8-2020

Form, Function, and Context: Lithic Analysis of Flaked Stone Artifacts at a 17th-Century Rural Spanish Estancia (LA 20,000), Santa Fe County, New Mexico

Clint S. Lindsay
University of Massachusetts Boston

FORM, FUNCTION, AND CONTEXT: LITHIC ANALYSIS OF FLAKED STONE ARTIFACTS AT A 17TH-CENTURY RURAL SPANISH *ESTANCIA* (LA 20,000), SANTA FE COUNTY, NEW MEXICO

A Thesis Presented
by
CLINT S. LINDSAY

Submitted to the Office of Graduate Studies,
University of Massachusetts Boston,
in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

August 2020

Historical Archaeology Program

FORM, FUNCTION, AND CONTEXT:
LITHIC ANALYSIS OF FLAKED STONE ARTIFACTS AT A 17TH-CENTURY RURAL SPANISH *ESTANCIA* (LA 20,000), SANTA FE COUNTY, NEW MEXICO

A Thesis Presented
by
CLINT S. LINDSAY

Approved as to style and content by:

____
Heather B. Trigg, Research Scientist II
Fiske Center for Archaeological Research
Chairperson of Committee

____
Stephen W. Silliman, Professor
Member

____
Stephen Mrozowski, Professor
Member

____
David B. Landon, Program Director
Historical Archaeology Program

____
Stephen W. Silliman, Chairperson
Department of Anthropology

ABSTRACT

FORM, FUNCTION, AND CONTEXT:

LITHIC ANALYSIS OF FLAKED STONE ARTIFACTS AT A 17^{TH}-CENTURY RURAL SPANISH *ESTANCIA* (LA 20,000), SANTA FE COUNTY, NEW MEXICO

August 2020

Clint S. Lindsay, B.S., Utah State University
B.S., Utah State University
M.A., University of Massachusetts Boston

Directed by Dr. Heather B. Trigg

This thesis examines the flaked stone artifact assemblage recovered from LA 20,000, a 17^{th}-century (ca. 1630-1680 AD) rural Spanish colonial *estancia* located near Santa Fe, New Mexico. Settlements like LA 20,000 were important locations of cultural interaction between Spanish colonists and local Indigenous peoples who often worked and lived together in multi-cultural households. By analyzing the procurement, production, and use of flaked stone artifacts to identify choices and activities performed at the site by the people who lived and labored there this study helps to fill gaps in the knowledge and understanding of 17^{th}-century flaked stone artifact production and use within a distinctly colonial setting. Raw materials, reductive strategies, types and frequencies of debitage and tools, obsidian sourcing results, and

spatial distributions are thus considered. For greater context, results are compared against data from other Spanish and Indigenous sites in New Mexico, revealing the ambiguities of materiality in colonial settings. As one of the few in-depth flaked stone artifact analyses to be conducted at an early colonial rural Spanish *estancia* in New Mexico this study not only provides comparative data and analysis to broaden regional understanding of flaked stone technology and use within an early colonial setting, it also allows fellow researchers to better interpret complementary data from other colonial contexts, both synchronically and diachronically. Furthermore, by combining textual evidence with archaeological data in the context of labor, this study fills a recognized need to integrate the study of Indigenous people involved in colonial labor relations into broader labor studies. While flaked stone tools in and of themselves do not signify or identify any one specific group of people, considering the socioeconomic context of early Spanish colonial New Mexico and its heavy reliance upon neighboring Puebloan and other Native American peoples for labor and trade, the flaked stone assemblage at LA 20,000 undoubtedly reflects the Spanish incorporation of Indigenous peoples, their traditions, and knowledge of flaked stone materials into daily practices situated within contexts of social labor relations where colonial inequalities were actively negotiated.

ACKNOWLEDGEMENTS

I would like to thank my advisor Dr. Heather Trigg for her direction and the invaluable comments and suggestions regarding my thesis drafts. She was consistently available to answer questions and to discuss new ideas. I would also like to thank my other committee members, Dr. Stephen Silliman and Dr. Stephen Mrozowski for their indispensable feedback, suggestions, and edits. A special thanks is extended to staff at the Andrew Fiske Memorial Center for Archaeological Research for their generosity in helping me to carry out the various aspects of my research. In particular, I greatly appreciate Dennis Piechota for his help and insight with XRF obsidian analysis, Dr. Douglas Bolender for his patience and assistance with GIS, Dr. John Steinberg for help with statistical analysis, and Melody Henkel for providing many of the artifact photos.

I would also like to thank James L. Moore and Dr. Bruce J. Kaiser for their time corresponding and providing me with relevant information regarding research. Jim was helpful in identifying New Mexico lithic materials and strike-a-light flint use-wear. Bruce calibrated the obsidian reference set readings used in the XRF analysis and looked over my findings and calculation conversions for the analyzed LA 20,000 obsidian samples.

