ephemeral polish on the lateral edges, but the strongest patterns of use-wear traces were concentrated along the center axis.

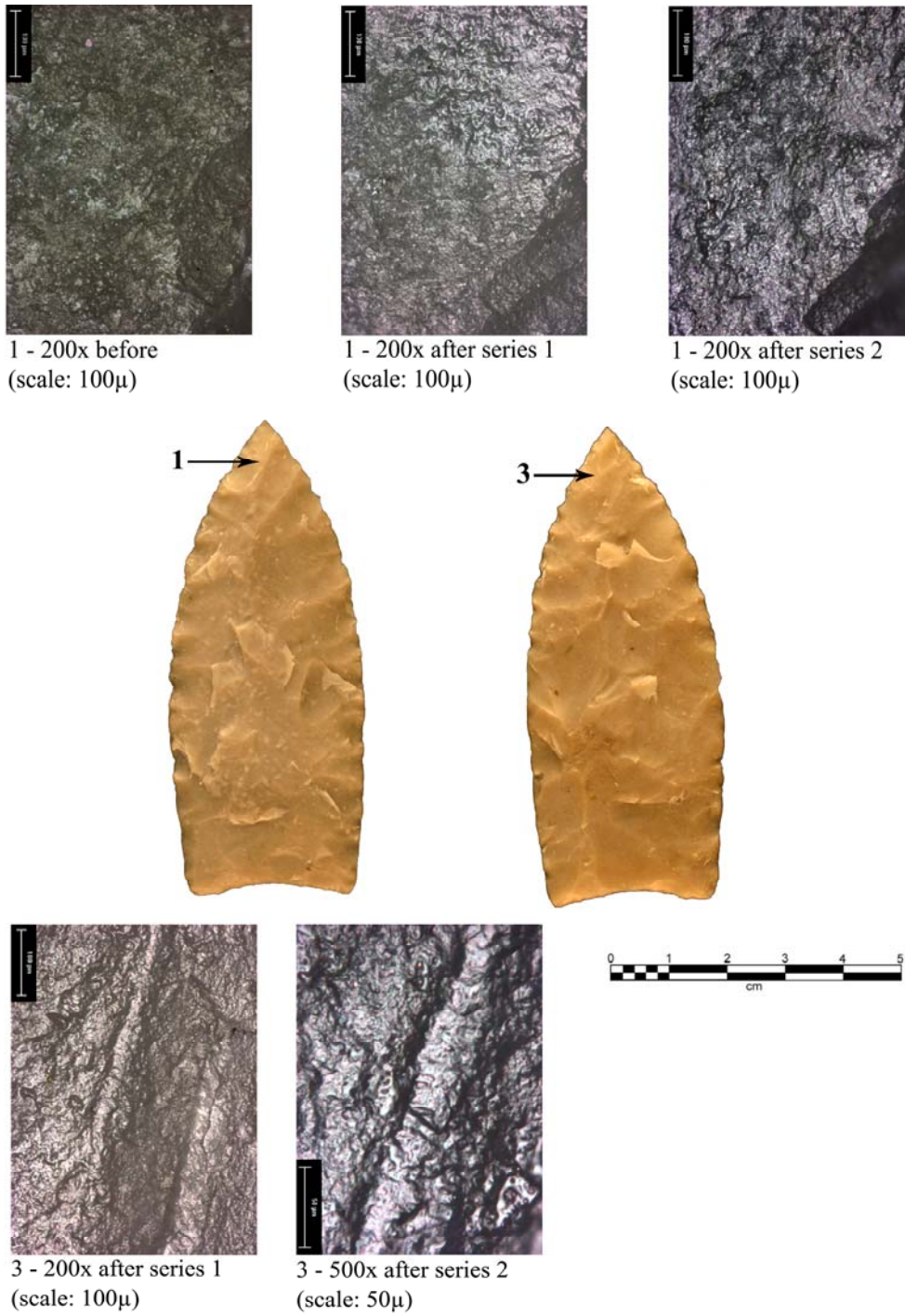


Figure 6. Experimental Point BUR21 Projectile Impact Study Plate 1 of 2.

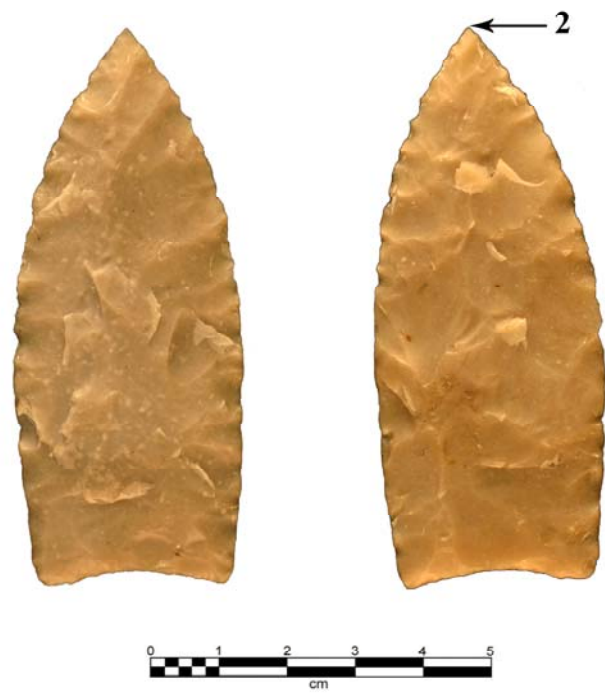
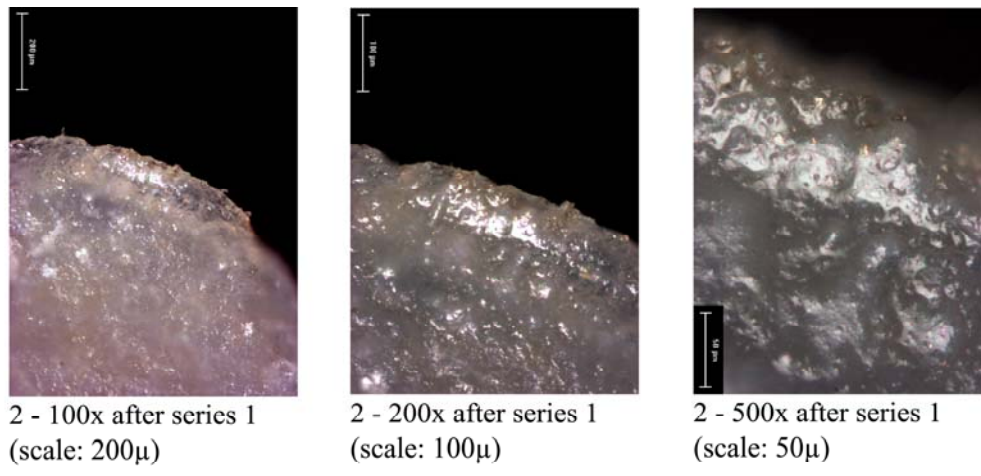


Figure 7. Experimental Point BUR21 Projectile Impact Study Plate 2 of 2.

Experimental Point BUR18

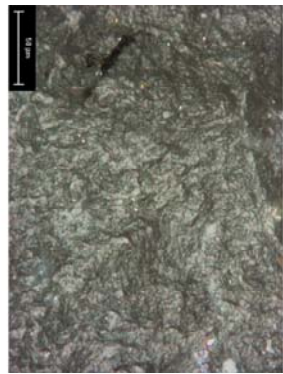
Series 1

In the first impact series BUR18, attached to the oak foreshaft, followed the same trajectory as BUR21 and entered the wound created by the previous impact. BUR18 penetrated the animal, but was slowed down by the diameter change at the mainshaft-foreshaft joint and blocked by the lodged antler foreshaft of BUR21. A snap fracture removed the extreme tip (approximately 1 cm) of BUR18. This damage was caused by the point's direct impact with the lodged foreshaft fitted to BUR21. The damage was only slight, consequently BUR18 was not reconditioned and utilized "as is" in the next impact series. BUR18 lost approximately 0.5 cm of the distal end from its impact with the lodged BUR21. Other than the macrodamage of the snap fracture at the point's tip, no indications of polishing and linear indicators were observed on BUR18 (Hayden 1979:134).

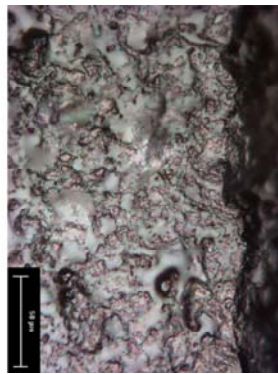
Series 2

In Series 2 BUR18 was thrust 1 cm anterior of the rib wound caused by BUR21. This point penetrated 28 cm to puncture hide and muscle before getting tightly wedged between the sixth and seventh anterior rib bones. BUR18 and its foreshaft were recovered from the animal and the point remained functional for the next impact experiment.

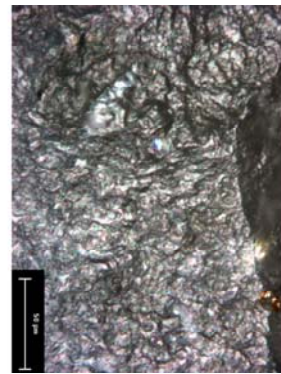
After Series 2, BUR18 acquired traces of wear at the predetermined location 1, and a new use-unit at an area called location 2. An additional location, referred to as



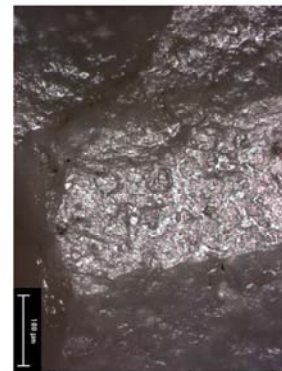
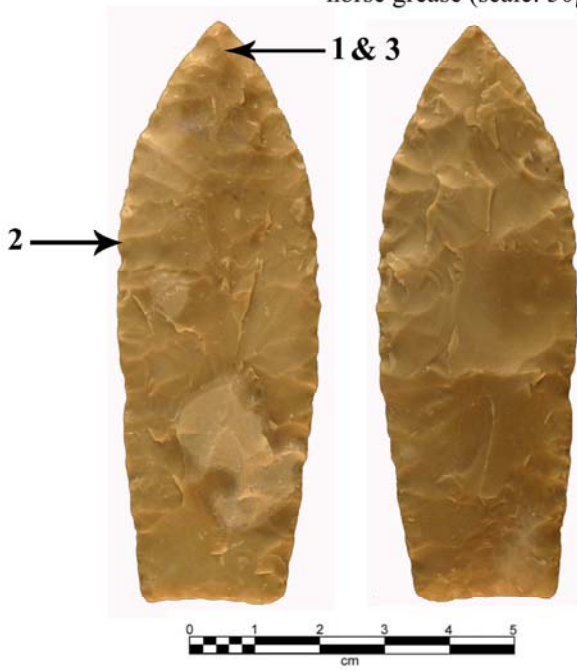
1 - 500x before (scale: 50µ)



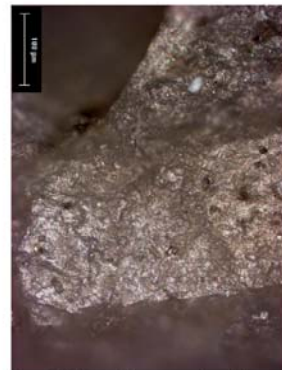
1 - 500x after series 2 with horse grease (scale: 50µ)



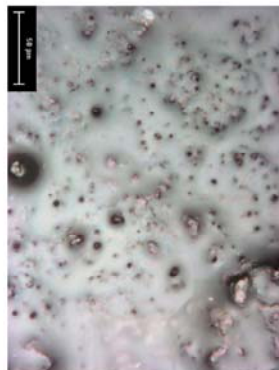
1 - 500x after series 2 phase 2 cleaning (scale: 50µ)



2 - 200x after series 2 with horse grease (scale: 100µ)

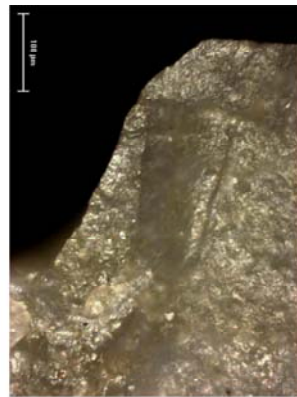


2 - 200x after series 2 phase 2 cleaning (scale: 100µ)

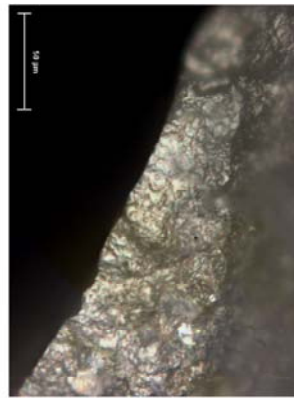


3 - 500x horse grease on surface (scale: 50µ)

Figure 8. Experimental Point BUR18 Projectile Impact Study Plate 1 of 2.



4 - 200x after series 3 and phase 2 cleaning (scale: 100 μ)



4 - 500x after series 3 and phase 2 cleaning (scale: 50 μ)

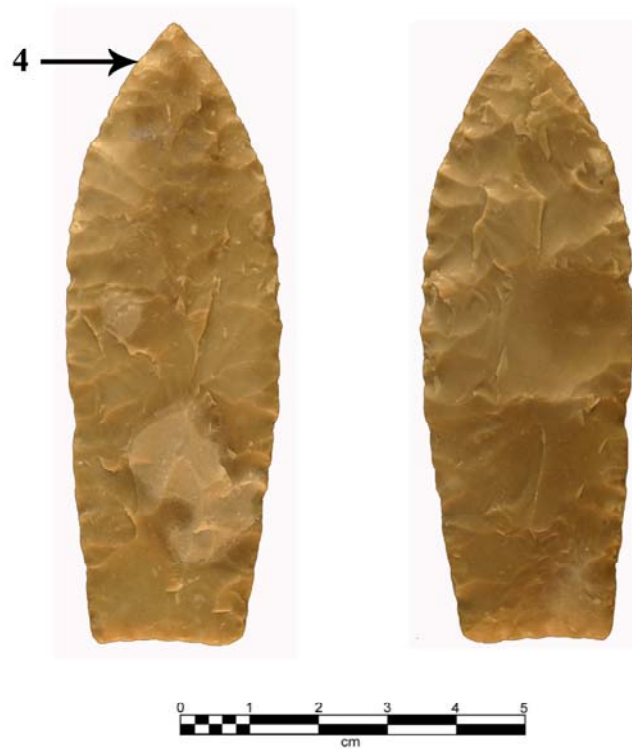


Figure 9. Experimental Point BUR 18 Projectile Impact Study Plate 2 of 2.

location 3, obtained a residue that was recorded. Ephemeral and isolated polish units on the lateral edges began to fade slightly inland towards the center axis and regained intensity at the center ridge of the tool. As mentioned above, BUR18 did not obtain use-wear traces after Series 1, but with Series 2 the point developed substantial evidence of impact. This was most likely due to BUR18's impact trajectory that sent the point sliding between two ribs and left it tightly wedged in the animal.

It was immediately apparent that a thorough cleaning was critical for analysis. With the first examination BUR18 appeared to have obtained the most highly-developed, "linked up" polish yet seen (Figure 8: 3–500x horse grease on surface). This "polish" appeared to be thickly laid over the surface of both high and low faces and stuck up under step fractures of the point. The point itself had a shine that was visible even without the aid of the microscope. As the analysis progressed and the piece was cleaned with alcohol, the highly-developed "polish" was determined to be a layer of horse grease that was not removed by the standard cleaning. An additional phase of cleaning was conducted for the following reasons:

1. Any substance on the surface that can be removed by cleaning is not a true polish but a residue left behind on the surface.
2. The residue required removal because the reflectivity of the residue refracted light to negatively affect the camera's capabilities to capture microscopic images.

The predetermined locations, recorded before use, on BUR18 were photo-documented prior to the additional cleaning to plot the general distribution of the animal grease. This exercise helped establish the appearance of animal grease on the chert surface and

helped determine if there was a correlation between the distribution of animal grease and the distribution of wear traces present after the more thorough cleaning (personal communication, Kay 2005). For the second phase of cleaning, referred to as Phase 2 cleaning, a gentle emulsifier was used to cut the animal grease.

After the Phase 2 cleaning, the layer of grease was removed to reveal wear traces on the tool's actual surface (Figure 8: 1–500x before; 1–500x after series 2 with horse grease; 1–500x after series 2 phase 2 cleaning). The effect of additional cleaning was best evident at location 2, an aris of two lateral flake scars on the lateral edge 3.5 cm back from the point's tip (Figure 8: 2–200x after series 2 with horse grease; 2–200x after series 2 after phase 2 cleaning). The high surface received a thick layer of horse grease, and once the grease was removed, the texturally smoothed lateral ridge of the aris was revealed. Again, the distribution of horse grease directly correlated with the distribution of wear traces.

Series 3

In the third series BUR18 was an effective tool and penetrated the animal to create a wound that measured 3.2 cm in length, 1.5 cm in width and 18.5 cm deep into the horse's left latissimus dorsi muscle.

Generally speaking, after the third impact series BUR18 maintained the wear distribution and intensity established in the previous two uses. The projectile point obtained an additional use-unit, referred to as location 4. Wear traces were concentrated on the center-axis, with high asperities on the microtopography texturally smoothed.

The damaged tip was polished and incised with two ephemeral striations that ran parallel and slightly oblique to the long-axis (Figure 9: 4-200x after series 3 phase 2 cleaning; 4-500x after series 3 phase 2 cleaning). The orientations of the linear indicators were two slightly different directions given that they were microscopic expressions of the chaotic nature of stabbing.

Experimental Point BUR17

Series 1

Point BUR17, fitted to the pine mainshaft, penetrated hide, epidermis, and the thoracic part of the serratus ventralis muscle to pierce the animal between the right scapula and ribs. The point and foreshaft entered the carcass, but the implement did not penetrate past the junction at the mainshaft. BUR17 penetrated near the cranial lobe of the right lung to trigger considerably more bleeding. The piece did not directly contact bone and was removed from the animal undamaged by impact.

BUR17 exhibited only minimal indications of polish after its first thrust. The development of use-wear traces was recorded at a predetermined location 1, and a blood residue was detected at location 2. Location 1 obtained evidence of polish in the initial stages of development. Located on the ventral face, location 1 was a high aris 0.8 cm from the point's tip. The surface was polished in a constricted area of 200 μm by 50 μm with the longest dimension oriented longitudinally down the center axis (Figure 10: 1–200x after series 1). Perhaps a more significant aspect of this analysis was the blood residue that remained at location 2 on BUR17 after cleaning. At first glance, location 2

seemed to be polished from impact, but further investigation of this “polish” revealed noticeable differences in appearance. The surface appeared to be cracking where the “polish” was more diffuse and actually deposited on the surface at thicker concentrations. While the distinct red of blood was evident in some areas of the thicker residue concentrations, light refraction made other portions seem like plastically smoothed areas (Figure 10: 2–200x horse blood on BUR17 surface). To verify that this was not true polish and instead just blood residue, images were taken of fresh human blood on a chert flake (Figure 10: 200x human blood on chert flake surface). The same cracking and plastic-like concentrations were observed to confirm that location 2 on BUR17 was not polished from impact series 1.

Series 2

In Series 2, BUR17 was thrust behind the left front shoulder of the animal near the cranial lobe of the left lung and heart. The point penetrated 18 cm to pierce hide and the external abdominal oblique muscle before slightly puncturing the heart. The penetration was impeded by the thickness of the juncture of the mainshaft and foreshaft. BUR17 was successfully removed from the animal without any macroscopic damage from impact and employed in the next impact series.