Finally, but certainly not least, I would like to thank my family for their support and encouragement. Particularly my wife Anh, for her constant motivation, patience, and valued advice throughout the course of my academic pursuits.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS vi

LIST OF FIGURES ix

LIST OF TABLES x

CHAPTER Page

1. INTRODUCTION 1
   Historical Context 7

2. SITE BACKGROUND 11
   History of Archaeological Investigations at LA 20,000 14
   The Flaked Stone Assemblage 16

3. METHODS 19
   Challenges in Flaked Stone Artifact Analysis 20
   Analytical Techniques 21
      Debitage Attribute Analysis 21
      Stone Tool Attribute Analysis 26
      Use-Wear Analysis 27
      Obsidian Sourcing Analysis 30
      Spatial Analysis 31

4. FLAKED STONE ANALYSIS AND RESULTS 33
   Assemblage Overview 33
   Lithic Material Sources At and Around LA 20,000 35
   Flaked Stone Material Analysis 38
   Debitage Analysis 40
      Debitage Attributes 42
      Local versus Distant Lithic Material Reduction 50
      Debitage Summary 57
   Flaked Stone Tool Analysis 58
      Flaked Stone Tools 60
      Tool Reuse and Recycling 81
      Flaked Stone Tool Summary 84

CHAPTER Page

5. OBSIDIAN SOURCING 89
  XRF Analysis and Results 90
    Technological Analysis of Obsidian Geochemical Sources 93
    Obsidian Artifacts Summary 101
  Obsidian Procurement Strategies 102

6. SPATIAL ANALYSIS 110
  Spatial Analysis by Analytical Unit 111
    House Area 114
    Barn Area 116
    Corral Area 116
    Unit D Area 117
    Midden Area 118
    Sourced Obsidian by AU 119
    Spatial Analysis Summary 123

7. DISCUSSION AND CONCLUSIONS 125

APPENDICES

A. DEFINITIONS 145

B. EXPEDIENT TOOL DEBITAGE ATTRIBUTES 151

C. EXPEDIENT TOOL EDGE WEAR ATTRIBUTES 152

D. EXPEDIENT TOOL USE INTERPRETATIONS 156

E. OBSIDIAN X-RAY FLUORESCENCE DATA 159

F. SUPPLEMENTARY SPATIAL ANALYSIS 162

REFERENCES 173

LIST OF FIGURES

Figure Page

1. Site Location Map of LA 20,000 11
2. Site LA 20,000 Overview 12
3. Site LA 20,000 Geologic Setting 36
4. Combined Percentage of Dorsal Cortex and Size for all Complete Flakes 48
5. Complete Non-Cortical Flakes with Modified Platforms by Flake Size and Flake Scar Counts 50
6. Percent of Debitage Size for Obsidian and Non-Obsidian Materials 56
7. Examples of Cores from LA 20,000 62
8. Bifaces from LA 20,000 70
9. Projectile Points from LA 20,000 71
10. Drill-1 73
11. Strike-A-Light Flints from LA 20,000 76
12. Gunflints from LA 20,000 78
13. Geographic Distribution of LA 20,000 Sourced Obsidian Geochemical Groups 91
14. Flaked Sone Artifacts/Excavation Unit Area 111

LIST OF TABLES

TABLE Page

1. Lithic Debitage Assemblage Site LA 20,000 34
2. Flaked Stone Tool Assemblage 34
3. Material Type Frequencies 39
4. Debitage Types 42
5. Size Grade of Complete Flakes by Average Measurements....44
6. Platform Types and Frequencies....46
7. Debitage Groups 46
8. Type of Debitage by Amount of Cortex 47
9. Type of Platform by Amount of Dorsal Cortex 49
10. Complete and Proximal Flake to Angular Debris Ratios by Material Source....51
11. Platform Types for Complete and Proximal Flakes by Material Source....52
12. Amount of Cortex for Flakes by Material Source 54
13. Platforms for Complete and Proximal Non-Cortical Flakes by Material Source....55
14. Summary of Flaked Stone Reduction Strategy Indicators....57
15. Flaked Stone Tools by Material Types 59
16. Cores 61
17. Core Type by Average Size 63
18. Informal Flaked Stone Tools 64
19. Informal Tool Attributes 66

TABLE Page

20. Suggested Informal Tool Motions and Functions 67

21. Formal Flaked Stone Tools 69

22. Strike-A-Light Flint Attributes 75

23. Gunflints from LA 20,000 78

24. Evidence of Reuse and/or Recycling 82

25. Counts and Weights of Obsidians by Source 92

26. Obsidian Debitage Assemblage from Site LA 20,000 93

27. Obsidian Flaked Stone Tool Frequencies and Weights 94

28. Platform Types for Complete and Proximal Obsidian Flakes by Source 96

29. Obsidian Cores 97

30. Expedient Obsidian Tools by Debitage Attributes 97

31. Formal Obsidian Flaked Stone Tools 97

32. Flaked Stone Artifact Type by Analytical Unit 112

33. Flaked Stone Material Type by Analytical Unit 114

34. Sourced Obsidian Counts by Analytic Unit 120

35. Sourced Obsidian Tools by Analytic Unit 120

36. Sourced Obsidian Tool IDs by Analytic Unit 120

CHAPTER 1

INTRODUCTION

There has been an underrepresentation of research on post-16th century flaked stone assemblages in the body of Southwest literature, as well as a scarcity of research conducted on both Spanish and Indigenous flaked stone assemblages during this time period in the Rio Grande region in general (Larson et al. 2017:97; Moore 1992). What little research has been done has primarily focused on formal tools (e.g., Kidder 1932), while debitage and informal tools have generally been excluded from any in-depth analysis. Even when flaked stone assemblages have been analyzed in full, a lack of standardization in methods and definitions has further impeded comparisons between assemblages (Larson et al. 2017:97; Railey 2011:187-189). While more recent investigations from cultural resource management projects have begun to address these issues (e.g., Railey 2011; Schwendler 2008), artifact sample size from these projects are often small, limited to in-field observations, and final reports difficult to access. Consequently, "differences in specific analytical methodologies accompanied by lack of comparability in recovery context and sample size, render detailed comparisons of these technological data untrustworthy" (Larson et al. 2017:97).

Similarly, research concerning the details of daily practices carried out at early colonial Spanish households has been scant (Levine 1992; Snow 1992) and the presence of flaked lithics, in particular, has received very little attention in colonial contexts when compared to other artifact classes (Cobb 2003:1-3; Moore 1992). Only a few early secular colonial Spanish homesteads have been excavated in New Mexico, and when flaked stone artifacts (excluding gunflints) have been found at these sites, they have generally been attributed to either contamination from earlier occupations or to reoccupation of the site by historically known Native American groups, but not to the people living there (Moore 1992:239). Interestingly, archaeological investigations conducted at later secular Spanish sites in New Mexico indicate that flaked stone tool use was a common occurrence at these sites and that settlers of Spanish and mixed heritage were likely practicing various, if only limited, forms of flaked stone tool manufacture into the 19th century (Moore 2004:179). As one of the very few early colonial Spanish homesteads excavated in the region, LA 20,000 offers a unique opportunity to reconsider such inconsistencies. Consequently, this study helps to fill gaps in the knowledge and understanding of 17th-century flaked stone artifact production and use within a distinctly colonial setting, a rural New Mexico *estancia.*

Rural *estancias* like LA 20,000 were centers for multicultural interaction and economic production and consumption (Levine 1992:205-206; Trigg 2005). In these types of settlements Spanish colonists incorporated many material elements from Indigenous cultures into their daily lives (e.g., foods, ceramics, flaked and ground stone technologies, architectural traits). This included individuals, especially Indigenous women, who, like things, were incorporated into Spanish households through various means (Gutierrez 1991; Jenks 2017:213-214; Rothschild 2006; Trigg 2005). While Spanish colonists likely made and used some lithic tools at LA 20,000 (strike-a-light flints and gunflints), other more formalized tools (projectile points and bifaces) indicate manufacturing techniques traditionally employed by Indigenous peoples of the region. Whether these formal tools were made and used by Native Americans on-site, were traded for and subsequently used by Spanish settlers, or were scavenged from earlier Indigenous sites and utilized by *estancia* residents are a few of the questions this lithic analysis attempts to answer. Evaluating the results of flaked stone analysis within the social and economic context of early colonial New Mexico may also reveal why people may have made the choices they made and allow the wider cultural context in which those choices were made to be interpreted.

It is important to realize that the mere presence of lithic materials does not necessarily signify Native American presence. Artifacts in colonial contexts "are not passive mirrors that reflect the cultural identity of their users and makers" (Silliman 2001:385). Items of Indigenous and non-Indigenous manufacture cannot simply be compartmentalized into "Indigenous" versus "Spanish" objects without considering the social and economic context of Spanish colonial labor. To do so would conceal the interpretive ambiguity of material culture that is often present within colonial assemblages. As Silliman (2001:401) states, "When set within a context of social practice and labor, artifacts lose their presumed straightforward expressions of 'native' versus 'Spanish.' They were items of material culture with a history and a context of production and use, but a mutable one." The same items, then, may not only have been used by different people (e.g., Spanish men, Spanish women, Native men, and Native women), they also likely held different meanings to those different people.

With that said, the presence of Native American people who may have bartered, worked, and/or lived at this large Spanish *estancia* is specifically suggested by the site's material culture (Trigg 2005), while historical documents discussing Indigenous labor requirements and alleged abuses in the region provide contextual evidence (Brown 2013; Gutiérrez 1991; Hackett 1937; Scholes 1937; Trigg 2004, 2005). The latter provides not only a proof of the existence of native labor, but also allows for an understanding of its parameters, form, function, and implementation from the perspectives of colonial administrators (civic and religious). The former (archaeological data) provides access to understanding how labor (whether imposed or voluntary) was experienced from the bottom up by individuals caught up in the colonial labor regime as reflected in the materiality of their daily practices (Silliman 2001). Therefore, this site, along with other comparable types, not only has the potential to allow for "a unique glimpse of lithic practices in a distinctly colonial setting rather than in a separate 'Contact-period' village or community" (Silliman 2003:128), but also to see labor as practice, as something people perform, experience, negotiate, and live daily (Silliman 2001).

Flaked stone artifacts were specifically selected for this study because they have never been fully analyzed for LA 20,000, nor has any thorough flaked stone artifact analysis been conducted at any other early colonial (AD 1598-1680) rural Spanish *estancia* in New Mexico. Flaked stone analysis not only helps to identify activities performed at LA 20,000 by the people who lived and labored there, but it also provides comparative data and analysis to broaden regional understanding of flaked stone technology and use within an early colonial setting, as well as allows fellow researchers to better interpret complementary data from other colonial contexts, both synchronically and diachronically. Furthermore, by incorporating textual evidence with archaeological data in the context of labor, this study fills a recognized need to incorporate the study of Indigenous people involved in colonial labor relations into broader labor studies (Silliman 2006:148).