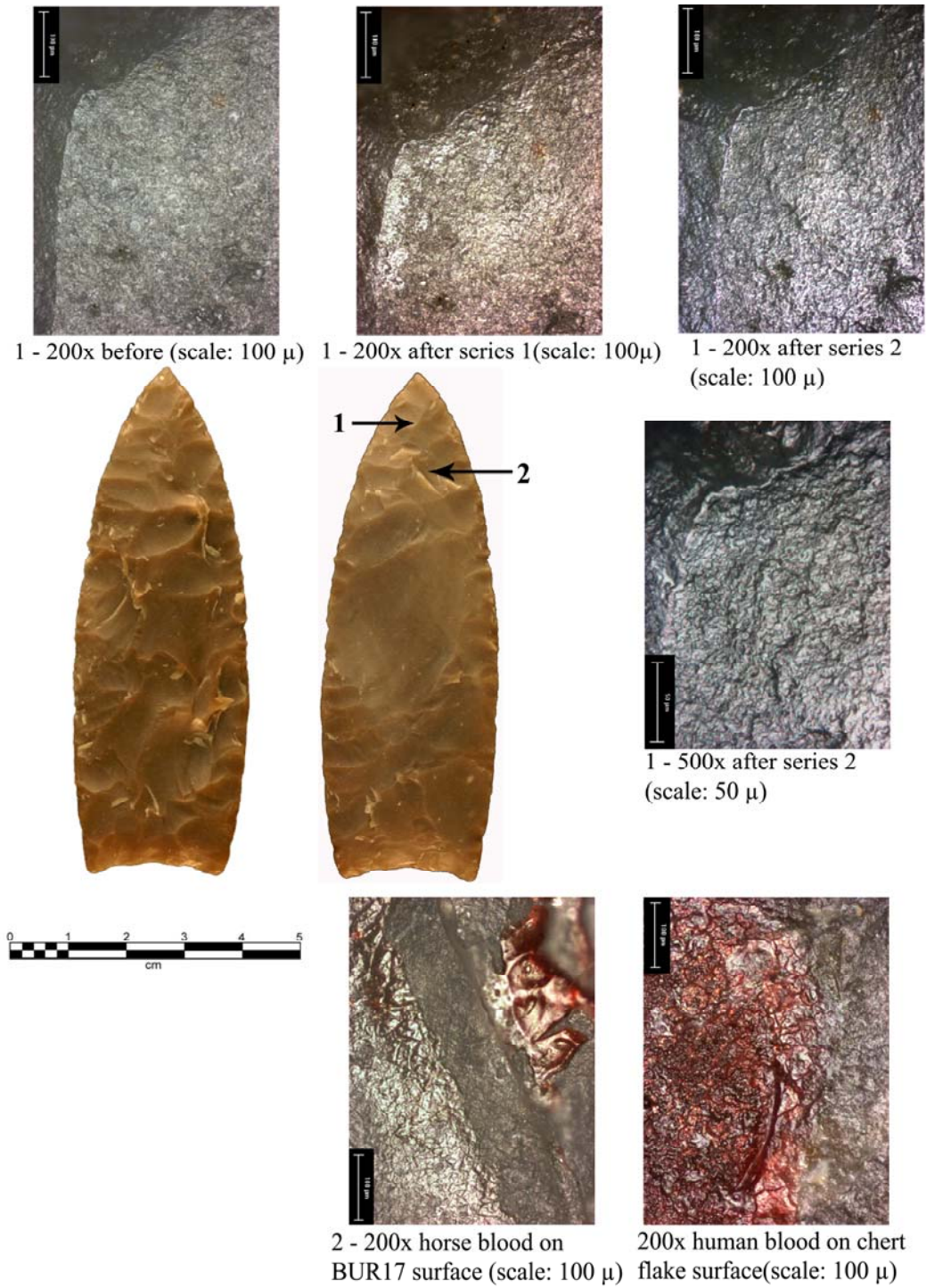


Figure 10. Experimental Point BUR17 Projectile Impact Study Plate 1 of 3.

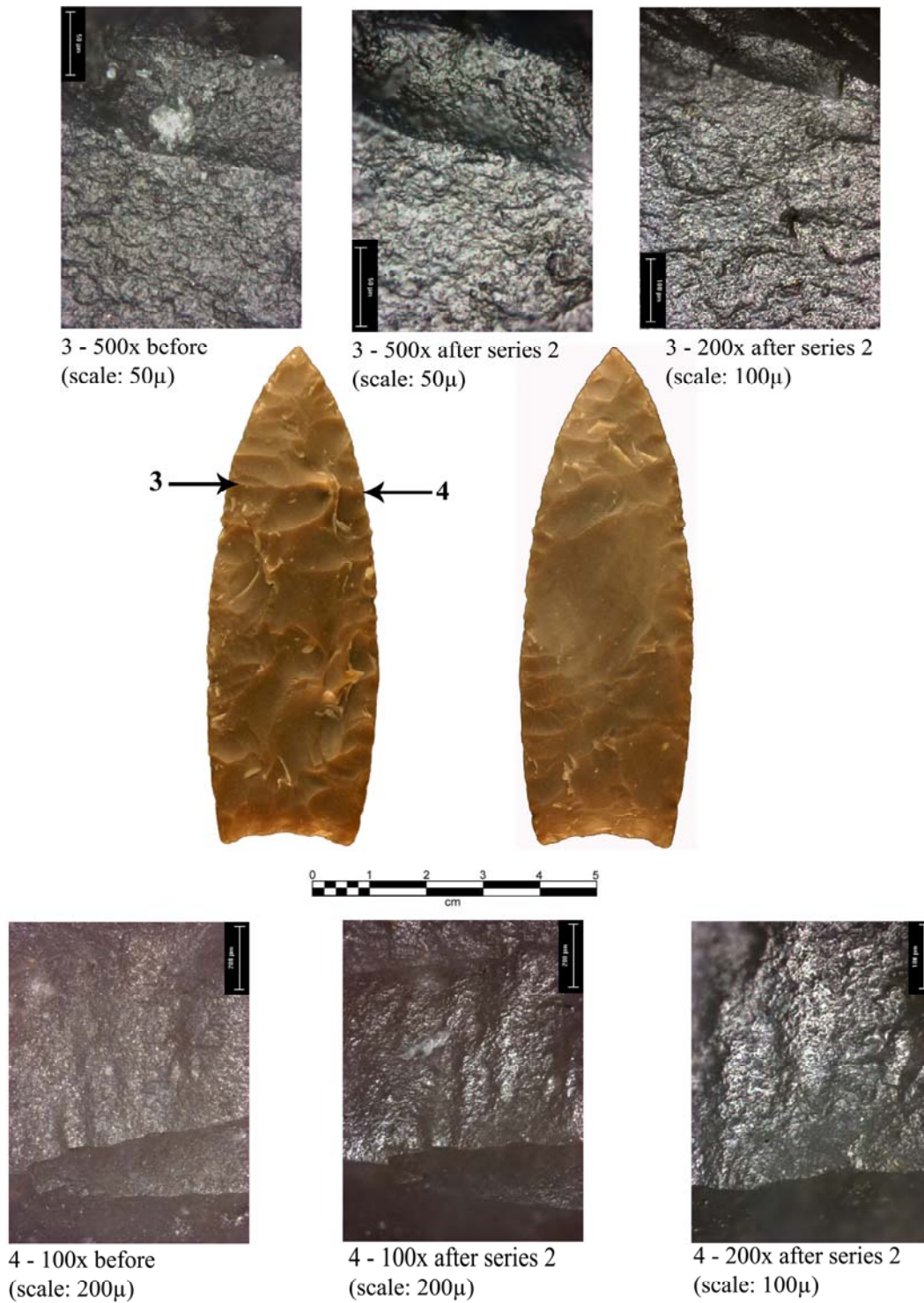


Figure 11. Experimental Point BUR17 Projectile Impact Study Plate 2 of 3.

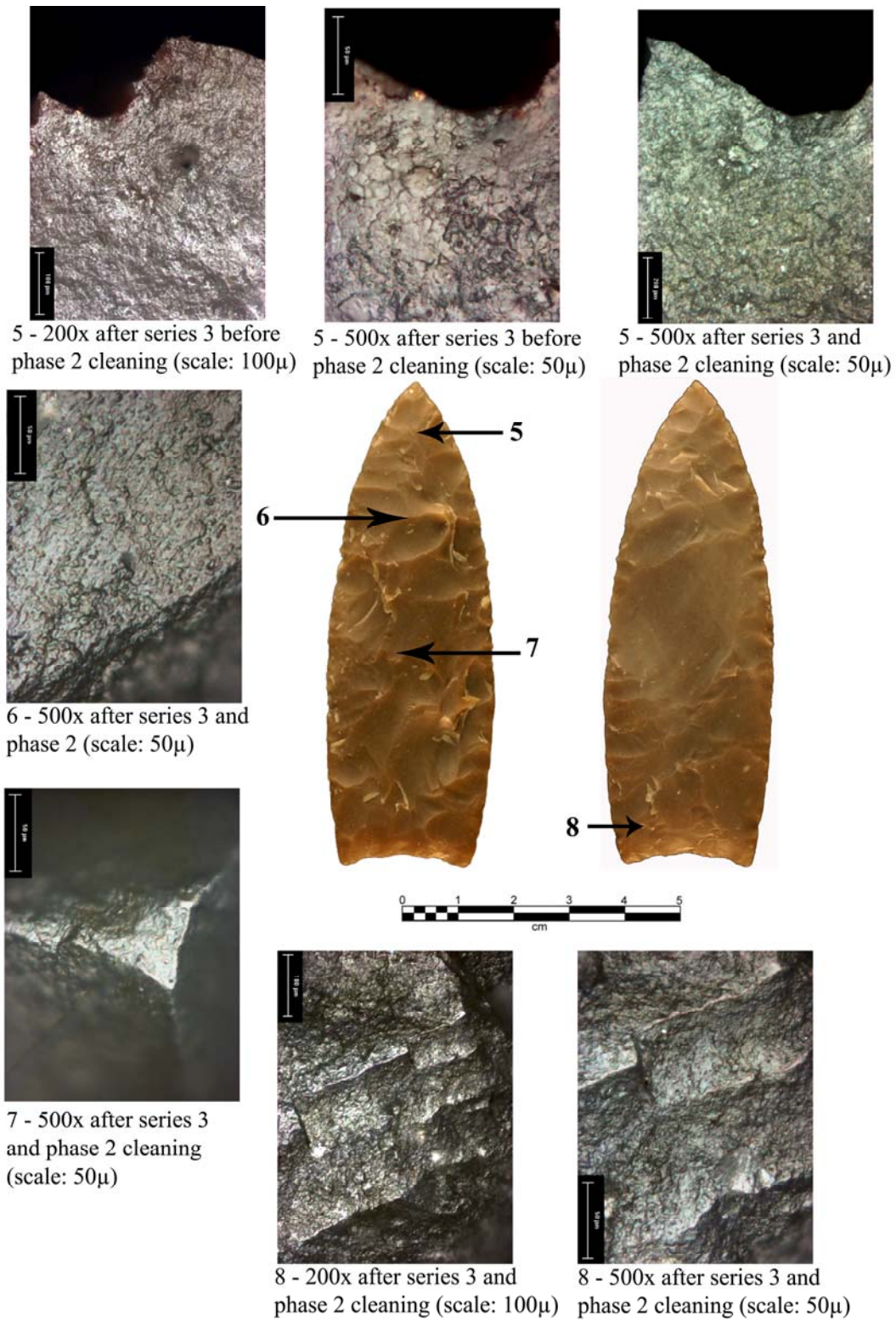


Figure 12. Experimental Point BUR17 Projectile Impact Study Plate 3 of 3.

After Series 2 BUR17 exhibited additional evidence of use with the most significant changes occurring along the lateral edges of the point. At location 1, use-wear traces acquired in the previous impact series were further developed. In addition, predetermined locations 3 and 4 developed use-wear evidence for the first time. After Series 1, location 1 acquired a polished surface with a constricted area of 200 μm by 50 μm with the longest dimension oriented longitudinally down the center axis; however, with the second impact series the once constricted area of polish became more diffusely spread over the surface (Figure 10: 1-200x before; 1-200x after series 1). Similar to the effects of Series 1, the highest distal-facing ridge continued to receive the most textural change, but with the second impact experiment there were noticeable textural alterations to the microtopography beyond this point (Figure 10: 1-200x after series 2). Location 3, positioned on a ridge of a lateral flake scar on the dorsal face, attained a polished surface diffusely distributed from the lateral edge (Figure 11: 3-500x before; 3-500x after series 2; 3-200x after series 2). The surface was altered after Series 1 with an ephemeral textural change that strictly affected high asperities on the microtopography. On the right lateral edge of the same face of the point, Location 4 obtained evidence of wear. The polished surface was linearly distributed in streaks that initiated at the lateral ridge and continued back towards the point's base (Figure 11: 4-100x before; 4-100x after series 2; 4-200x after series 2). Generally, the polished surfaces were constricted to the lateral edges then fade or grew more diffuse moving inward, before regaining intensity at the center ridge.

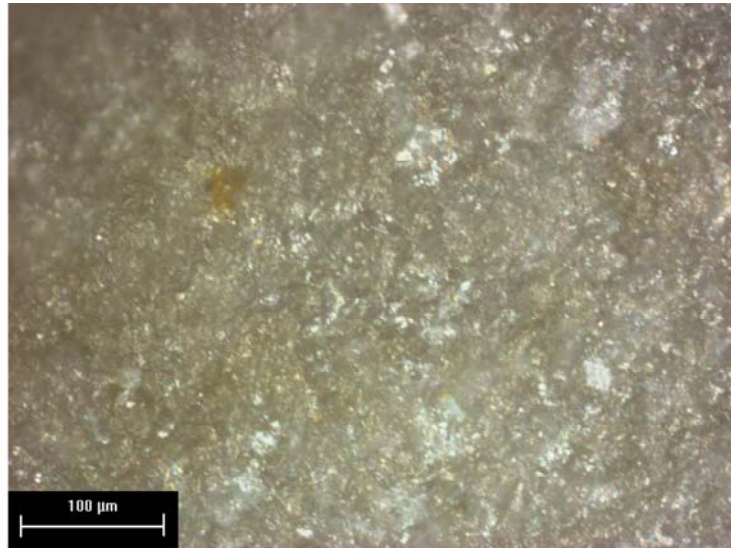
Series 3

The first thrust of experimental point BUR17 failed to penetrate the hide and bounced off the animal to strike the ground. Impact with the ground caused a fracture that removed a 3 cm long burin from the point's tip down the lateral edge. The burin removed the tip and created a sharp, fresh lateral edge. Instead of abandoning the tool, the point was thrust again under the assumption that hunting a live animal would have led to similar failed attempts. This time with more force behind the overhand thrust, BUR17 pierced the layer of hide, connective tissue, and the point and foreshaft were wedged in the latissimus dorsi muscle. BUR17 created a wound measuring 3.0 cm in length, 1.5 cm in width, and penetrated 17.7 cm deep. The burin fracture left this point unserviceable.

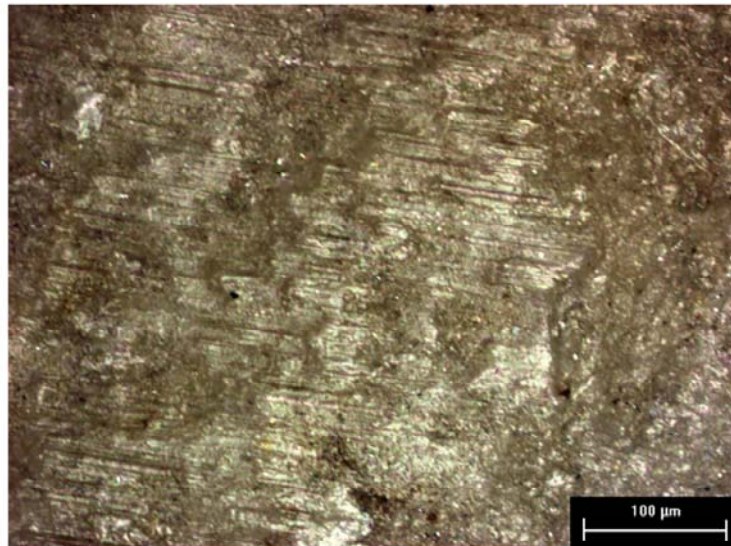
As mentioned above, BUR17 was damaged by a burin fracture that removed the tip and lateral edge of the point. Some locations documented in previous impact series were lost, but BUR17 still obtained diagnostic evidence of its use as a projectile. BUR17 maintained the wear distribution identified after previous impact series and in some use areas the intensity of wear traces increased. Four new use-units were documented: location 5, 6, 7, and 8. Again, cleaning was a central issue in this round of analysis. First, the point was examined to document the extent and distribution of horse grease. This scanning confirmed the previous conclusion that the distribution of the horse grease directly correlated with the distribution of actual wear traces caused from use. With the first phase of cleaning, the freshly damaged tip was still covered in a layer of horse grease and blood residue. When these residues were removed, sharp breaks and

texturally altered micro surfaces were apparent (Figure 12: 6-200x after series 3 before phase 2 cleaning; 6-500x after series 3 before phase 2 cleaning; 6-500x after series 3 phase 2 cleaning). Polished surfaces initiated at the damaged tip and were most prominent along the center axis. A series of lateral flake scars terminating at the center axis of the point to form a longitudinal ridge. This ridge was susceptible to polishing and accrued a series of striations with an average length of 250 μm . The striations incised the microtopography in a direction parallel to the long-axis; an orientation indicative of the overhand thrusting motion (Figure 12: 6-500xB after series 3 phase 2 cleaning). The polish gradually faded proximally down the center axis and became indistinguishable approximately 6 cm from the tip. At location 7 wear traces intensified approximately 1 mm into the portion of the point where the wooden haft contacted the stone surface and continued down to the ridge of the beveled basal edge (Figure 12: 7-500x after series 3 phase 2 cleaning). The center ridges on the point's basal ears were texturally smoothed. Location 8 was a series of three step fractures with polished surfaces on the higher step terminations (Figure 12: 8-200x after series 3 after phase 2 cleaning; 8-500x after series 3 after phase 2 cleaning). The polished surfaces at each termination suggested that the higher portions of the step flakes were in contact with a hard material, and this material did not affect the lower areas on the microtopography.

An experiment was in order to determine if wear traces found in the hafted area were the products of the hafting process itself, or evidence of the point moving in the haft during the use-activities. Images were captured on the surface of a fresh chert flake prior to the experiment. The flake was then shoved into a wooden foreshaft in the same



Chert surface before hafting simulation experiment 200x
(scale: 100 μ)



Chert surface after hafting simulation experiment with "linear
indicators" 200x (scale: 100 μ)

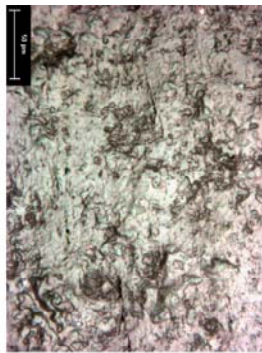
Figure 13. Hafting Simulation Experiment.

manner used on the experimental points in the original hafting process. After the first hafting simulation the point immediately acquired a series of what appeared to be linear indicators oriented with the direction of force into the haft (Figure 13). The flake was cleaned with the same methods utilized on the experimental points; the point was soaked in a solution of the emulsifier and warm water. The cleaning step removed all evidence of the “linear indicators.” Once more, the flake was forced into the haft and the surface accrued what appeared to be linear indicators and polish. This time it was cleaned with the method utilized on the Gault artifacts; the piece was rinsed in warm water and wiped with an alcohol-soaked cotton ball. This method also removed all the possible wear traces. With these results, it was concluded that wear traces in the haft area were the product of the hafting implements moving against the stone surface during the tool’s use. The actual hafting process only leaves behind ephemeral residues that can be removed in cleaning or more likely with thousands of years of deposition.