This study seeks to provide a comprehensive flaked stone artifact analysis of LA 20,000 in order to 1) investigate the material selection and reduction strategies employed at the site, 2) establish if raw materials were differentially used, 3) better understand the activities with which flaked stone tools were employed and examine the distribution of flaked stone artifacts across the site, and 4) explore whether flaked stone artifacts can be attributed to a specific cultural group or to a particular demographic group within it. Analyses were also undertaken to accurately describe the various morphological and technological attributes of the flaked stone artifact sample recovered from the site to provide a basis for more accurate comparisons with other early colonial Spanish/European and contemporaneous Native American flaked stone assemblages in the future. Therefore, I do not intend the observations and conclusions reached in this analysis to be considered typical of all early colonial Spanish *estancias*.

To achieve these objectives and address the various questions, a variety of analyses were undertaken. Chapter 4 first presents a material selection analysis to ascertain the likely origins of exploited lithic materials and then a comprehensive debitage analysis investigating reduction strategies employed at the site to identify how site occupants approached problems of producing flaked tools from available raw materials. This is followed by flaked stone tool morphological and use-wear analysis to identify activities that likely occurred at the site. In Chapter 5, obsidian sourcing analysis is used to better recognize raw material procurement strategies, mobility, landscape use (both geographical and social), and potential trade relations. Chapter 6 uses spatial analysis to examine the flaked stone artifact distribution across the site to understand the assemblage on a site-wide scale and to identify any specific activity areas.

Chapter 7 provides an inter-site comparative analysis investigating the occurrence of reduction strategies and flaked stone tools at other Spanish and Indigenous sites, as well as addresses the ambiguity of ascribing artifacts to specific cultural groups. This is followed by a discussion combining textual evidence with archaeological data to tease apart the complex and multi-valent meanings associated with Spanish and Indigenous flaked stone use in these colonial homesteads.

The Indigenous peoples traditionally associated with the region of New Mexico in which LA 20,000 is situated are diverse communities divided by different languages, kinships, and religions (Brown 2013:3; Ortiz 1979; Trigg 2005). Puebloan peoples alone are associated with four separate language families (Keresan, Tanoan, Uto-Aztecan (Hopi), and Zunian) with some of these further subdivided into different languages (e.g., Tiwa, Tewa, and Towa for Tanoan) (Hale and Harris 1979; Trigg 2005); strong, weak, or nonexistent katsina cults or ties to Catholicism (Brown 2013; Trigg 2005); and matrilineal or bilateral descent (Brown 2013:4). This does not even begin to allude to the complexities resulting from the mobility and fluidity of Indigenous peoples joining up or splitting apart within and between groups (Preucel 2010). For example, Pueblo San Marcos, just 12 km southeast of LA 20,000, has been described as being "ethnically and linguistically mixed, including both Tano and Queres speakers, and without a clear hierarchical organization or panregional structure…[probably] composed of a series of linguistically and culturally distinct barrios" (Ramenofsky and Schleher 2017b:4). Apache, Navajo, and Ute groups are similarly as diverse and distinct, each having their own entangled histories. Therefore, terms like "Puebloan" and "Plains" peoples refer broadly to lifestyle and economy (sedentary adobe villages and agriculture versus more mobile hunter-gatherers) and general geographic location (Northern Rio Grande versus Southern Plains), while more specific names (e.g., Apache, Navajo, and Ute) refer to broader groups of affiliated peoples whose affiliations may be modern constructs rather than 17th-century identities.

Historical Context

During the early colonization of New Mexico (AD 1598-1680), Spanish colonists engaged in raising livestock, agriculture, mineral exploration, and other economic activities, often forcing Native American peoples into providing labor - making them work as household servants, field hands, herders, and artisans (Brown 2013; Ramenofsky and Schleher 2017a; Rothschild 2006; Trigg 2005). As a result of early colonial New Mexico's heavy reliance upon neighboring Puebloan and other Native American peoples for labor and trade (Brown 2013; Hackett 1937; Snow 1983; Trigg 2005), rural *estancias* like LA 20,000 were important locations of cross-cultural interaction between Spanish colonists and local peoples who often worked and lived together in multi-cultural households where colonial inequalities were actively negotiated and differential knowledge, cultural practices, and material cultures were incorporated (Payne 2012:77; Rothschild 2006; Trigg 2005).

To ensure that they had a steady supply of material goods and labor, New Mexico's early Spanish colonists (including average citizens, *encomenderos*, civic officials, and religious leaders) conscripted or coerced Indigenous peoples to work for them using several well-established mechanisms. These included the systems of *encomienda*, *repartimiento, reduccion*, wage-labor, and even enslavement (Barrett 2012; Brown 2013; Gutierrez 1991; Trigg 2005). For the purpose of this analysis I limit my discussion of these systems as they relate to secular homes like the rural *estancia* at LA 20,000 (see Trigg 2005 concerning these systems at Franciscan conventos in Pueblo villages).