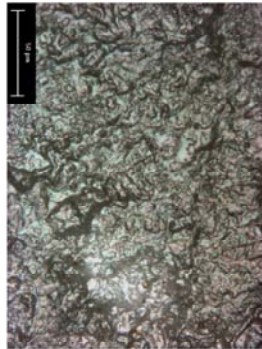
Experimental Point BUR20

Series 1

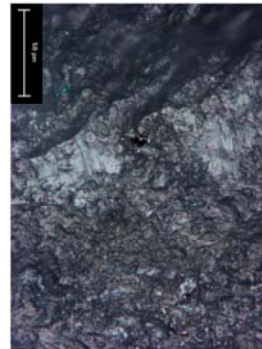
BUR20, fitted for the oak mainshaft, entered the animal directly behind the right shoulder near the ribcage of the horse in the body region known as the costal portion of the thorax (McCracken et al. 1999:4). The projectile penetrated the hide, epidermis, and the external abdominal oblique muscle to slightly graze the animal’s sixth rib. The thrusting force penetrated the point up to the junction where the foreshaft meets the mainshaft. Despite attempts to thin and taper the juncture, the increase in diameter



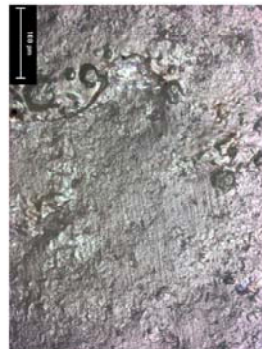
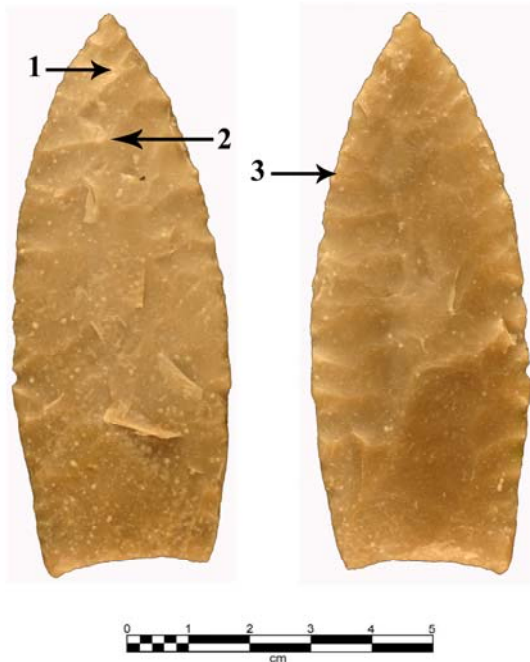
1- 500x after series 1
(scale: 50μ)



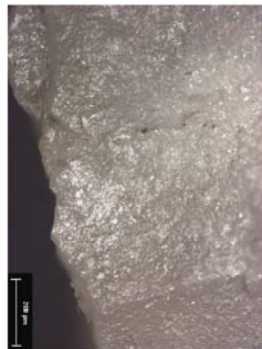
1- 500x after series 2
(scale: 50μ)



1- 500x after series 2 and
phase 2 cleaning (scale: 50μ)



2 - 200x after series 1
(scale: 100μ)



3 - 100x after series 1
(scale: 200μ)

Figure 14. Experimental Point BUR20 Projectile Impact Study Plate 1 of 3.

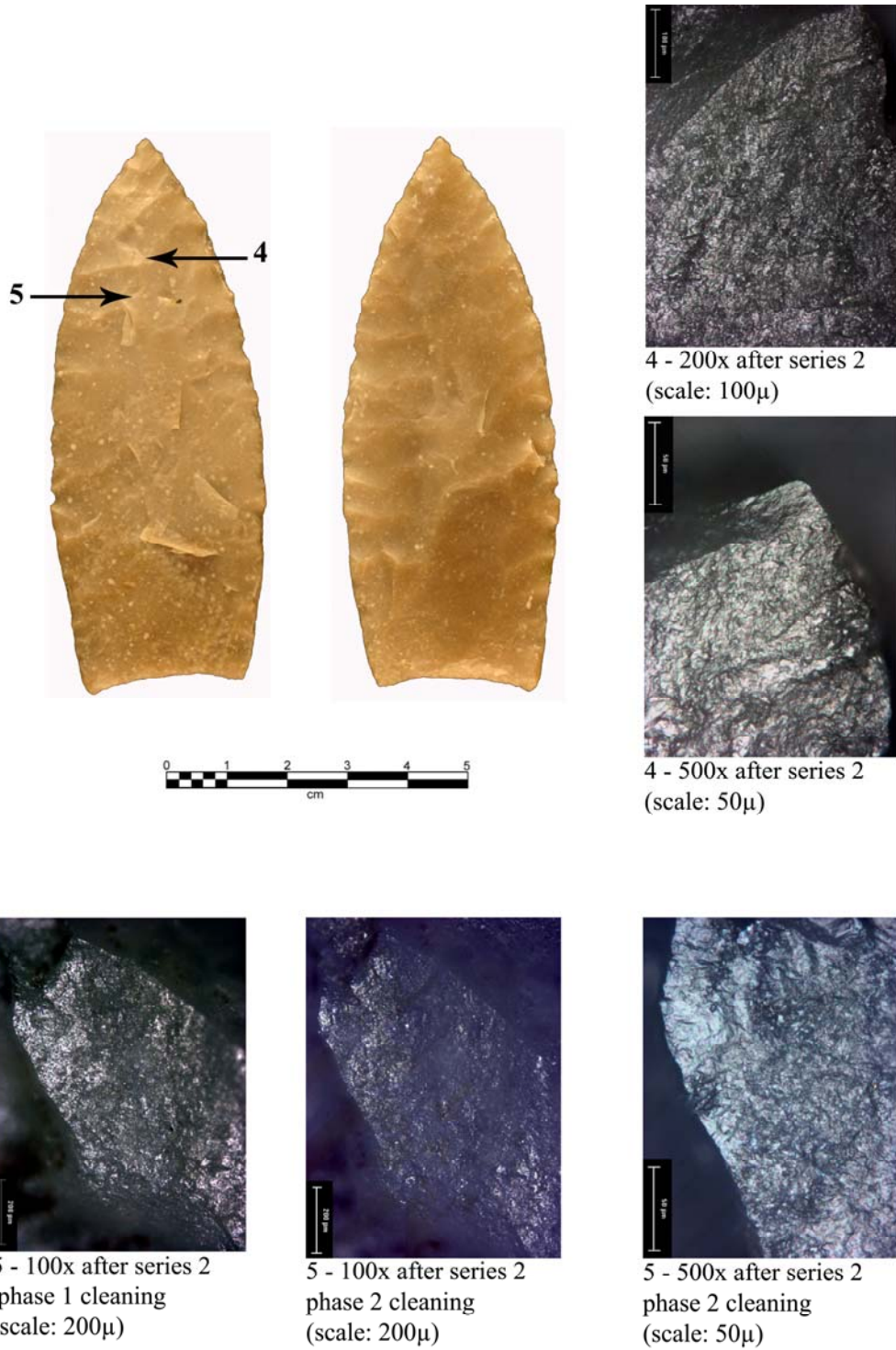
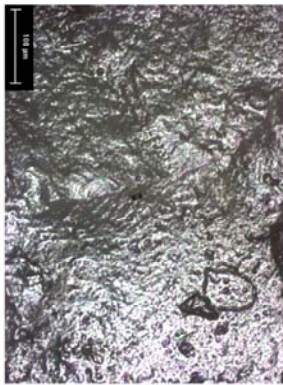
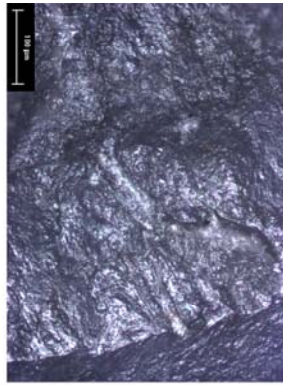


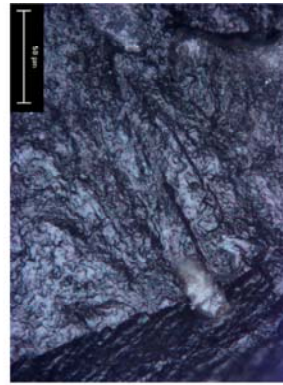
Figure 15. Experimental Point BUR20 Projectile Impact Study Plate 2 of 3.



6 - 200x after series 2
and phase 1 cleaning
(scale: 100 μ)



6 - 200x after series 2
and phase 2 cleaning
(scale: 100 μ)



6 - 500x after series 2
and phase 2 cleaning
(scale: 50 μ)

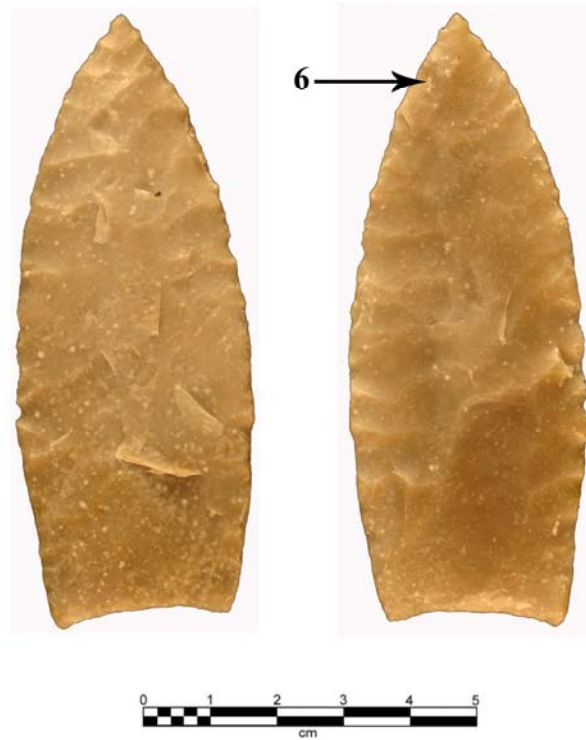


Figure 16. Experimental Point BUR20 Projectile Impact Study Plate 3 of 3.

from the foreshaft to the mainshaft stopped the penetration of the mainshaft. BUR20 was not broken during the process and remained serviceable for the following series.

After only a single thrust, BUR20 exhibited wear traces indicative of its use as a projectile. Three use-units were affected by the first impact series: predetermined location 1, a new use-unit location 2, and predetermined location 3. Location 1, on the dorsal face, was situated on a distal-facing aris of a lateral flake scar 1 cm from the point's tip. The natural convexity of the projectile point positioned location 1 at a higher microtopography relative to the extreme tip. The polished surface initiated at the high aris and extended proximally in a constricted streak along the center long-axis. Fine striations ran parallel to the long-axis to demonstrate the projectile's trajectory into the animal (Figure 14: 1–500x after series 1). Slight textural changes confirmed that high micro-surfaces at this location received abrasive polishing, while lower areas retained their original texture. Use-unit location 2, also located on the center-axis, obtained a polish streak along the long axis of the point. The area acquired fine striations within the polished surface, as well as within the immediately surrounding non-polished area (Figure 14: 2–200x after series 1). The extreme lateral edges remained unaffected by the first impact experiment. For example, location 3, an area directly on the lateral edge and 3 cm from the point's tip, did not acquire evidence of polish or linear indicators (Figure 14: 3–100x after series 1).

Series 2

In the second impact series BUR20 followed the same projectile trajectory as BUR17, but penetrated 1 cm deeper (a total of 19 cm) into the heart of the animal. While the foreshaft attached to BUR17 was too thick at its junction with the pine mainshaft, BUR20 penetrated deeper because it was more tapered to the oak mainshaft. The point slipped unobstructed between two anterior ribs to penetrate deep into the animal's heart. BUR20 remained serviceable for the next impact series.

After Series 2, BUR20 obtained use-wear traces again at location 1 and acquired four new use-units are locations 4, 5, 6, and 7. BUR20 required two phases of cleaning to reveal the use-wear traces on the stone surface. After the first phase of cleaning, BUR20 exhibited a highly reflective sheen along the center axis and lateral edges. This reflective surface was laid over the microtopography in both high and low locations. Upon cleaning an area that previously had wear traces, that area no longer had the same use-wear indicators. After Series 1 location 1, acquired what appeared to be linear indicators that initiated at the first high aris and extended back parallel to the long axis. When this location was re-examined after Series 2 and Phase 1 of the cleaning process, the linear indicators were no longer on the surface and a diffuse sheen was the only indicator of use evident (Figure 14: 1-500x after series 2). The loss of the linearity could have been the result of the following two explanations:

1. Use-wear traces on the surface of the point were removed because that surface was altered and/or removed from impact with bone. Levi Sala (1996: 60) suggests that after similar use activities the only wear traces evident on a tool's

surface should be wear traces that are the products of the most recent use activity because the distribution patterns are superimposed.

2. Linearity was not the result of the material, from the animal or the stone itself, incising the stone's surface. Instead these particles were leaving linear marks in a thin layer of animal grease that remained on the surface after cleaning.

Re-examination of the location led this researcher to believe that the linear traces were left behind in a layer of animal grease that was removed in the first phase of cleaning after Series 2. The surface alterations were documented and then the piece was subjected to the second phase of cleaning. With the second cleaning the reflective sheen created by the thin layer of grease was removed to reveal an abrasively polished ridge. This polished surface initiated at the distal most portion of the ridge and was linearly oriented to show the direction of impact (Figure 14: 1-500x after series 2 phase 2 cleaning). Location 4, positioned along the center axis approximately 2.1 cm from the point's tip, revealed evidence of use after Series 2 and Phase 2 of the cleaning process. This location, a high surface on the microtopography created by the intersection of two step fractures, was not affected in the first series. The texture on the remnant surface was polished with a linear orientation that was most intense at the distal portion of the ridge and faded back (Figure 15: 4-200x after series 2). The corner formed by the intersecting step fractures had the majority of the natural asperities smoothed away leaving a polished surface (Figure 15: 4-500x after series 2). Location 5, location on a prominent flake scar raised approximately 0.45 mm above the surrounding microtopography, was a use-area of interest after Impact Series 2 and Phase 1 cleaning

due to the. With the initial observation, the surface of this high face acquired a reflective sheen that indicated the location was modified during Impact Series 2 (Figure 15: 5-100x after series 2 phase 1). Phase 2 of cleaning eliminated the grease to expose a texturally changed or polished surface along the ridge (Figure 15: 5-100x after series 2 phase 2 cleaning; 5-500x after series 2 phase 2 cleaning). The center axis of the point's ventral face also acquired evidence of use-wear. Location 6, a flake scar oblique to the center axis positioned 7 mm from the point's tip, exhibited the distinct shine and distribution indicative of animal grease (Figure 16: 6-200x after series 2 phase 1 cleaning). When this location was examined after the second phase of cleaning the grease was removed leaving behind a texturally smoothed ridge incised with stria (Figure 16: 6-200x after series 2 phase 2 cleaning). The stria were approximately 50 μm long and oriented parallel to the center axis from the leading aspect of the tool back toward the base. A chert particle from the point's surface was picked up during the impact and moved across the surface producing a furrow on the microtopography. The particle remained attached to the stone surface (Figure 16: 6-500x after series 2 phase 2 cleaning). This observation helped to demonstrate the linear patterning indicative of the projectile's trajectory, as well as the actual mechanism in which the stria were formed.

Series 3

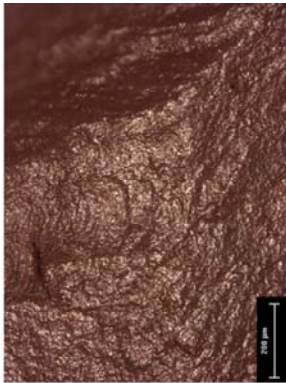
BUR20 failed to penetrate the animal in the third series. BUR20 was thrust but impact with the anterior portion of the rib cage caused the foreshaft to break in the

mainshaft. No noticeable macroscopic or microscopic damage was done to the point, but the broken foreshaft made further stabbings impossible.

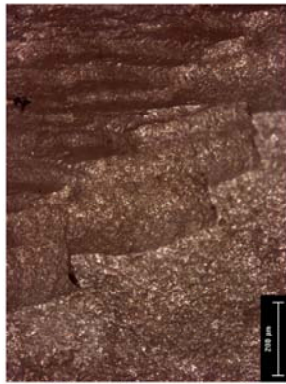
Experimental Point BUR24

Series 1

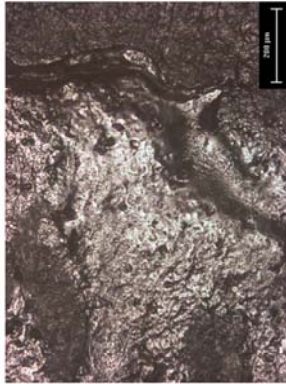
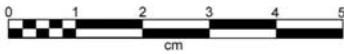
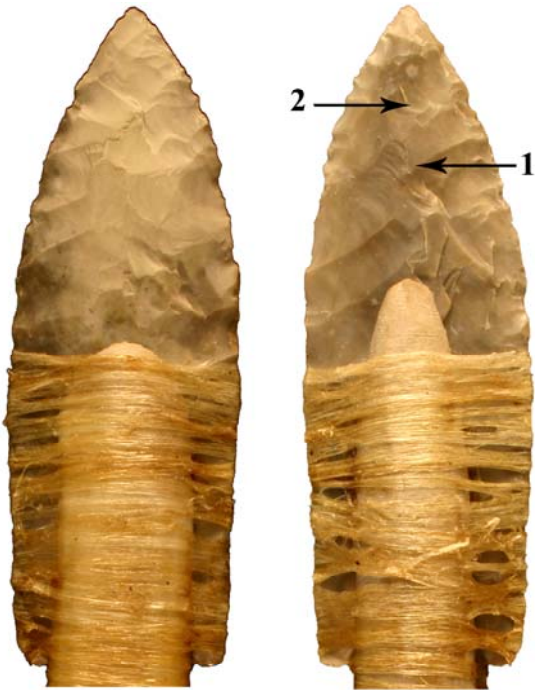
BUR24, with the antler foreshaft FA1 fitted into the bois d'arc mainshaft, was thrust left of the previous wounds and hit the animal at the midsection of the anterior portion of the ribcage. BUR24 directly contacted the animal's fifth rib bone and suffered extensive damage upon impact. A roll break, spanning diagonally from the longitudinal center axis down to the left lateral edge of the ventral face, removed a maximum of 1.9 cm. In addition, a snap fracture removed 1.2 cm of the tip from the center axis to the right lateral edge of BUR24 (Hayden 1979:134-135). Examination of the wound revealed that BUR24 penetrated hide, epidermis, and the triceps brachii muscle but was stopped by direct contact with the animal's rib. The point had enough force to slightly crack the rib and remove fine pieces of bone. The majority of the tip was lost in the carcass. The force of impact with the rib bone also caused the foreshaft to fail. The experiment demonstrated that FA1 was not designed to socket down deeply enough into the mainshaft. The mainshaft-foreshaft junction did not have the strength to support the lengthy foreshaft and consequently the impact caused the tapered tip (proximal-most 5 cm) of the antler foreshaft to break off in the mainshaft. BUR24 and FA1 were no longer functional for Series 2 and 3.



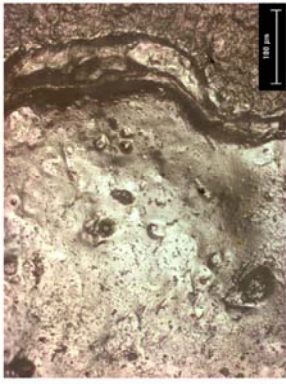
1 - 100x before
(scale: 200μ)



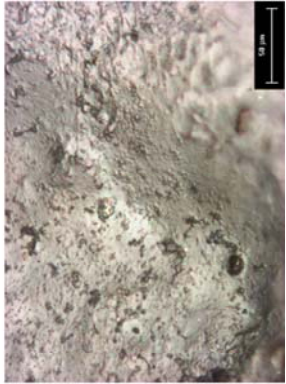
1 - 100x after series 1
(scale: 200μ)



2 - 100x after series 1
(scale: 200μ)



2 - 200x after series 1
(scale: 100μ)



2 - 500x after series 1
(scale: 50μ)

Figure 17. Experimental Point BUR24 Projectile Impact Study.