One common economic institution often implemented early on during the colonization process throughout colonial New Spain was *encomienda*, a tribute provided by conquered native towns or individuals to a few privileged colonists (*encomenderos*) as payment for past or future service to the Spanish Crown, or for providing protection and education of Catholic doctrine to the native peoples under their charge. Although the amount and type of tribute to be collected was strictly limited by law, the system's regulations were often violated (Brown 2013:75; Simmons 1979:182-183; Trigg 2005:136-138). In New Mexico, *encomienda* payments were collected up to twice a year, lasted for up to three generations, and could only be assigned to villages that had been converted to Christianity (i.e., Pueblo) (Snow 1983; Trigg 2005:137). This economic institution was "unique in that the payments involved only a certain segment of the Spanish population, limited by law to 35 individuals, and a certain segment of native peoples, the Pueblos" (Trigg 2005:139). Even though the Spanish government forbade *encomenderos* from converting *encomienda* debts into labor obligations, such violations are known to have occurred (Brown 2013; Gutierrez 1991; Trigg 2003:68).

Another economic system, *repartimiento,* was one of forced labor. It was designed to provide *encomenderos* and governors exclusive access to Indigenous labor through labor obligations (Brown 2013; Trigg 2005:121). Unlike *encomienda*, the teaching of Spanish beliefs and values or Catholic doctrine were not required for *repartimiento* (Brown 2013:75). Although a labor obligation, Indigenous laborers were supposed to be paid for their work, but this appears to have rarely been done (Trigg 2005:123).

To provide greater access to Indigenous labor, as well as to make supervision and proselytization of the Puebloan peoples easier, Puebloan peoples were occasionally resettled into fewer, more concentrated settlements through the process of *reduccion* (Trigg 2005:78-79). One pueblo possibly created by Spanish authorities as a *reduccion,* La Cienega, is presumed to be located near LA 20,000 (Barrett 2012). If so, this *reduccion* may have supplied temporary laborers who would have likely worked and lived at the site.

In addition to these conscripted mechanisms, Indigenous peoples were also coerced or forced to participate in wage-labor, although wages were not always paid (Brown 2013; Gutierrez 1991; Trigg 2005). Spanish colonists became so dependent upon Puebloan peoples for labor that individual households, government officials, and religious leaders often competed for their services. Such high demand resulted in Puebloan peoples not having enough time to produce goods for tribute or barter. As a result, one governor increased the daily wage Puebloan laborers were to be paid to reduce Spanish demand so Pueblo peoples would then be free to raise surplus crops to help sustain the colony (Gutierrez 1991:119).

The final mechanism 17th-century Spanish colonists used to appropriate Indigenous labor was enslavement. Despite legislation that discouraged this practice, Indigenous peoples were enslaved and forced to work in colonist's homes for various reasons including as punishment for crimes (both legitimate and fabricated), repayments of debt, or being captives of "war." (Gutierrez 1991; Trigg 2005). While Puebloan peoples were enslaved out of punishment or debt obligation, "war" captives were often Utes, Navajo, or Apaches who had been captured in slaving raids (Gutierrez 1991:112; Trigg 2005:92).

Through the use of these well-established economic mechanisms, Spanish colonists were able to extract personal services from Indigenous peoples through use as domestic servants, field hands, herders, guides, transporters of goods, builders, weavers, and artisans (Brown 2013; Gutierrez 1991; Ramenofsky and Schleher 2017a; Rothschild 2006; Trigg 2005). Although often exploitive and oppressive, early Spanish New Mexico's heavy reliance upon Native American peoples for labor and trade meant that rural *estancias* like LA 20,000 were important locations for cultural interaction and the exchange of materials, practices, and knowledge between Spanish colonists and Indigenous peoples who often worked and lived together at these multi-cultural households in inequity (Payne 2012:77; Rothschild 2006; Trigg 2005). It is through the analysis of archaeological materials like flaked stone artifacts that important details relating to the daily practices and activities performed and negotiated at these pluralistic households of colonial inequality can be detected and better understood.

CHAPTER 2

SITE BACKGROUND

LA 20,000 is a middle 17th-century Spanish *estancia* located in present day La Cienega, New Mexico, some 12 miles southwest of Santa Fe. Most of the site is situated on a roughly 2-acre mixed alluvial and colluvial terrace at the southern base of a west trending ridge approximately 500 m southeast of La Cienega Creek. The confluence of La Cienega Creek and the Santa Fe River occurs roughly 1.46 km downstream of the site, while the northern end of the Cerrillos Hills lie about 5 km due south of LA 20,000 (Figure 1).