After Series 1, BUR24 acquired use-wear traces at predetermined location 1 and at a new use-unit referred to as location 2. In addition to extensive fracture damage on the tip, BUR24 exhibited use-wear in the form of microflaking and polish. Impact with the rib bone produced jagged step fractures on the high ridges along the center axis, and this microflaking was evident at location 1 (Figure 17: 1-100x before; 1-100x after series 1). In addition, polishing occurred at an area approximately 2 mm from the roll break. Location b was abrasively polished from contact with a hard material, in this case the rib bone. The high surface was extensively polished, while depressed areas retained the material's original texture (Figure 17: 2-100x after series 1; 2-200x after series 1). An image captured at 500x reveals that the polished area contained linear patterning with shallow striations running parallel to the center long-axis (Figure 17: 2-500x after series 1). The extent of polish development on BUR24 was unexpected and the explanation for the intensity of use-wear evidence was the point's direct impact with the animal's rib bone.

Conclusions

Conclusions from Projectile Impact Experiment Series 1

The locations documented for "before" images were selected because they were predetermined as areas of potential use-wear. The analysis proved that though these locations seemed to be likely locations for wear to accumulate, this was not always the case. Some of my predetermined locations exhibited wear while others experienced no

apparent changes. When the entire tool was scanned, new areas were documented. This exercise demonstrated what many scholars have suggested, that there exists a diverse set of variables that interplay to influence a behaviorally complex use-activity (Schiffer 1979:18). While each specimen was utilized as a projectile on the same animal, the quality and condition of each individual point, the speed and force behind each thrust, the impact location on the animal, etc, all affected the variability within the experiment (see Semenov 1964:13). If this variability existed in experimentally controlled situations, it undoubtedly existed in a far greater degree in prehistoric conditions. Consequently the individual projectiles exhibited different degrees of wear after one impact series, but general wear patterns within that variability were recognizable. The general impact wear characteristics evident after a single use as a projectile include:

1. The wear types evident after the first impact series included impact fractures, ephemeral polish, and linear indicators.
2. Based on Grace's (1989: Figure 55) schematic representations of polish development, the wear intensity or the degree of development on the projectiles is an A+. According to Grace, an A+ designation indicates that the individual elements of polish are large but not yet linked up in concentrations of polished surfaces (See figure).
3. Polished areas were limited to only high surfaces of the microtopography and are generally oriented with a longitudinal asymmetry down the center axis. No polish development was yet evident on the extreme lateral edges of the projectiles. Ahler (1979:316) suggests that use-wear is not randomly distributed but instead

differentially distributed according to the tool's use trajectory. The polish distribution on projectile replicas BUR20, BUR21, and BUR24 reflects Ahler's concept that the relative motion of a tool leads to a kinematic patterning indicative of function.

4. Striations, if detectable, were shallow and ran parallel to the long-axis in the direction of impact and penetration. The linear direction of the striations observed on BUR20 was consistent with the projectile motion of the tool (Ahler 1979:316).

Conclusions from Projectile Impact Experiment Series 2

The major goal of the second impact series was to monitor the development of use-wear evidence caused by the continued use of a projectile point.

Cleaning issues were a central aspect of this round of observations. Animal grease affected the appearance of the points' surface, but with the removal of the animal grease actual wear traces were revealed. The wear types evident on the projectiles included microflaking, linearly distributed polish, and striations. In general, impact wear traces became more intense and more widely distributed after the second round of use. Based on Grace's (1989: Figure 55) levels of polish development the experimental projectiles developed a level B polish, meaning that the polish elements were joined together, but the majority of the point's surface was unpolished. After the first impact series the wear traces were concentrated from the points' tip proximally along high ridges on the center axis. Wear traces were distributed with a longitudinal asymmetry (Ahler 1979: 316). The second round intensified impact wear traces along the same

center ridge, but also left ephemerally polished surfaces along the extreme lateral edges. Wear traces on the lateral edges, along with traces along the center axis, were still oriented with the direction of tip impact and penetration. Use-wear on the lateral edges indicates that as a projectile point penetrates an animal that point's lateral edges are in contact with the animal and actually cutting through the hide and muscle. Dockall (1997: 325) noted lateral edge wear on projectile points and advises analysts not to confuse these traces with secondary butchering activities. Based on this experimental program, Dockall is correct and for this reason butchering experiments were conducted.

Conclusions from Projectile Impact Experiment Series 3

The third impact series provided significant insights into the formation of haft wear on projectile points. By simulating the actual hafting event and recorded the effects before and after cleaning the tool, it was concluded that wear found on artifacts and experimental tools after cleaning was the result of the stone tool moving in the haft during the use-activity. Haft wear is manifested in the form of texturally smoothed surfaces on the microtopography. These polished surfaces were the highest features on the microtopography that were abrasively polished by contact with the haft; the flute scar terminations, the ridges of basal ears, and the basal ridge before the bevel. The distribution and intensity of these haft wear patterns served as an informative analogue for the Gault projectile points.

Butchering Experiments

Methods for Butchering Experiments

BUR19 was chosen to simulate wear patterns indicative of animal butchering. This point was hafted using the knotted hafting method employed with FO1, FO2, and FO3. The point was secured in the wooden foreshaft with asphaltum and sinew dipped in a thin solution of hide glue and water (Figure 18). Following the high and low power microscopic documentation, one lateral edge was designated specifically to cut animal tissue and bone. In order to observe the development of wear traces relative to extent of use, each experiment was conducted as a series of use events. The tool was held with the point down perpendicular to the bone. After a series of use was performed, the biface was analyzed and documented under the compound microscope to evaluate alterations from its prior state.

Experimental Point BUR19

Series 1 of Butchering

In the first series of the butchering experiment, BUR19 removed the meat from a 2.27 kg cow shank (the fused radius and ulna that form the animal's forearm). The tool was pulled along the animal's bone to the body with an overhand power stroke. This motion was repeated for 327 strokes to clean the meat from the bone. Considerable tension was required to remove the tendons and connective tissue. During this process, the force and contact with bone caused a snap fracture at the tip of BUR19. Subsequent



Figure 18. Experimental Point BUR19 in Foreshaft (scale: 3:4).

strokes rounded off this break, changing the appearance of the distal portion of the point. With an additional 673 strokes the meat was sliced and cubed. The series took two hours and the tool performed 1,000 strokes.

No noticeable use-wear traces beyond the snap fracture were evident after the first round of butchering. No evidence of polish or linear indicators was recorded.

Series 2 of Butchering

Experimental point BUR 19 was utilized in a second series of butchering to remove meat from the bone of a 2.27 kg cow forearm. The task required 511 overhand strokes to remove the fresh meat from the bone. After breaking through the thick membrane that held the meat to the bone, BUR19 remained sharp enough to easily slice the meat from the large bone. Several strokes contacted the bone during this task, further rounding the tip of the point. The tool performed an additional 489 precision cuts to slice the meat in strips and reduce it to chunks. After another 1,000 strokes, 2,000 strokes total between Series 1 and 2, BUR19 appeared to have retained a suitable cutting edge for the next task.

BUR19 was subjected to my standard initial cleaning of a mild detergent and wiping with an alcohol soaked cotton ball. The predetermined locations were photo-documented to record changes after 2,000 cut strokes on the beef shank. The tool was then cleaned with the emulsifier and once again, locations were photo-documented to observe any apparent differences on the surface. In this case, the second phase of cleaning made no apparent difference to the point's surface and the wear traces

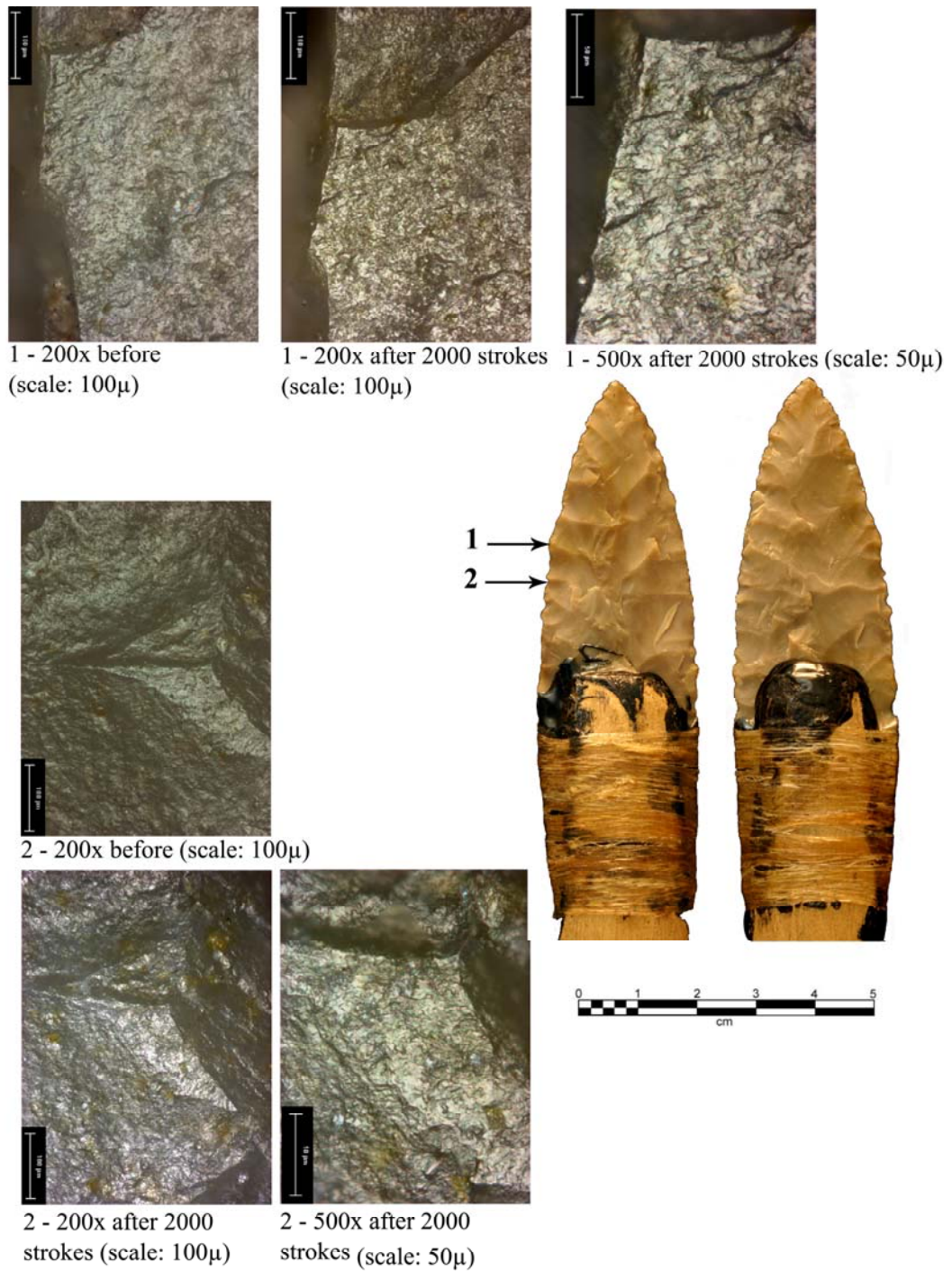


Figure 19. Experimental Point BUR19 Butchering.

remained. The second phase of cleaning proved unnecessary most likely because the shank portion was not an overly greasy cut of meat. While the projectile points encountered horse fat and bodily fluids that necessitate additional cleaning, the surface of BUR19 was not covered and distorted by a layer of animal grease.

The point acquired the most noticeable changes along the lateral edges at the predetermined locations 1 and 2. The lateral edges retained examples of the polishing process in early stages of development. The highest asperities on the microtopography were removed, leaving behind isolated polished surfaces that were ephemerally distributed along the lateral edge and did not link up in concentrations on the microtopography. Location 1, a series of micro step fractures along the left lateral edge of the point's dorsal face, was one of polished during the activity. The polished surface initiated at the extreme lateral edge of the higher step face and faded towards the center axis. The textural change was most evident on the corner of the two micro steps at the highest magnification of 500x (Figure 19: 1-200x before; 1-200x after 2000 strokes; 1-500x after 2000 strokes). Predetermined location 2, approximately 1 cm proximal of location a on the lateral edge and a prominent ridge of a lateral flake scar, contained polish to reveal the tool's use-direction. The proximal facing facet of this aris was polished from the lateral edge up to the flake scar ridge (Figure 19: 2-200x before; 2-200x after 2000 strokes; 2-500x after 2000 strokes). The orientation of this early stage polish indicated that the tool's use-activity was a back and forth cutting motion that polished both distal and proximal-facing flake facets.

Conclusions

Conclusions from Series 1 of Butchering Experiment

After the first series of butchering, there was no development of wear traces, demonstrating that polish formation caused by cutting meat is not an instantaneous process. These conclusions were consistent with butchering experiments conducted by Juel Jensen (1988) and Levi Sala (1996), and in part, conclusions made by Keeley (1980). Jensen states that polish must reach a particular state of development before diagnostic wear traces are evident. The period of activity required to reach this state or threshold to produce use-wear differs depending on contact material. Jensen (1988: 55) found that after 60 to 90 minutes of cutting meat polish did not develop beyond a generic weak formation. Keeley (1980: 53) admits that meat polish shows little contrast from unaltered flint. Levi Sala (1996:28-29) emphasizes the ambiguities of what some call a “meat polish” and precautions that archaeological specimens with “meat polish” are actually undergoing the early stages of soil sheen. Evidence from the first butchering exercise correlated with the conclusions made by Jensen and Levi Sala. Artifacts that appear to have use-wear evidence from butchering were most likely utilized in an activity that surpasses 1,000 strokes.

Conclusions from Series 2 of Butchering Experiment

After 2,000 use strokes BUR19 contained evidence of use on the high faces of the extreme lateral cutting edge. The point obtained wear traces in the form of microflaking, edge rounding, and polish. This polish was ephemeral with no linking up of texturally smoothed asperities. Based on Grace's (1989: Figure 55) scale of polish development the degree of polish development on the tool was between stage A and A+. Individual polish elements were isolated with the greater portion of the point remaining unpolished. Wear traces were distributed with a bilateral symmetry, with an increased frequency and intensity of wear on the left lateral edge of the dorsal face (Ahler 1979:316). The polish was most intense at the cutting edge and gradually faded inward toward the center ridge creating a marginal asymmetry of wear traces along the lateral edge. The number of texturally smooth asperities decreased closer to the replica's center axis, however it is significant to note that some polished elements were evident off the extreme edge.

Expedient Tool Experiments

Methods for Expedient Tool Experiments

The goal of the following experiments was to observe the wear traces acquired on bifacial tools used in expedient tasks. Fifty-nine of the sixty-five bifaces in the Gault assemblage are early-stage or unfinished artifacts. If use-wear traces were observed on these bifaces they were most likely the products of expedient tasks conducted at the site.

Therefore, the following experiments established the type, distribution, and intensity of wear traces produced from the designated expedient use-activities, chopping and scraping wood. The experimental bifaces manufactured for these tasks were not curated tools, meaning that the implements were early stage bifaces made for an immediate task and remained unhafted (Binford 1973 see Cahen, Keeley, and Van Noten).

Expedient Tool Experiment BUR4

BUR4 was a stage 2 biface with a width to thickness ratio of approximately 4:1 (Whittaker 1994:202). This biface was used to chop an oak tree branch measuring 4.5 cm in diameter. The proximal end of the tool was slightly backed to dull the portion of the edge that contacted the hand. The tool trajectory was a downward chopping motion for 1,600 strokes to split the branch. Prior to analysis, BUR4 was thoroughly cleaned with the two phases of cleaning to remove all wood residues. After the first phase of cleaning it was apparent both macroscopically and microscopically that residues still remained on the surface, so the working edge of the biface was held in a sonic bath for approximately five minutes to complete the cleaning process.

BUR4 acquired use-wear in the form of microflaking and polish. Use-units were documented at two locations along the working edge, location 1 and 2.

The chopping task damaged the original tool edge with micro step-fractures and hang flakes, or flakes that remain partially attached to the flake nucleus. Wear traces were marginally distributed with an abrasive polish that began at the working edge and increased in intensity at its furthest extent approximately 1 mm into the center of the biface. Polish was restricted to the highest portions of the microtopography. Location 1, a prominent aris of the first lateral flake scar situated approximately 1 mm inland from the distal edge of the tool, was texturally smoothed with an A gradient polish (Figure 20: 1-500x after chopping). Location 2, on the opposite face, was also abrasively polished with an A gradient polish development (Figure 20: 2-500x after chopping). The orientation of the texturally smoothed asperities demonstrated the general direction of the use-activity, perpendicular to the working edge. These isolated, ephemeral polish elements indicated the tool was utilized, however a much lengthier use-duration was required for substantial or linked-up polish development.

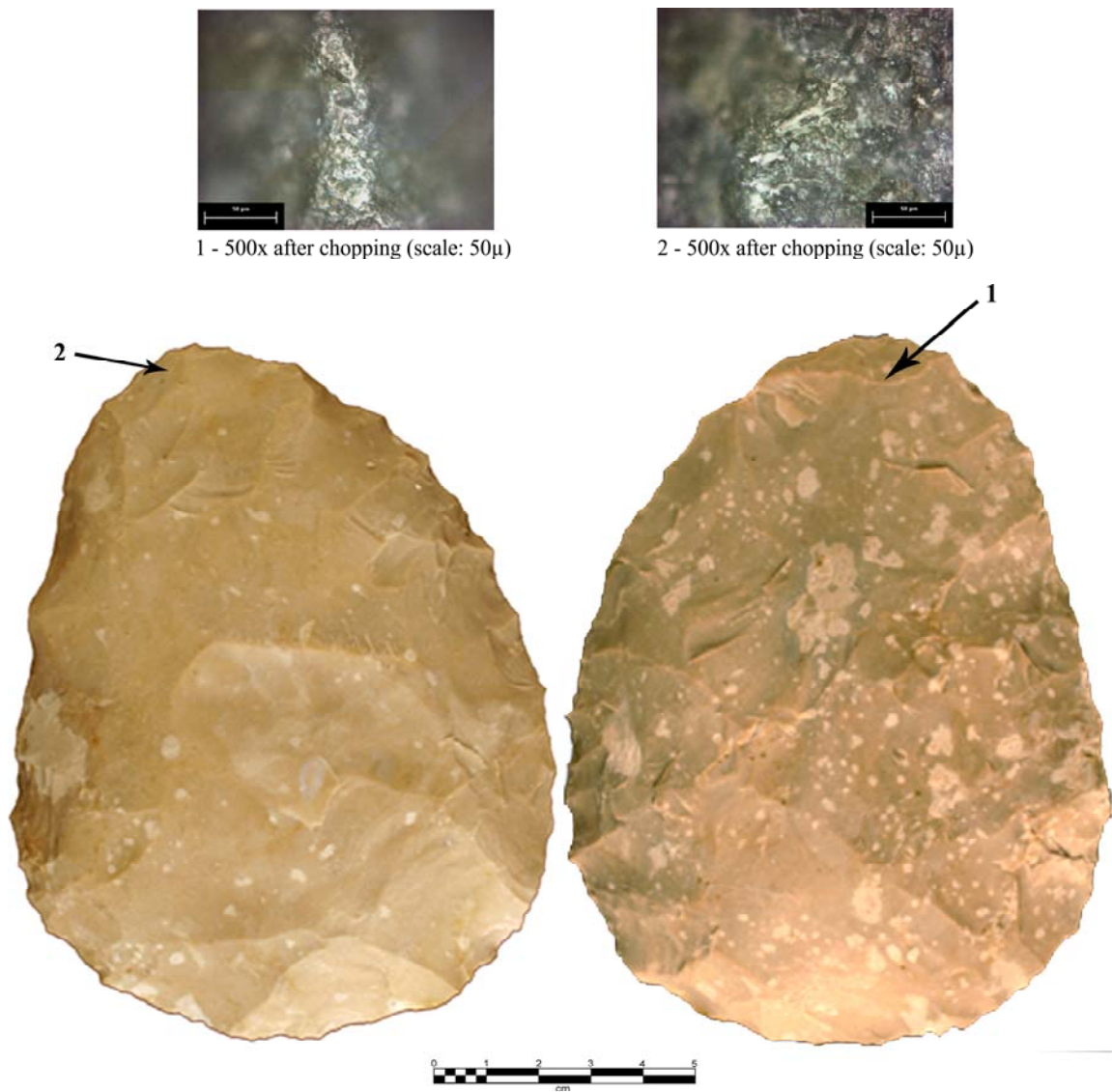


Figure 20. Experimental Biface BUR4 Expedient Tool Experiment Chopping.

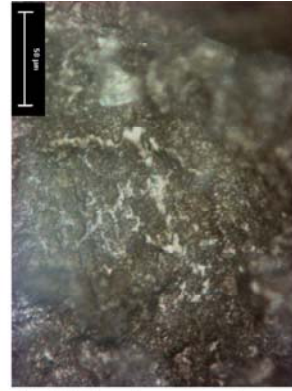
Expedient Tool Experiment BUR8

BUR8, a stage 2 biface, was chosen as a suitable scraping tool based on the general morphology; a band of cortex on the lateral edge served as a natural backing for the hand. This tool performed a total of 1,000 scraping strokes to remove the bark from an oak tree branch. BUR8 required two phases of cleaning to remove wood residues; the biface was soaked in a solution of warm water and emulsifier and then emerged in a sonic bath for five minutes to remove any remaining residue.

The most significant evidence of use was the extensive microflaking on the scraping edge. The perpendicular trajectory of the scraping motion produced step fractures and hang flakes. Similar to the observations made on BUR4, polish elements were isolated and restricted to only the highest features on the chert surface. In some cases these ephemeral polish elements illustrated the use-trajectory of the tool. At the highest portion of location 1, an isolated polish element located on a series of step fractures directly on the scraping edge, asperities were smoothed in a linear orientation perpendicular to the working edge (Figure 21: 1-7-500x after scraping). BUR8 acquired an A gradient polish development distributed with a bilateral asymmetry concentrated on the first 0.5mm of the scraping edge. There was no evidence of use-wear off the edge closer toward the center axis, though this portion of the tool was in contact with wood during use.



1 - 200x after scraping
(scale: 100µ)



1 - 500x after scraping
(scale: 50µ)

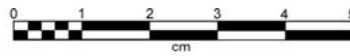


Figure 21. Experimental Biface BUR8 Expedient Tool Experiment Scraping.

Conclusions from Expedient Tool Experiments

The expedient tasks produced general patterns of use-wear evidence that served as didactic tools for the Gault biface analysis. For example, all polish elements were located strictly on high features of the microtopography. These areas were slowly abraded away, with polish facets only evident at a 500x magnification. Polish elements developed to an ephemeral A gradient polish and remained isolated from one another with no linking up. When this evidence was compared to microwear produced from the butchering and stabbing experiments, the traces acquired during these scraping and chopping tasks resulted in a more limited distribution on the tool surface. This most likely was the product of the hardness level of the softer wood and the extent of tool penetration into the contact material. The working edges developed extensive scarring or microflaking, but did not appear to be rounded from use. More rounding and attrition of the surface texture may occur with a longer duration of use.

Multi-functional Tool Experiments

Marvin Kay (1998) suggests that striations on the stone tool surface help distinguish a tool's functional purpose over time, and he uses the orientation of superimposed striations to interpret the use-sequence of a given tool used in more than one type of use-activity. Levi Sala's (1996:60) experimental results present contrary evidence that suggest different polishing episodes can only be determined if the use-activities produce different polish distributions. Therefore, evidence of one episode is

lost once another episode is superimposed over it. The purpose of this experiment was to investigate the wear traces produced when a single tool is utilized for more than one type of use-activity. The goal was to discern if a single tool can 1) acquire distinguishable traces of wear from two different activities and 2) if these distinguishable traces are maintained after consecutive uses.

Multi-functional Tool Experiments: Impact and Butchering

BUR21 gained diagnostic projectile wear traces from two series of horse stabbings, but the damage done to the antler foreshaft during the second impact series left the hafted point unserviceable as a projectile. The tool was then used to partially butcher the horse stabbed in the third impact experiment. The incision, initiated at the wound created by BUR17, cut down the horse's coastal portion of the thorax to the sternal region and cut back caudally towards the left quarter. The connective tissue and cutaneous trunci muscle were cut away with the layer of hide. The tool performed 200 underhand cut strokes to peel the animal's hide and muscle back. With precision cuts the point removed the latissimus dorsi muscle and sliced through the fascia. BUR21 was used to detach the external abdomen oblique muscle from the ribs, with precision cuts that slid the point along the ribs and exposed the animal's body cavity. BUR21 was an effective butchering tool and performed 300 strokes without any sign of weakening.

Multi-functional Tool Experiments: Impact and Butchering Results

BUR21 acquired flake damage on the cutting edge in the form of fresh step fractures and gouges. Newly acquired microscopic use-wear traces were most prominent on the tip and along the cutting edge of the tool. Use-wear traces were documented at four new areas along the cutting edge. A small band of abrasive polish extended along the extreme lateral edge from the tip to the haft (Figure 22: 4-200x after butcher phase 2 cleaning; 4-500x after butcher phase 2 cleaning). BUR21 acquired wear traces at locations 5, 6, and 7 that illustrated the tool's use-trajectory. Proximal-facing facets on the microtopography were texturally smoothed, indicating that the tool was used with a back-and-forth motion on the contact material (Figure 22: 5-500x after butcher phase 2 cleaning). Location 6, situated on the cutting lateral edge approximately 1.5 cm from the tip, was a proximal-facing facet that was polished and incised with a striation oriented oblique to perpendicular to the lateral edge (Figure 22: 6-200x after butcher phase 2 cleaning, 6-500x after butcher phase 2 cleaning). The linear indicator resulted from the particles, either chert or bone fragments, incising the microtopography as the tool sliced against and along the ribs. The once rounded tip of the point was damaged with micro-step fractures and the surface was polished. The tip acquired a series of ephemeral linear indicators oriented obliquely from the point's tip proximally (Figure 22: 7-500x after butcher phase 2 cleaning).

Multi-functional Tool Experiments: Impact and Butchering Conclusions

BUR21 obtained wear traces from the butchering activity that were distinguishable from traces obtained from the point's previous uses. The most prominent indication of the new task was the distinct distribution of use-wear traces on the tool's surface. After the projectile impact series, use-wear traces were most intense along the center-axis of the points. The lateral edges did obtain an ephemeral polish, but when compared to the intense polish development on the center-axis, the stabbing use-trajectory was apparent. The butchering task produced an opposite effect on the polish distribution. Polished surfaces were distributed with a bilateral asymmetry that was biased to the extreme cutting edge. Locations along the center-axis that previously acquired wear were not altered by the new task; however, the cutting edge developed a consistent, constricted band of polish with a B gradient of development (Grace 1989). Proximal-facing or trailing edges of flake arises were texturally altered, indicating that the contact material slid along the microtopography from the proximal end of the tool. The tool's use-trajectories, an underhand back-and-forth motion and precision cuts perpendicular to the contact material, were also expressed by the newly acquired striations perpendicular or oblique to the lateral edge. Based on the distribution and intensity of the wear traces, traces produced from stabbing and traces acquired during butchering could confidently be distinguished.

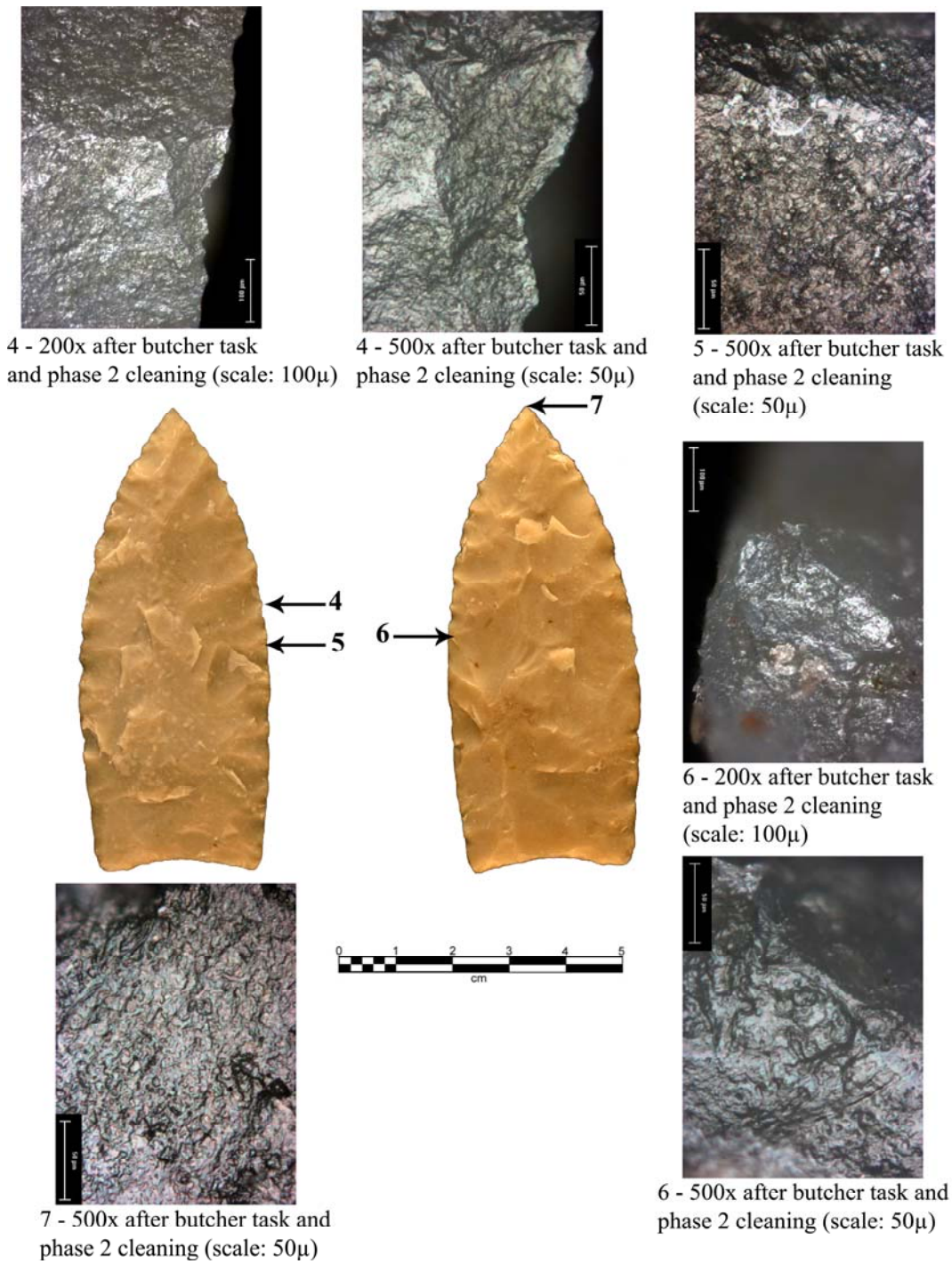


Figure 22. Experimental Point BUR21 Multi-functional Experiments: Impact and Butchering.

Multi-functional Tool Experiments: Impact and Cutting Raw Hide

BUR24 acquired impact fractures and microwear traces during the first impact experiment. The tool was not utilized in the following impact experiments because the foreshaft snapped in the animal. BUR24 was not reworked, but instead recycled to cut strips of raw hide dried from a bison yearling. This task helped to differentiate between secondary cut wear attained from slicing meat and wear attained from slicing a tougher, drier material. A total of 300 strokes were made to cut four long strips of raw hide. A sawing motion was used to initiate the cut and overhand strokes were performed to slice the strips.

Multi-functional Tool Experiments: Impact and Cutting Raw Hide Results

BUR24 was removed from the haft and soaked for approximately 12 hours in a solution of warm water and emulsifier to dissolve hide glue and any other unwanted residues.

Cutting raw hide created noticeable wear at four use-areas: locations 3, 4, 5, and 6. The rough contact material altered the lateral edge with extensive flaking and microwear. All arises and protrusions along the cutting edge acquired microstepping and abrasive polish (Figure 23: 3-200x after cutting rawhide; 3-500x after cutting rawhide). The trailing edges of flake scars and proximal facets of flake arises were polished. For example, the orientation of polish at location 4 illustrated the tool's cutting motion (Figure 23: 4-200x after cutting rawhide). The hardness of the raw hide was enough to produce linear indicators on the cutting edge. Both locations 5 and 6

were abrasively polished and incised with striations that oriented perpendicular to the cutting edge (Figure 23: 5-500x after cutting rawhide; 6 BUR24-25-500x after rawhide). In this experimental program bone was the only other contact material that produced this wear type.

Multi-functional Tool Experiments: Impact and Cutting Raw Hide Conclusions

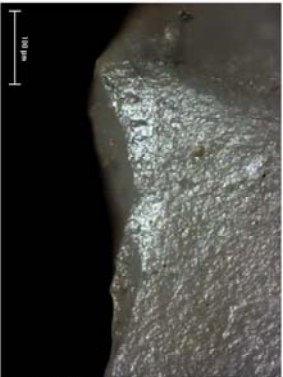
BUR24 proved to be an inefficient tool for this task. The sinuosity of the point's lateral edge produced ragged, imprecise cuts. This problem could be resolved in the future by using a flake or blade tool to cut the raw hide strips. However, the goal of the task was accomplished, to create a wear distribution distinct from wear produced from stabbing. Use-wear traces were concentrated on the lateral edges, while locations on the point's center-axis remain unaffected. This exercise illustrated the effects of contact material hardness on tool edges used in cutting tasks. The lateral edge experienced more extensive microflaking and damage relative to BUR21, the projectile recycled to butcher the horse. In general, individual areas of use-wear attained a much more developed polish; a C polish gradient on Grace's (1989) polish development scale. Further, when compared to BUR21, striations on BUR24 were more deeply incised in the polished surface. This was due to the fact that the lateral edge of BUR24 made more consistent contact with the hard raw hide, whereas the butchering tool infrequently slid along bone. The majority of the butchering task was spent cutting much softer meat and connective tissue.



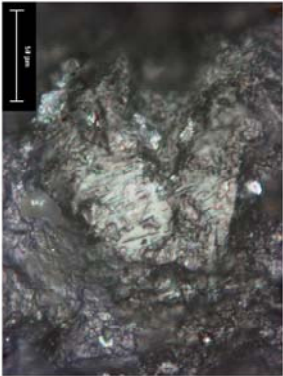
3 - 200x after cutting raw hide (scale: 100μ)



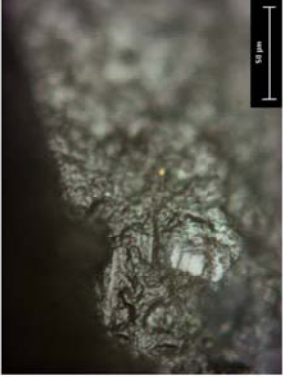
3 - 500x after cutting raw hide (scale: 50μ)



4 - 200x after cutting raw hide (scale: 100μ)



5 - 200x after cutting raw hide (scale: 100μ)



6 - 200x after cutting raw hide (scale: 100μ)

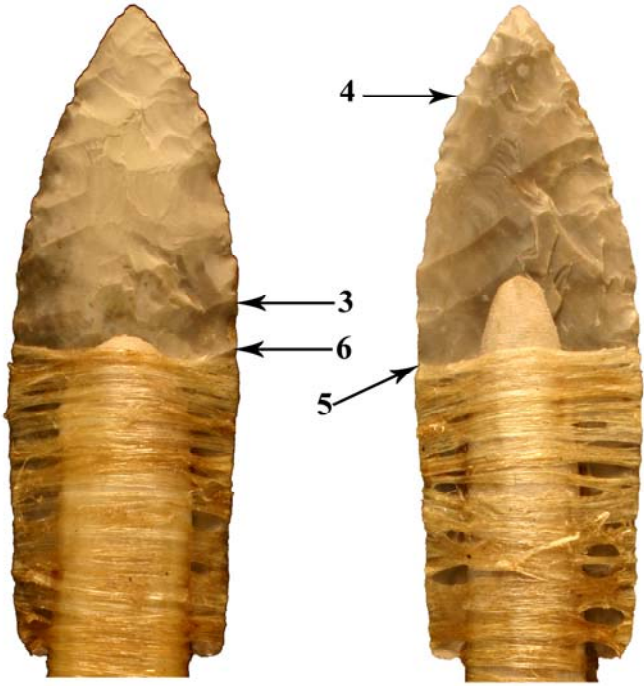


Figure 23. Experimental Point BUR24 Multi-functional Experiments: Impact and Cutting Raw Hide.

CHAPTER V

USE-WEAR ANALYSIS OF THE GAULT COLLECTION

Finished Points

Excavations at the Lindsey Pit of the Gault Site recovered one preform, one preform base, the tip of a point, a point base, and three complete finished points. All of these points, with the exception of the unidentified point base, were reduced from bifacial cores made with the local variant of Edward's chert. The preforms help provide a complete understanding of the reduction sequence and bifacial technology at the Gault Site, but they did not acquire evidence of use-wear. However, the fluted projectile points show signs of an extensive life-cycle of use, repair, recycle, and discard. In the following section, the use-wear evidence detected on each of the projectile points and point fragments is identified and the potential functional significance is reported.

Finished Point 383A

Finished projectile point 383A is an extensively re-worked lanceolate Clovis point found within the Clovis clay unit (3a) of the Lindsey Pit. Specimen 383A acquired strong indications of use near the point's tip, base, and in the remnant flute scar. Use-wear traces at five locations help to reconstruct the use-history of the fluted projectile point. Rounded arrises at the tip and along lateral edges indicate that the point was used after the extensive re-work took place. Rounded edges are associated with polished surfaces in the form of textural changes on the microtopography. These wear traces

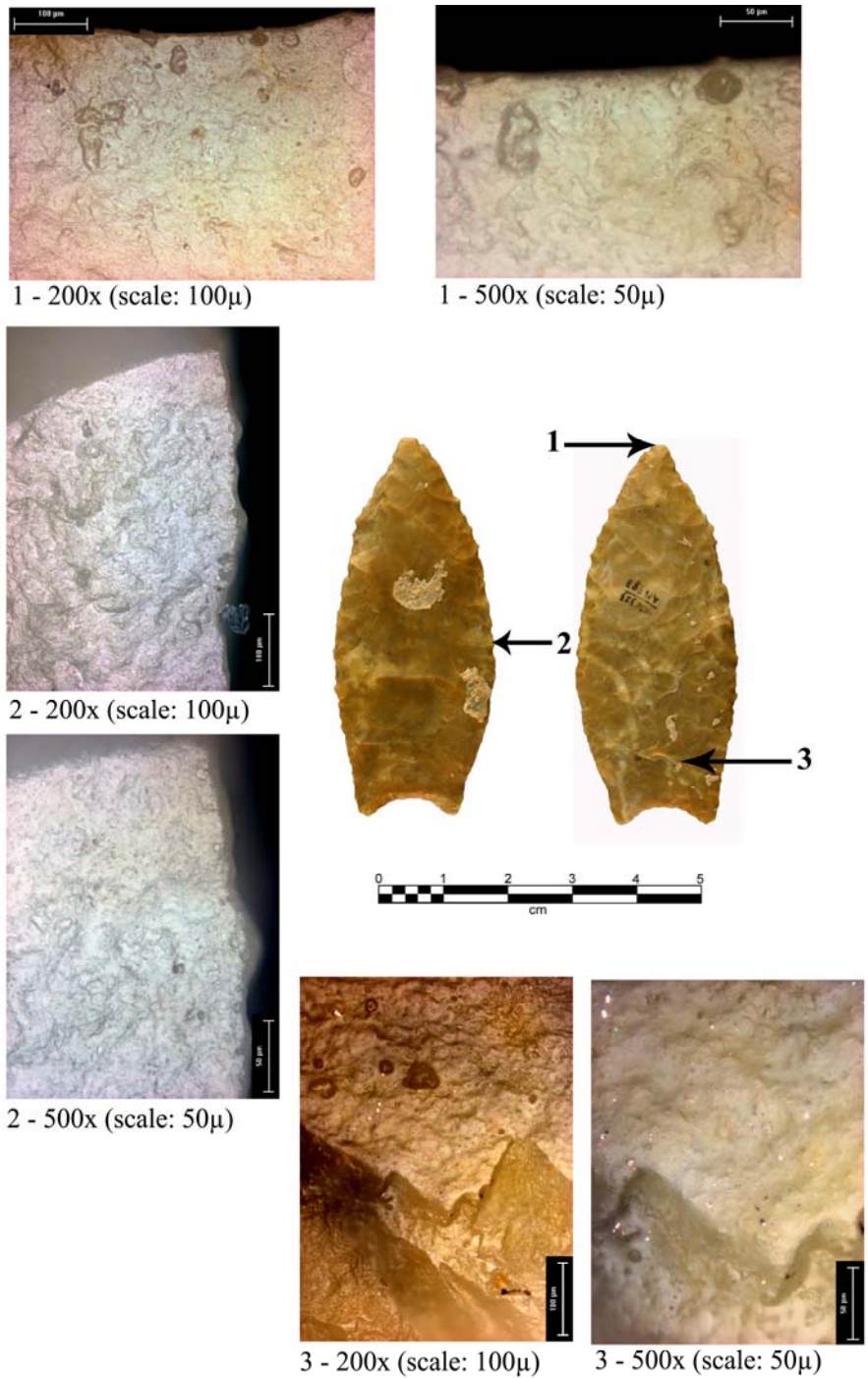


Figure 24. Gault Finished Point 383A Use-wear Images.