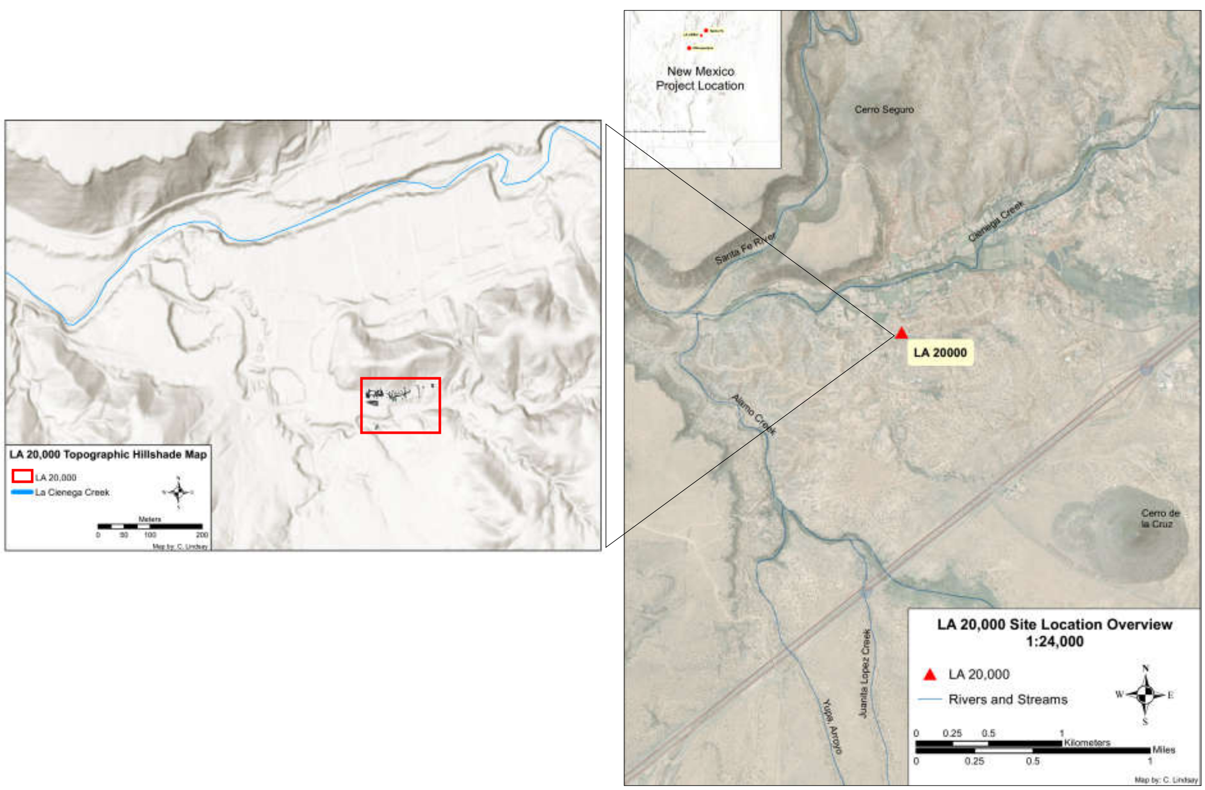


Figure 1. Site Location Map of LA 20,000.

LA 20,000 is one of the largest and most complex 17th-century Spanish ranch sites in New Mexico (Snow 1992:192). The main site area consists of a 10-15 room residential home, a barn, a corral, and a midden area (Snow 1994; Trigg 2017) (Figure 2). A possible *torreon* (tower) located south of the midden is separated from the main site by a broad arroyo eroding the southern margin of the two-acre terrace. Tree-ring dating of wooden timber fragments from the barn revealed cutting dates of 1629 and 1631 and widespread layers of ash and charcoal across the site indicate that much of the site experienced intense burning, likely resulting from the Pueblo Revolt of 1680 (Snow 1994). Based on archaeologically recovered artifacts, tree-ring dates, and the presence of intense burning across much of the site, LA 20,000 has been identified as a single component Spanish ranch occupied from about 1630 to 1680 (Snow 1994; Trigg 2017).

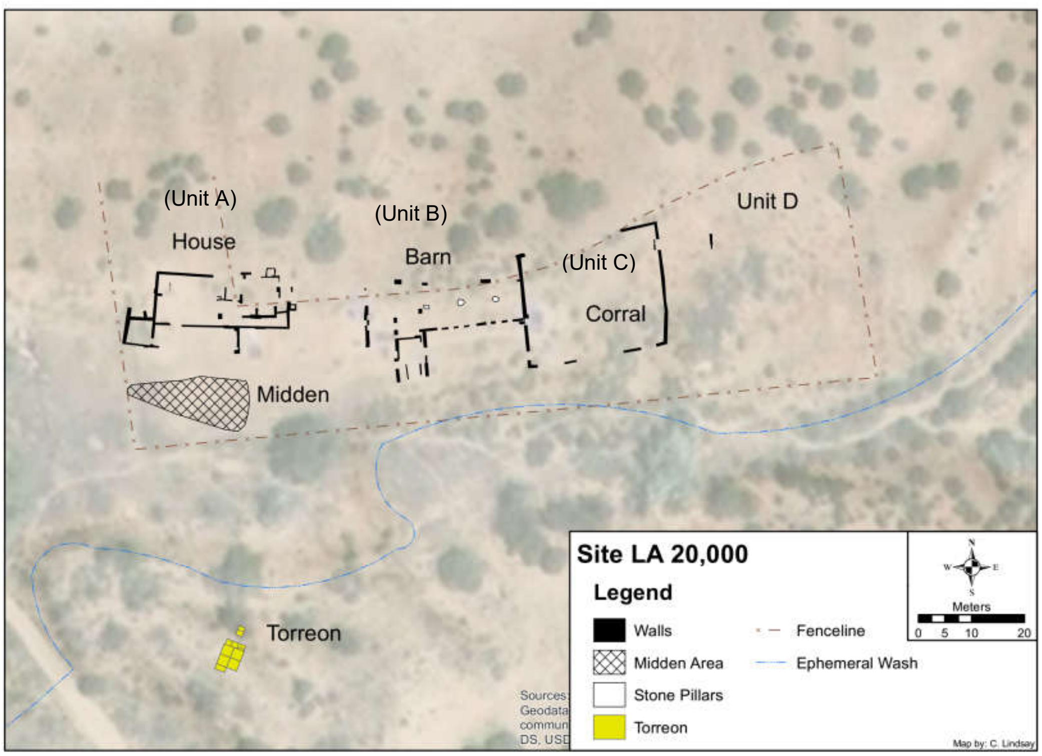


Figure 2. Site LA 20,000 Overview.