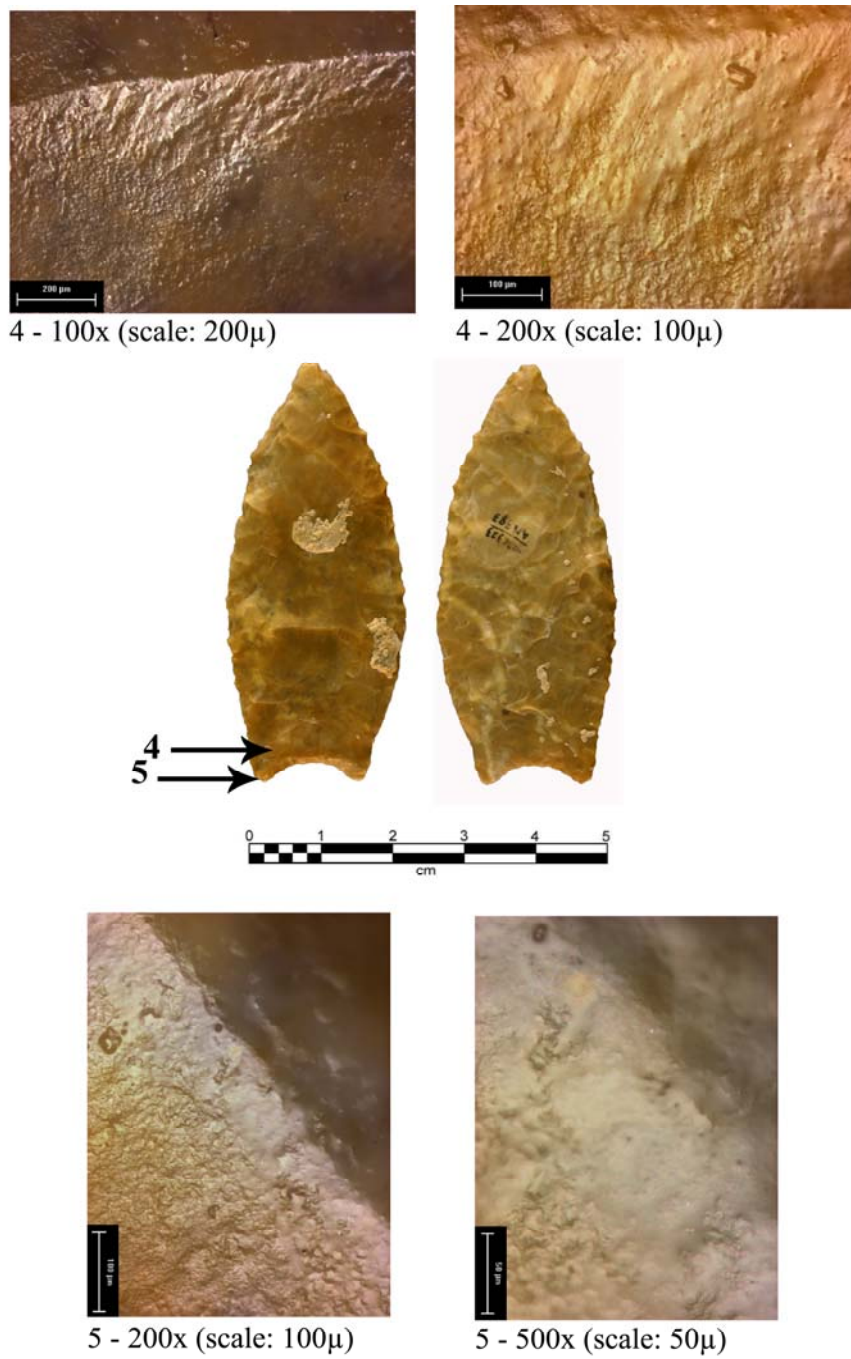


Figure 25. Gault Finished Point 383A Use-wear Images.

begin at the distal-most portion of the tip and continue proximally along the center axis and lateral edges for 3.5 cm. Location 1 (Figure 24: 1-200x, 1-500x) is a damaged portion of the tip that is rounded and abrasively polished, with nearly all surface asperities removed. The frequency and intensity of both the polish elements and linear indicators increase in the proximal half, or the formally hafted portion of the point. Based on the previous experimental program, wear traces in the hafted region of a projectile are the products of movement in the haft during use, not the results of the haft binding process. Location 2 represents the region on the projectile point where rounding and polishing caused by the contact material ends, and more intense evidence of haft wear begins (Figure 24: 2-200x, 2-500x). I detected a similar pattern on experimental point BUR17. Wear traces are intense at the tip, fade as you move proximally from the tip, and abruptly increase in intensity in the hafted region of the point. The haft wear traces reveal the point's complex life-use history. After the original basal end was broken off, the proximal end was reworked to leave behind only a remnant of the previous flute scar. Microwear traces concentrated at the termination of this remnant scar could possibly be the combined evidence of the early use-activity, before the re-work and uses following the re-work of the point's base. The original flute terminates with a micro-step fracture that has been rounded and abrasively polished, due to the area's direct contact with the haft (Figure 24: 3-200x, 3-500x). Use-wear traces at the proximal edge of the point's base are undoubtedly the products of the most recent use-activity. The point's re-worked base and basal ears are polished and acquired linear indicators from movement in the haft during use. Location 4 represents an area on the

center ridge of the point's basal ear that has been abrasively polished and incised with striations (Figure 25: 4-100x, 4-200x). The striations start at the ridge of the basal ear and run parallel to oblique to the long-axis of the point. The orientation of these striations indicates that 383A was still being used as a projectile after the final re-work of the base. Well developed use-wear traces continue from the center ridge of each basal ear into the remnant flute scar and along the concave base or proximal edge of the point (Figure 25: 5-200x, 5-500x). An identical distribution was detected on experimental point BUR17, and these observations concluded that the polish elements accurately plotted the locations where the stone surface came in contact with the haft. Therefore, haft wear traces on projectile 383A plot the general width and style of the final hafting implement. The final hafting implement was fixed between the basal ears, measured approximately 1.5 cm wide, and made contact with the point's beveled basal end. Haft wear traces present on both the dorsal and ventral faces suggest that the hafting technique was have been a wedge design or beveled foreshaft with a shim-like binding piece fixed to the opposite face.

Fluted projectile point 383A exhibits a very well developed C polish on high surfaces of the point's tip and lateral edges (Grace 1989). This polish is more intense than the traces observed after three rounds of experimental stabbing. From the tip toward the proximal end, the frequency of polished surfaces gradually decreases. The polish regains frequency and intensity at the base of both the ventral and dorsal faces, approximately 3.5 cm from the tip. The linear indicators and polish pattern suggest that

the point's final use was as a projectile and this was most likely the primary function throughout the entire use-history.

Finished Point 191

Finished Clovis projectile 191 is a complete lanceolate point crafted from Gault's local chert material. Specimen 191 was recovered at the junction between the Clovis-age soil (3b) and a colluvial gravel unit. This artifact was extensively used and re-worked before discard. The distal end of this point was re-worked before the tip was blunted by a series of micro-step fractures. Scars on the ventral face indicate that the point had several fluting episodes, and the final episode created a deeply concave base. Patination and staining altered the proximal two-thirds of the chert surface, making a use-wear analysis ineffective. While traces were observed on the tip and lateral edges, they only serve as functional clues rather than a complete picture of the point's use-life. Nonetheless, the tip of 191 has been extremely rounded and abrasively polished from use; three areas are identified as use-units. Location 1, on the ventral side of the re-worked tip, is a high surface on the microtopography that has been differentially polished to leave a smooth surface texture with little asperities (Figure 26: 1-200x, 1-500x). Similar traces of rounding and polish were observed on the extreme tip of experimental projectile point BUR21 (see Figure 6: location 2). Use-wear traces continue along the center ridge of the point. Location 2, situated 3 mm from the extreme tip on the ventral face, is an example of a pattern consistently found on artifact 191. This location is an oblique pressure flake aris that is rounded and abrasively polished on

the leading edge or distal-facing portion of the flake scar (Figure 26: 2-200x, 2-500x). Again, a similar pattern of wear was observed on an experimental projectile point, BUR20 (see Figure 14: location 1; Figure 15: location 4 and 5). The distribution of use-wear traces on distal-facing facets suggests the tool's use-trajectory was that of a projectile. The point penetrated the contact material, moving from the tip proximally down the center-axis, to leave traces on the leading edges of lateral flake scars. This general distribution and type of wear continue on the point's dorsal face; arises at the reworked tip and along the center-axis are rounded and polished (Figure 26: 3-200x, 3-500x).

Finished point 191 exhibits a B linked polish development in use-units on the tip and center ridge of both faces. Use-wear traces are distributed with a longitudinal asymmetry along the point's center axis. At individual areas of use, the polished surface initiates at the leading edge, or distal-facing surface, and fades in intensity proximally on the microtopography. Patination and staining make a conclusive functional interpretation impossible. Based on wear traces found on the unaffected distal portion and traces documented on experimental projectile points BUR20 and BUR21, fluted point 191 appears to have been reworked and utilized at least once more as a projectile.

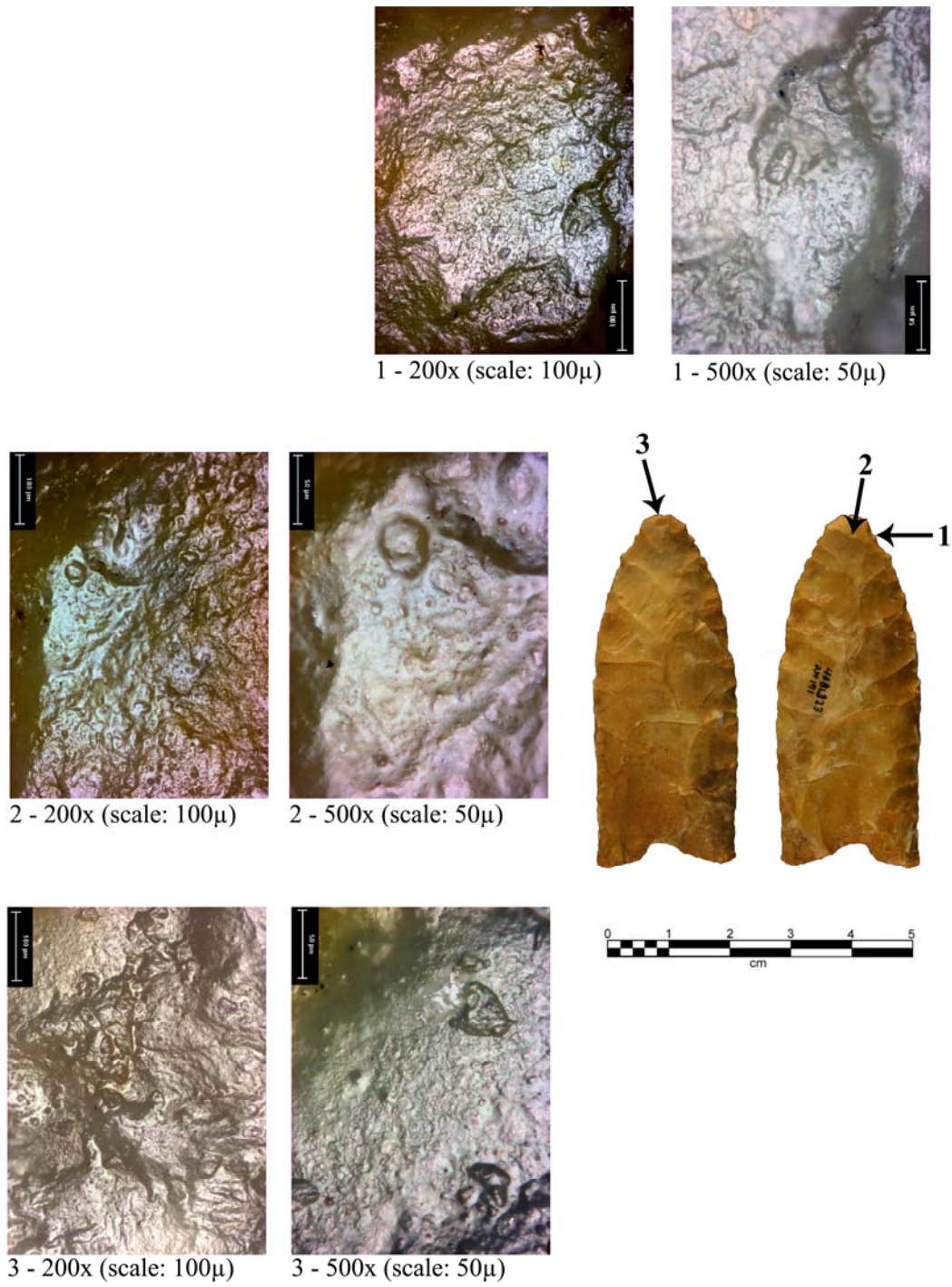


Figure 26. Gault Finished Point 191 Use-wear Images.

Finished Point 228E

Finished point 228E is a lanceolate projectile point recovered from the Clovis clay stratigraphic unit (3a). The distal portion of this point was extensively re-chipped along the lateral edges to produce a narrow shape with a length that is approximately three times the width. This point initially functioned as a projectile, but at some point during its use-life 383A was utilized as a knife. Fourteen use-units are identified to describe the evidence of utilization on fluted point 228E. The original use as a projectile resulted in a slight impact fracture at the tip and basal corner. The point's tip is rounded and polished with a B+ polish gradient (Grace 1989). Polish elements are abrasively smoothed and link up on the microtopography (Figure 27: 1-200x; 2-200x, 2-500x). Experimental point BUR21 acquired similar damage and use-wear distribution after two rounds of stabbing. The experimental point's direct contact with a rib bone produced a blunted or rounded facet at the extreme distal end. Compared to BUR21, the Gault specimen has a more intense polish development on the tip. Therefore, it follows that after the re-work fluted projectile point 228E was utilized more than two uses as a projectile. Polish begins at the distal tip and extends proximally along the center-axis. Projectile use-wear was observed at location 3, an area on the center-axis formed by the intersection of three pressure flakes. Polish at this location is distributed with a linear orientation that fades in intensity, from the distal portion of the flake scar ridge proximally (Figure 27: 3-100x). This polish pattern was consistently detected on experimental replicas utilized in the projectile impact study.

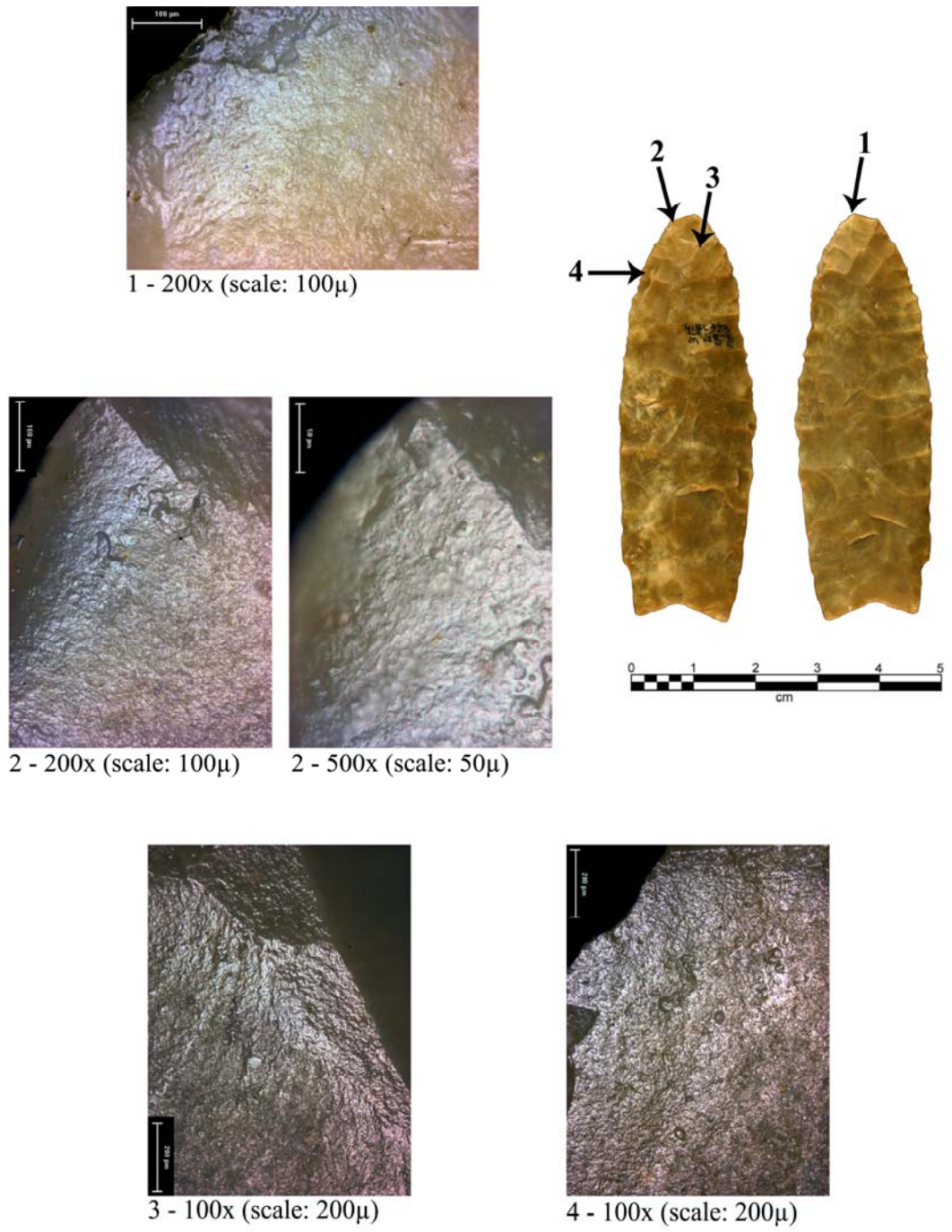
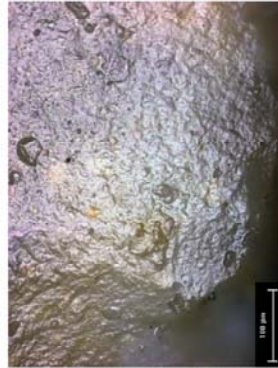


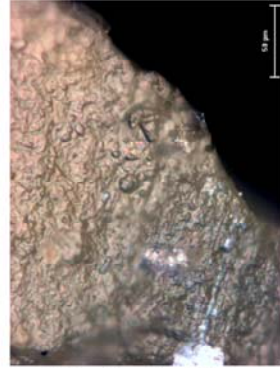
Figure 27. Gault Finished Point 228E Use-wear Images. Plate 1 of 3.



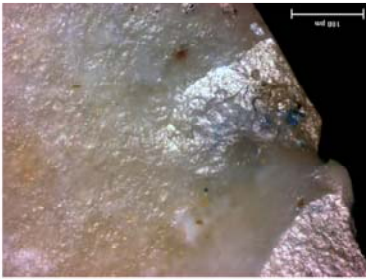
5 - 200x (scale: 100µ)



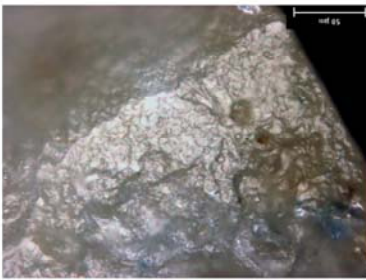
6 - 200x (scale: 100µ)



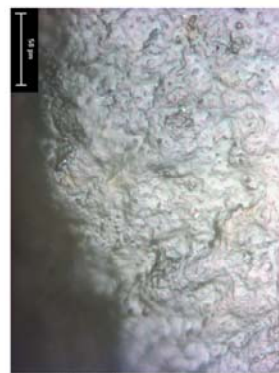
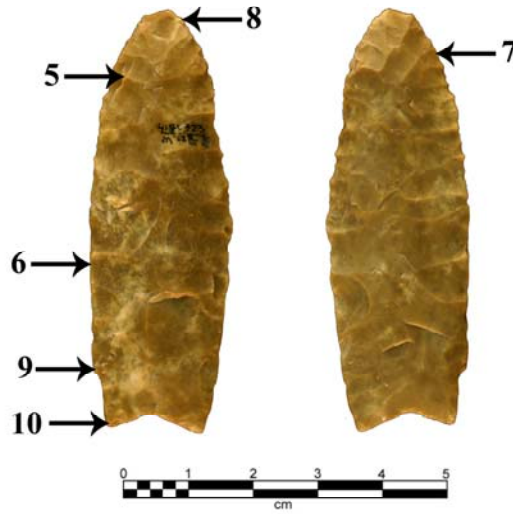
7 - 500x (scale: 50µ)



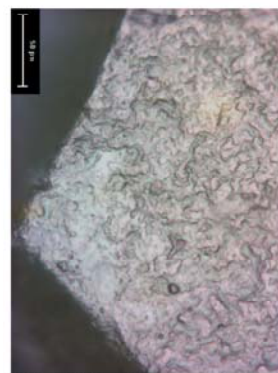
8 - 200x (scale: 100µ)



8 - 500x (scale: 50µ)

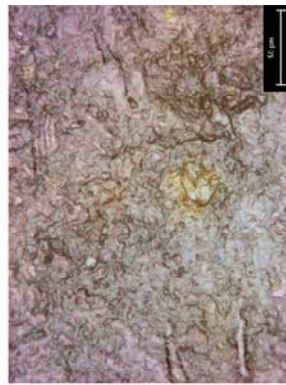


9 - 500x (scale: 50µ)



10 - 500x (scale: 50µ)

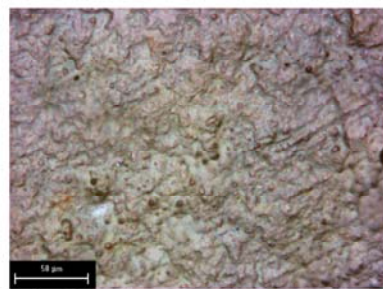
Figure 28. Gault Finished Point 228E Use-wear Images. Plate 2 of 3.



11 - 500x (scale: 50µ)



12 - 200x (scale: 100µ)



14 - 500x (scale: 50µ)



13 - 200x (scale: 100µ)

Figure 29. Gault Finished Point 228E Use-wear Images. Plate 3 of 3.

In addition, a distinct suite of use-wear traces along the lateral edges indicate that 228E was also utilized as a knife. The extreme lateral edge is consistently polished in a band that gradually fades towards the center-axis (Figure 27: 4-100x). The trailing edges of flake scar arises, or proximal-facing faces, are abrasively polished (Figure 28: 5-200x; 6-200x). The polish patterns on experimental butchering tools BUR19 and BUR21 had a similar distribution. Distributions on these butchering tools were distinct from experimental projectile points because polish elements were not only on leading edges, but also on the proximal-facing facets. Further, the strongest evidence of the fluted point's alternative function is the series of striations incised into the extreme lateral edge. Linear indicators perpendicular to the lateral edge indicate the tool use-trajectory was a cutting motion. Location 7 is a polished conchoidal flake scar on the lateral edge with striations incised into the flattened microtopography (Figure 28: 7-500x). BUR21 acquired linear indicators with the same perpendicular orientation after only 300 strokes butchering a horse (Figure 22), and BUR24 acquired the same evidence after cutting raw hide (Figure 23). In addition, the distal half of the opposite lateral edge of 228E was re-worked and then this edge was also utilized as a knife after the modification. Proximal-facing facets are polished with a B+ polish development. Location 8 sits on the tool edge, approximately 1 mm from the tip, with a proximity to the tip that makes the area subject to the affects of both projectile and cutting use-activities. This location is a significant glimpse at the life-use history of 228E. Linear indicators at this location are oriented both perpendicularly and parallel to the edge (Figure 28: 8-200x, 8-500x). Based on the wear traces along the center axis this point

was initially utilized as a projectile. The distal half of the damaged right lateral was reworked. The edge was then used in a cutting activity that produced a micro-step fracture that initiated from the lateral edge, a polish element with a C polish gradient, and ephemeral striations perpendicular to the use-edge. Following the cutting activity, 228E was utilized once again as a projectile. This final use-event created a deeply incised striation oriented parallel to the edge that overlaps the perpendicular striations and step fracture. This linear indicator is consistent with the direction of impact and penetration.

The proximal portion of the point also contains use-wear evidence that reveals the point's life-use history. After the basal end was broken off in the haft, this portion was re-worked with a double flute on the dorsal face and a single flute on the ventral. The point was re-hafted and utilized after this modification. The proximal end of the dorsal face acquired a developed C+ polish on the high ridges of the double flute scar and basal ears from contact with the hafting implement (Figure 28: 9-500x; 10-500x). Inside the flute scar a differential polish is limited to the highest areas on the microtopography. Striations have incised a polished surface along the lateral edge of the hafted area. The orientation of the shallow linear indicators is parallel to the lateral edge, the expected direction from usage as a projectile (Figure 29: 11-500x) (Kay 1998:772). On the ventral face, the point developed polish elements with a B+ gradient along the high flake arises, the ridges of basal ears, and flute scar ridges (Figure 29: 12-200x). On this face, linear indicators serve as the most prominent evidence of hafting and use. Location 13, on the right aris of the flute scar, is a polished surface with more

than fifteen striations running oblique to perpendicular to the center-axis (Figure 29: 13-200x). On the left aris of the same flute scar, another series of striations incise the polished surface. However, these linear indicators are oriented with an oblique to perpendicular direction that runs in the opposite direction of the previous series (Figure 29: 14-500x). The multiple orientations of the linear indicators serve as further evidence that 228E was not strictly a projectile, but also functioned as a hafted knife.

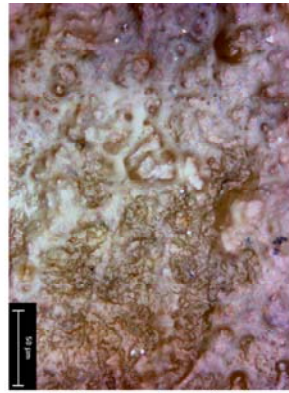
The linear indicators at the point's tip are testaments and haft wear of the adaptability of the tool. Well developed wear traces at the tip and along the center-axis indicate that the finished point functioned as a projectile that penetrated animal and slid along bone. Microflaking and linear indicators originating at the lateral edges, as well as polish elements on the trailing aspects of flake scars, are evidence of use as a knife. At the point's tip these distinct functions are superimposed to reveal a functional cycling sequence of use-events. Point 228E was most likely hafted into a foreshaft that could be attached to a mainshaft for projectile usage, and detached from this shaft to interchangeably serve as a hafted knife for butchering tasks.

Finished Point 281

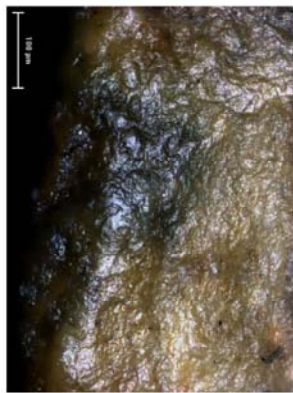
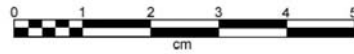
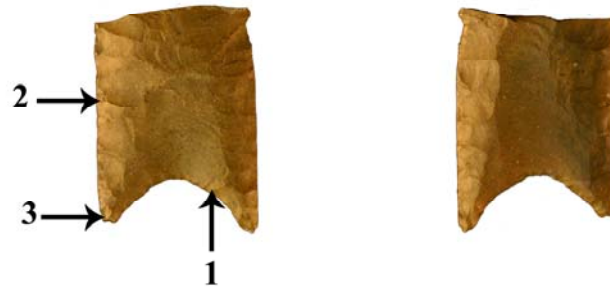
Specimen 281 is the basal half of a finished Clovis point found at the junction of the colluvial gravel and the Clovis clay unit (3a). The material type is suggested to be a type of jasper, but the specimen has not been definitively sourced. Point 281 may represent the only exotic stone recovered from the Lindsey Pit excavation area. While the point is incomplete, the point snapped in the haft, the basal end has a distinct morphology with a significant set of use-wear traces, and three areas on the point serve



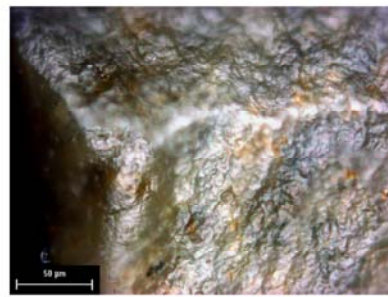
1 - 200x (scale: 100 μ)



1 - 500x (scale: 50 μ)



2 - 200x (scale: 100 μ)



3 - 500x (scale: 50 μ)

Figure 30. Gault Finished Point 281 Use-wear Images.

as examples of utilization. The deep flutes on each face have created a concave base with minor micro-flaking on the extreme basal edges. The base is extensively polished along the lateral edges, basal ears, basal edge, and inside both the dorsal and ventral flute scars. This same wear distribution was observed on the hafted portion of experimental replicas BUR17 (Figure 12) and BUR24 (Figure 17). On fluted point base 281, polish inside the flutes starts at the retouched proximal edge and extends up to the transverse break. All high surfaces on the microtopography have been abrasively smoothed with a C+ polish gradient; individual polish elements have little to no surface asperities and are linking up on the microtopography (Figure 30: 1-200x, 1-500x). Polish is most intense along the basal and lateral edges of the point. Lateral edges have been grinded from the basal ears up to the transverse break. These edges are extensively rounded and polished from the grinding and movement in the haft element (Figure 30: 2-200x; 3-500x). The extent of dulling and the transverse break indicate the extent of the haft. Specimen 281 is a classic example of projectile point discard. Most likely, this specimen was broken in the haft due to impact damage; the base remained stuck in the haft element during transport, and was finally removed at the Lindsey Pit for discard and re-tooling.

Finished Point Tip 277ZZ

This specimen is a tip fragment of a finished point found within the Clovis levels. Use-wear traces at five areas on the stone tool surface clarify that the fragment was utilized before a transverse break damaged the point. The distal-most portion of the tip is extensively rounded, with B gradient polish elements present on both the dorsal

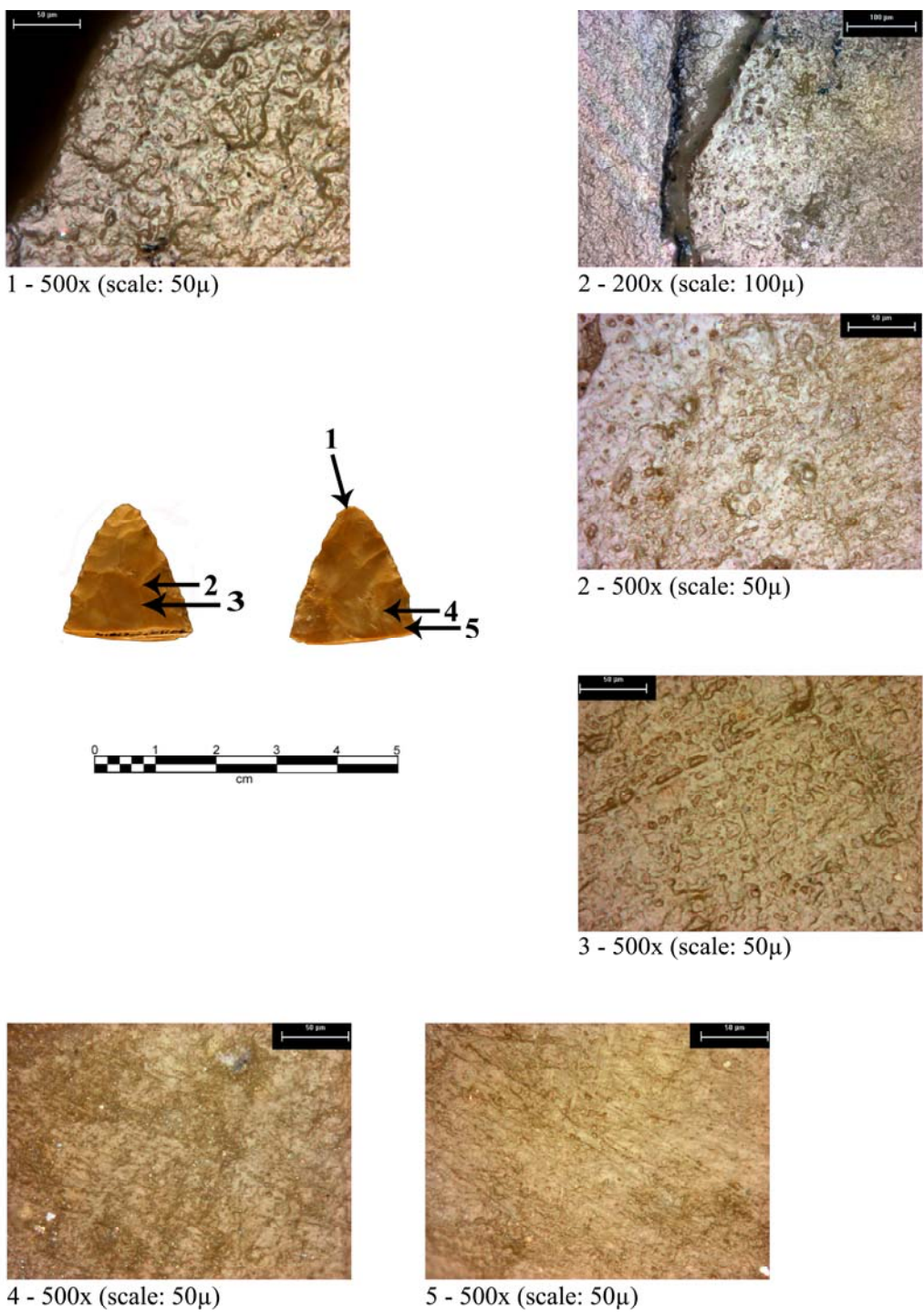


Figure 31. Gault Finished Point Fragment 277ZZ Use-wear Images.

and ventral faces (Figure 31: 1-500x). Wear traces on the fragment gain intensity and frequency approximately 1 cm from the distal-most portion of the tip. Location 2 is a step fracture with abrasively polished elements and linear indicators on the highest feature of the step flake. These same types of use-wear traces also developed on the lowest portion of this feature, at the base of the step (Figure 31: 2-200x, 2-500x). Polish on the lateral-facing facets indicates that the contact material initiated at the lateral edge of the tool. Further, polish elements on the step-flake facet and at the base of the fracture are the results of a soft contact material that affected both high and low features of the microtopography. In close proximity to this step feature is a series of cross-hatched striations incising a gradual ridge on the tool surface (Figure 31: 3-500x). The orientation of these linear indicators indicates that the tool was utilized with two general use-trajectories; a cutting motion and a penetration trajectory. This pattern continues on the same lateral edge of the opposite face, in an area approximately 0.5 mm from the transverse break. Location 4 is situated in the conchoidal waves of a negative flake scar. Again, this low feature on the microtopography was differentially polished by an evasive or soft contact material. Evidence of the tool trajectories is also present at polish elements on the transverse fracture. Striations produced by a cutting motion incise the polished surface with an orientation that is oblique to the lateral edge (Figure 31: 4-500x). At location 5, deeply incised oblique striations cross-cut short, more ephemeral linear indicators parallel with the long axis and clarify the tool's use-sequence (Figure 31: 5-500x).

The distribution of polish elements and superimposed wear traces indicate that the tool first functioned as a projectile then was utilized in a butchering task. Polish elements with a B development gradient are bilaterally distributed along the right lateral edge and center-axis (Ahler 1979:316). Polished asperities on both high and low areas of the tool's surface attest to the softness of the contact material and the extent it permeated down into features on the microtopography. These traces are most likely the result of contact with animal meat during butchering. According to the extent and intensity of the oblique linear indicator, the butchering task was an intense use-activity that caused the blade edge to repeatedly contact bone. Finally, the transverse break that damaged the point at its tip was the last use-wear produced from the tool's final task.

Finished Point Conclusions

First and foremost, the Gault finished points are extensively curated tools. Continual retouch and re-work produced points substantially smaller in size than the average Gault preform. The extent of use and re-work is not only evident by the general size and shape of the points, but is further reinforced by the microscopic use-wear traces they acquired. Generally speaking, the final use-events of the Gault points have created wear traces that are more intense, in both frequency and extent, than those traces detected on the experimental points. These traces first confirm that the resharpened and refurbished points were still functional projectile points, and secondly, suggest the extent of use before discard. While an impact or thrusting event is a naturally chaotic event, the presence of more advanced wear traces on the Gault specimens potentially implies

that the points were utilized, in their final re-worked state, for more than three rounds of projectile usage. Further, two of the five specimens obtained use-wear evidence that clearly shows point recycling, beyond use as a projectile. My observations are in agreement with Kay's (1998) interpretation that the effects of multiple uses can be microscopically detected on a tool surface. Projectile usage and butchering tasks create distinct polish distributions and linear patterns on a tool surface. At locations where the tool surface was affected by both use-activities, wear traces are found superimposed on the microtopography, and their succession illustrates the sequence of use-events. One specimen in particular acquired linear indicators that demonstrate a cycling of use as a projectile and use as a knife. The repeated alternation of tool functions requires a shaft design with a foreshaft that is easily extractable and replaceable. These extensively re-worked points were designed to be easily maintainable tools, and in some cases, meet the needs of both projectile and butchering tasks interchangeably.