Due to the mass burning of Spanish churches and buildings during the Pueblo Revolt of 1680, very few 17th-century New Mexican documents survive. As a result, the original inhabitants of LA 20,000 have not yet been identified with certainty. Snow (2009:12) notes that "the estancia of Alonso Varela Jaramillo at La Cienega is mentioned in a document dated 1632." However, several other 17th-century families have also been identified as living in the general La Cienega area at this same time (Barrett 2012). Although the identities of the site's residents are uncertain, many of the identified families, like Alonso Varela Jaramillo, were original colonists who came to New Mexico in 1598 with Oñate, the leader of the colonizing party and the colony's first governor (Barrett 2012; Snow 2009:12). If any of these original colonists, or their descendants, owned LA 20,000, they likely would have been an *encomendero* who received tribute and labor from their nearby Pueblo *encomiendas*. Even if this was not the case, "documents from the rebellion indicate that most colonists' households had native people (Apaches and Pueblos) serving as domestics or day laborers or helping with agricultural production" (Trigg 2004:230). In either situation, it seems highly likely that the *estancia* at LA 20,000, given its considerable size, would have housed not only a large extended family of Spanish colonists, but also any native peoples who worked or were enslaved there as domestics, as well as provided lodging for any temporary laborers. All these people, permanent and temporary, would have been essential in carrying out the *estancia's* domestic, livestock, and agricultural operations.

At least three Pueblos are known to have been located near LA 20,000. Although its exact location remains unknown, La Cienega would have likely been the nearest (Barrett 2012). San Marcos, located roughly 12 km southeast of the site, is next closest, followed by

Cochiti Pueblo, located approximately 25 km to the west of LA 20,000. As a rural *estancia* that likely relied upon native peoples for labor and other services, any or all these pueblos may have provided domestic servants and/or temporary laborers who worked and lived at the *estancia*.

History of Archaeological Investigations at LA 20,000

Discovered in 1980 as a result of backhoe trenching that turned up 17th-century cultural materials, initial archaeological investigations (1980 and 1982) were carried out by Museum of New Mexico's Laboratory of Anthropology archaeologists. Subsequent surface investigations and excavations were conducted as a series of field schools by Colorado College under the direction of Dr. Marianne Stoller in collaboration with David Snow (1987-1995) and by the University of Massachusetts Boston under the direction of Dr. Heather Trigg (2015-2017) of the Andrew Fiske Memorial Center for Archaeological Research (Trigg et al. 2019).

Excavations revealed a house area (Unit A) consisting of a multi-room residential unit with basalt rock footings and adobe brick walls, an associated *horno* (bread oven), cobblestone surface feature, and midden area. A barn area (Unit B) located east of the residence also consisting of basalt rock footings along with three interior cobblestone pillars/columns and a cobblestone floor surface area was also found. A roughly 25 by 25 m square corral (Unit C) with basalt rock footings was located to the east of, and likely attached to, the barn resulting in a single large structure related to livestock associated activities. The eastern-most area of the site (Unit D) consists of basalt rock alignments that most likely represent recent efforts to halt erosion of the area. Finally, remnants of a possible *torreon* were located south of the house midden area on the opposite side of the arroyo (Snow 1994; Trigg 2017) (Figure 2).

Impacts to the site include both natural erosive forces and recent human activities. The arroyo downcutting the southern margin of the terrace is thought to be much deeper and broader at present than during 17th-century Spanish occupation (Snow 1994:4, 2009:13), and hillslope erosion has formed rills and gullies notably affecting the site's eastern portion. The amount of site area and cultural materials removed by these erosive actions is uncertain, but infield observations indicate that architectural features (e.g., wall footings) have been removed and structures (e.g., *torreon*) isolated from the rest of the site (Snow 1994:8-9). Besides initial backhoe trenching, heavy machinery had been used to level part of the site for development, create a *tanque* out of sediments along the arroyo, and clear surface debris from the edge of the terrace below the barn area (Snow 1994:7; Trigg et al. 2019:4). These actions likely removed some quantity of architectural features and cultural materials from these areas.

Archaeological excavations utilized standard excavation units (1 by 1 m, 1 by 2 m, etc.), test pits, and shallow trenches for delineating wall footings. Excavations were conducted using hand tools (trowels, shovels, and occasionally small pick mattocks) and all sediments were either screened through 1/4-in (6-mm) hardware cloth, 1/8-in (3-mm) hardware cloth for select features, or processed as flotation samples (Snow 1994; Trigg 2017). As a result, very small artifacts (< 6 mm) were likely missed during surface collections and screening. Although bias toward larger artifact size may be present, debitage analysis (Chapter 4) indicates the likelihood that flaked stone counts and artifact forms are reasonably representative of the entire LA 20,000 assemblage. Furthermore, heavy fractions from flotation samples that would have retained cultural materials smaller than 6 mm were visually scanned by University of Massachusetts Boston personnel, with only one flaked stone artifact being recovered.