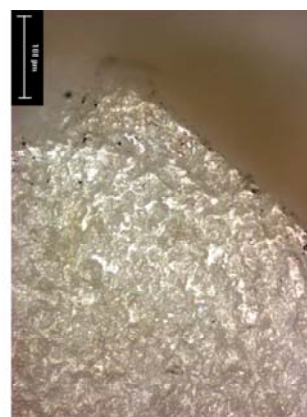
Unfinished Tools

Approximately 90% of the biface collection recovered from the Lindsey Pit consists of unfinished bifacially flaked stones left in early stages of the reduction sequence. While the majority of these bifaces were discarded due to manufacture mistakes and/or internal material flaws, there are unfinished bifaces that have ephemeral evidence of utilization. These wear traces are most likely the result of expedient use-activities conducted at the site, and therefore, the functions they represent help

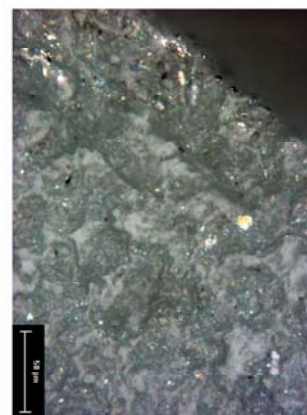
reconstruct Paleoindian life-ways at the Gault Site. The following specimens serve as examples of quarry manufacture byproducts utilized as expedient bifacial tools.

Bifacial Tool 261VV

This specimen, recovered from the Clovis clay stratigraphic unit (3a), is a large irregular-shaped blade core with three small blades removed from the proximal end. The blade removals produced a beveled proximal edge that is unifacially damaged with micro-step flaking and crushing from the tool's use as a chopper. High-power microscopic analysis of this biface reveals an A gradient polish that initiates at the proximal edge and extends 4 mm in from the working edge. Surface asperities along the proximal edge are abrasively smoothed, with isolated polish elements linearly distributed on the highest step features of the microtopography (Figure 32: 1-200x, 1-500x). Experimental chopper BUR4 serves as a direct analogue for this Gault biface. After approximately 1,600 chopping strokes on wood, BUR4 developed isolated polish elements with the same wear distribution and intensity. Based on the use-wear on the artifact itself and the experimental analogue, 261VV appears to have been recycled as a large chopper to perform an expedient task on hard wood.



1 - 200x (scale: 100 μ)



1 - 500x (scale: 50 μ)

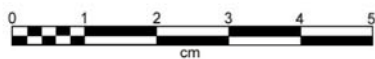


Figure 32. Gault Bifacial Tool 261VV Use-wear Images.

Bifacial Tool 314BB

Artifact 314BB is a stage III biface recovered from the Clovis clay unit (3a) of the Lindsey Pit. This specimen is the proximal-lateral portion of a bifacial core removed by a perverse fracture. Lateral parallel flaking along the tool edge is well spaced with minor edge crushing. The general morphology of the tool lends itself to an expedient use. The perverse break created a smoothed surface that fits comfortably in hand and enables the curved flaked edge to be utilized with short side strokes. Based on use-wear evidence at six locations on the tool's edge, 314BB was recycled after the fracture and utilized as an expedient scraper. The working edge has developed an A+ gradient of polish with large polished elements that are not yet linking up on the microtopography. The arises of lateral flake scars have been abrasively polished with a texturally smoothed polish element oriented perpendicular to the tool's edge (Figure 33: 1-500x). The lateral edges of negative flake scars are also polished by the use-activity. The perverse break produced a tip with an abrasively polished step fracture (Figure 33: 2-500x). Wear at the tip extends slightly onto the perverse fracture break indicating that the tool was utilized after bifacial fragment 314BB was broken off from the core. The natural curvature of the biface creates a concave portion of the edge, and the intensity of use-wear evidence on this surface indicates that this portion of the edge did the majority of the work. The entirety of the concave edge acquired polish oriented 90 degrees to the long-axis and extensive microchipping that initiates at the edge and extends inward toward the center-axis approximately 100 μ m (Figure 33: 3-200x). Experimental scraper BUR8 obtained a similar

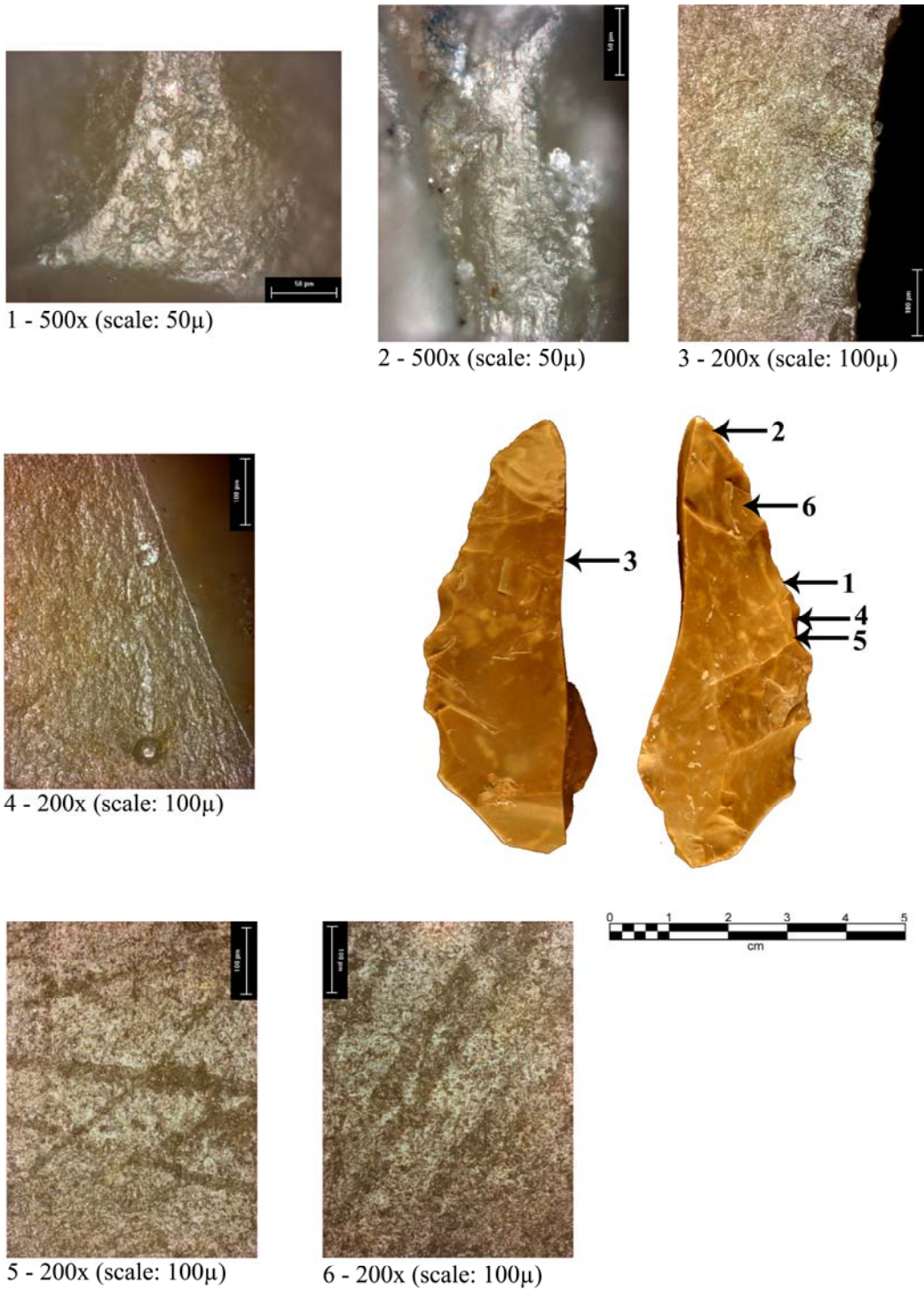


Figure 33. Gault Bifacial Tool 314BB Use-wear Images.

microflaking pattern with step fractures and invasive chipping at the extreme use-edge up the tool face (Figure 21).

The use-trajectory is best revealed by the series of linear indicators detected at two distinct areas along the curved edge, the proximal extent and the distal extent of the concave portion of the lateral edge. Location 4, situated on the second ridge of a micro-step series at the proximal end of the curved lateral edge, not only demonstrates the tool's trajectory, but also illustrates one mechanism responsible for the formation of linear indicators. At this location a portion of a surface asperity has been broken off from the edge, pushed along the surface to create a furrow, and relocated approximately 225 μm from its origin. The tool surface and the asperity itself were polished prior to particle movement. Then the scrapping use-activity plucked a portion of the polished asperity and dragged the piece across the tool surface producing a furrow or striation that remains unpolished (Figure 33: 4-200x). Levi Sala (1996: 68) refers to this wear pattern as the mechanism responsible for "comet tail Pits" and suggests that this is a major mode of formation of polish and linear indicators on a utilized tool. More extensive evidence of the tool's use-life is apparent at location 5, a triangular, polished, facet created by two flake removals. Asperities were removed and dragged across the surface with a crisscross orientation (Figure 33: 5-200x). This indicates that the tool angle changed slightly during the use-activity and created furrow paths at the new angle. Additional signs of linearity are also apparent on the distal portion of the concave edge, at location 6. This location was effected by asperities moving along the polished surface with a

transverse orientation (Figure 33: 6-200x). Therefore, during the last task this portion of the tool edge contacted the worked material with a constant use-angle.

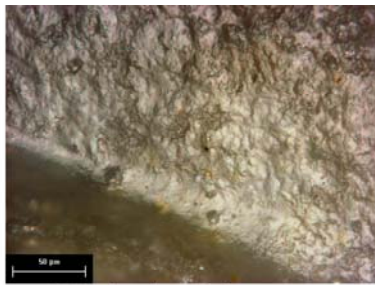
In conclusion, use-wear evidence proves biface 314BB was not immediately abandoned after manufacture failure, rather this specimen was recycled as an expedient scraper. Based on the extent and distribution of the A+ polish, this biface was utilized for a short duration. The facial asymmetry of the use-wear traces indicates the concave portion of the lateral edge performed the task. Transverse striations are the products of short scraping strokes. More specifically, the individual operating the expedient scraper slightly altered the angle of the use-trajectory, perhaps with a twist of the wrist. Finally, the frequency and intensity of these linear indicators suggest that the tool was used to scrape a hard contact material, such as a hard wood, that continually removed and relocated surface asperities.

Bifacial Tool 319V1

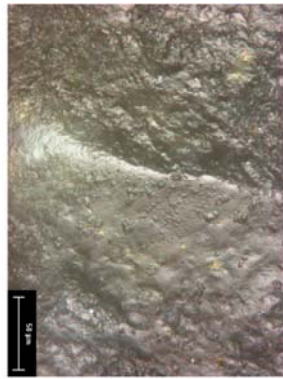
This specimen is the lateral and medial fragment of an ultrathin late stage biface recovered from the Clovis clay unit (3a) of the Lindsey Pit. The biface has marginal pressure flaking and may have been in its final state of manufacture before the transverse snap created the fragment. Use-wear evidence from six locations on the lateral edge indicates that biface 319V1 was utilized as a knife after the break. High features on all the marginal flake scars have been abrasively polished with a C+ polished gradient. Flake arises have been extensively rounded, and almost all the surface asperities at polish elements have been removed (Figure 34: 1-500x; 2-500x; 3-500x; 4-500x). At

location 5, the highly developed polished surface is microflaked with a general orientation that is perpendicular to the working edge (Figure 34: 5-500x). The transverse break created a fresh snap on the lateral edge that has acquired evidence of use after the manufacture failure took place. At this location, a series of step fractures are rounded and abrasively polished (Figure 34: 6-500x). The extent of damage in this area suggests that this portion of the tool may have been the leading edge.

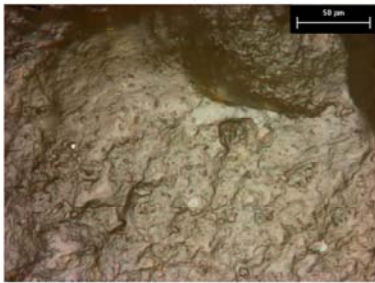
In summary, bifacial tool 319V1 obtained a marginally distributed C+ polish along the lateral edge and snap break. Use-wear traces are found only on the lateral edges with an orientation to that edge that is indicative of cutting. Based on the placement of polish elements, the highly developed polish is limited to high features on the microtopography, and the extent of rounding this tool appears to have been used on a hard contact material. The experimental program proves that wear traces with this intensity could not be produced by meat-cutting activities, and therefore, I deduce specimen 319V1 was recycled at the Gault Site as an expedient knife to cut or incise bone.



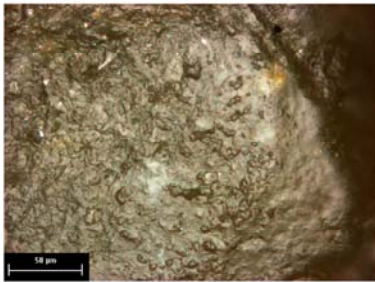
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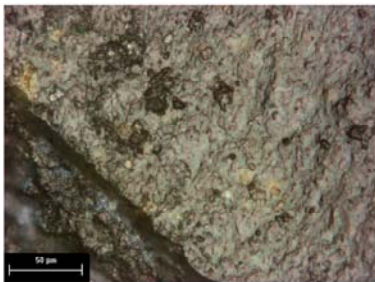
2 - 500x (scale: 50μ)



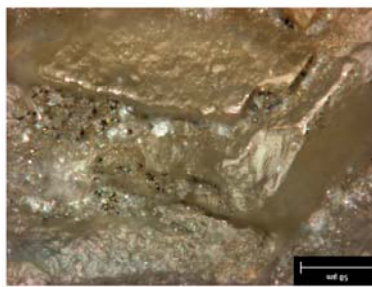
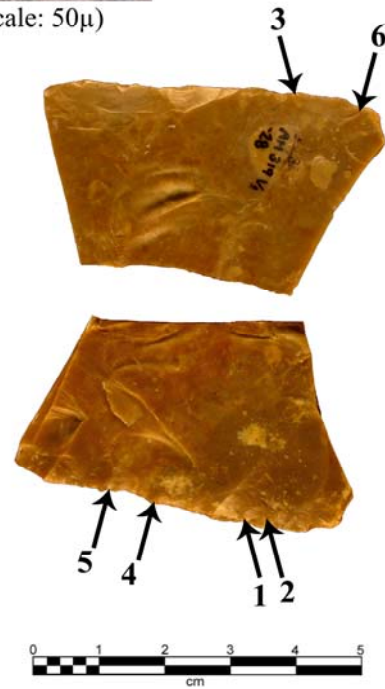
3 - 500x (scale: 50μ)



4 - 500x (scale: 50μ)



5 - 500x (scale: 50μ)



6 - 500x (scale: 50μ)

Figure 34. Gault Bifacial Tool 319V1 Use-wear Images.

Unfinished Bifacial Tool Conclusions

The extent and intensity of wear traces on the unfinished bifaces indicate that Paleoindians at the Gault Site were not only quarrying chert materials, but also completing expedient tasks. Based on the extensive concentrations of cultural materials and the necessary time invested in producing such lithic debris, it is not startling to find that people at Gault required tools for non-quarrying activities. While quarrying was certainly the primary task, the byproducts of manufacture failure were employed in activities that represent other on-site tasks such as butchering, chopping wood, scrapping wood, and cutting bone.

CHAPTER VI

CONCLUSIONS

The Gault Biface Collection

This investigation demonstrated the effective role of use-wear studies in understanding tool functionality. The analysis was a rare opportunity to study a large collection of Clovis-age artifacts recovered from a quarry-camp site context, with Clovis bifaces representing all stages of reduction and manufacture. Use-wear evidence provided a more thorough understanding of the life-use history of the bifaces recovered from the Lindsey Pit by establishing which bifaces were chosen to be utilized tools, demonstrating the functional purpose of those tools, and suggesting their extent of use.

The conclusions based on use-wear analysis of the biface collection from the Lindsey Pit of the Gault site are as follows:

1. Of the sixty-five bifaces analyzed, ten specimens (approximately 15 %) have evidence of utilization. The strong use-wear indicators on eight (approximately 12 % of the total assemblage) of the ten bifaces allowed me to confidently describe the life-use history of these artifacts.
2. When the bifaces are separated into their respective stages of manufacture (Table 3) (according to Callahan's (1979) steps in manufacture), there is a corresponding relationship between the number of bifaces in later stages of manufacture and the number of those bifaces utilized as tools. This pattern is the expected product of behavior at a paleoindian quarry site; extensively utilized finished fluted projectile

points discarded and new points were in the process of manufacture. While there are comparatively more finished tools with evidence of utilization, there are also bifaces in the early stages of manufacture that obtained use-wear traces. Based on microscopic analysis, these tools were employed for expedient tasks, and their use indicates temporary campsite activities. In summary, this use-wear analysis confirms that the Gault site was a quarry-campsite context, with quarrying as the primary site activity.

Table 3. Number of bifaces within each stage of manufacture with use-wear evidence.

Stage of Manufacture	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
Total Number of Bifaces	22	17	13	5	3	5
Total Number of Bifaces with Use-wear	1	1	0	2	1	5

3. Perhaps the most significant set of conclusions reached in this study pertain to the functional interpretations made on the five Clovis projectile points and point fragments. Generally, the function of fluted projectile points is often assumed. Prior to this study, use-wear traces were detected and interpreted on only four other Clovis projectiles. This analysis doubled the body of evidence of Clovis projectile point functionality and revealed the complicated use-lives of the projectiles recovered from the Lindsey Pit. The fluted projectile points obtained evidence of extensive use, re-work, and recycling, with use-wear traces that are more intensely developed than the traces obtained in three rounds of experimental uses. All of the Gault fluted points acquired linear indicators and polish distributions indicative of their use as projectiles. In addition, two specimens acquired use-wear evidence indicative of cutting; the serviceable blades edges were employed as butchering knives. One of these points was utilized with a cycling pattern from projectile usage, to utilization as a butchering tool, and to a final use as a projectile once again. Highly developed haft-wear on the proximal ends of three of the projectile points help to reconstruct the haft binding technique; the extent of these traces are indirect evidence for a wedge style of foreshaft or mainshaft. In short, the analysis of these use-wear elements contributes to a better understanding of Clovis technology and fluted point functionality.

The Experimental Program

The experimental program in this thesis clarified a number of issues concerning stone tool function and demonstrated how experimental analogues are an essential aspect

of use-wear investigations. The use-wear traces on experimental replicas served as an empirical basis for the evaluation and interpretation of the Lindsey Pit biface assemblage. The conclusions based on the analysis of replicas utilized in the experimental program are as follows:

1. Projectile point replicas obtained diagnostic use-wear traces with a consistent pattern of distribution. Polish elements were concentrated high arises and facets at the point's tip and extended proximally along the center-axis; these use-units gained intensity with each stabbing. Linear indicators were oriented in the direction of impact and penetration. The lateral edges of the points did begin to develop isolated use-units of an ephemeral polish after two rounds of stabbing, but traces were by far more apparent and developed along the point's center-axis.
2. Further, the projectile point replicas obtained diagnostic use-wear traces after only one series of impact with the animal. The appearance of such traces was unexpected due to the instantaneous nature of stabbing and impact, however, the tip and center-axis of the projectiles that slid along bone acquired polish elements.
3. Butchering experiments entailed a combination of slicing meat and bone, and it was predicted that this repetitive activity would quickly produce use-wear traces. Quite the opposite, after 2,000 strokes, use-wear evidence remained strictly ephemeral in development and was distributed in isolated use-areas along the extreme cutting edge. Diagnostic evidence of butchering includes polished surfaces on proximal facing facets along the lateral edge and oblique to perpendicular linear indicators initiating at the cutting edge.

4. It is possible to identify two distinct use-activities performed with the same tool. In agreement with Kay's (1998) conclusion, this experiment demonstrated that a tool acquires distinguishable traces of wear from butchering and stabbing, and these distinguishable traces are maintained after consecutive uses. Therefore, the placement of polished facets and superimposed linear indicators help map out the changes in functional tool purpose over time.

In conclusion, this analysis is a contribution to a more thorough understanding of the function of Clovis bifacial tools, and in turn, the behavior of the paleoindian peoples who made use of them.

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