The Flaked Stone Assemblage

The lithic assemblage in this study comes from surface collections and all excavations. All lithics are considered contemporaneous and of the early colonial period, specifically, occurring during site occupation from ca. AD 1630-1680 for the following reasons. Excavations revealed no pre-Spanish, nor any post-1680 occupational features or deposits - at least not until the modern era – and, with the exception of a few older Ancestral Puebloan ceramic sherds, all temporally diagnostic artifacts are indicative of that time period. In addition, flaked lithics were recovered from various locations across the entirety of the site, as well as from various layers of a repeatedly used stratified midden in the same temporal and spatial contexts as other Spanish materials including ceramics, faunal remains, glass, metal, and items of personal adornment.

Regarding Stoller and Snow's lithic materials, they had been stored for over a decade before being analyzed in 2017. Unfortunately, an artifact catalog completed in 1995 is missing much of the provenience and excavation information and several of the listed artifacts are absent from the current collection. The disparity between the available flaked stone artifacts and the catalog may be due to, or at least in part to, collection practices that discarded specimens deemed not to be artifacts, often labeled "goonies."

Flaked stone artifacts listed in the catalog but absent from the current collection are not included in this analysis (N=83); nor are artifacts collected from the arroyo (N=1) or the *torreon* area south of the arroyo (N=3). The reasons for not including missing artifacts are as follows: analysis of Stoller and Snow's flaked stone assemblage revealed several instances of misidentified lithic materials, debitage types, and tool types; most missing artifacts (58%;

N=48) lacked descriptions identifying even basic artifact type (flake, shatter, core, etc.); lithic material type was not given for the vast majority of missing artifacts (88%; N=73); and, as mentioned above, a large number of recovered lithic materials were deliberately discarded. Due to the inaccuracies and missing information likely resulting from the hastiness of initial in-field artifact analysis, little confidence could be given to the few descriptions or identifications made concerning the missing artifacts. As one of the aims of this study is to rectify discrepancies in original classification by providing a detailed analysis of flaked stone artifacts, as well as to provide a consistent and replicable study using an attribute analysis approach for debitage and tool use, only flaked stone artifacts present in the current collection from the LA 20,000 assemblage are included in analysis.

As for the flaked stone artifacts collected from the arroyo and *torreon* areas being left out of this analysis, both areas lack confidence in the provenance and contexts of these artifacts. As the arroyo is both an erosive and depositional feature, any artifact collected there cannot be assumed to be in primary context, or even necessarily associated with the site. Fluvial action can transport artifacts great distances from upstream sites, redepositing cultural materials far away from their original contexts. The *torreon* area was "not included within the property purchased for preservation of the archaeological remains designated LA 20,000" (Snow 1994:8). As a result, I was unable to examine the *torreon* area, or its adjacent areas, to investigate the possibility of contamination from any nearby lithic scatter(s) unassociated with the site or the 17th century. Since context could not be confirmed, it was decided that removing the three lithic artifacts associated with the *torreon* area from analysis would not substantially impact statistical outcomes and inferences given that the sample size of LA 20,000's flaked stone artifact assemblage is large enough to absorb some amount of error (N=317).

In summary, artifacts recovered and collected for this analysis are from various locations across the entirety of LA 20,000 north of the arroyo, including the midden, house, barn, corral, and Unit D areas. The analyzed sample consists of 317 available flaked stone artifacts out of 404 recorded field specimens (78.5%). The sample constitutes an adequate representation of the flaked stone cultural material in terms of frequency, volume, and spatial variability. Thus, it can be used to gain insight into patterns of lithic technology and use during a specific time and place in early colonial Spanish New Mexico including, but not limited to, aspects of raw material availability, procurement strategies, lithic reduction strategies, stone tool use, mobility, and even geographical and social ties.

CHAPTER 3

METHODS

Because one goal of this study is to accurately describe the various morphological and technological variables observed in the LA 20,000 flaked stone assemblage, for clarity, definitions for select terms are provided in Appendix A. For this analysis, flaked stone artifacts were categorized as either debitage or flaked stone tools (Andrefsky 2004:74-84). Debitage was divided into products of angular shatter, flakes (complete, proximal, and fragment), and bipolar flakes. Flaked stone tools were classified as cores (unidirectional, multidirectional, and bipolar), informal (non-flake, flake, and unifacial) and formal (bifacial) tools, strike-a-light flints, and gunflints. Informal tools and strike-a-light flints were considered, first, as debitage when investigating the technological aspects of lithic reduction at the site and then as tools when exploring the type of use and modification present. Since strike-a-light flints and gunflints are considered both temporally and culturally diagnostic of introduced European technologies and are generally associated with Spanish use, especially during early colonial settlement of New Mexico (Moore 2001b:79), these flaked stone tools, while still compared with other lithics, are discussed separately from the broader categories of informal and formal tools.

All lithic artifacts, regardless of condition, were recorded for analysis. A binocular microscope with an external light source was used to examine each artifact to aid in the identification of material type, define morphology, examine platforms and breaks, and determine whether the artifact was used as a tool. The level of magnification varied between 10x and 50x, with higher magnifications used to help identify informal tools and investigate edge use damage. All linear dimensions were measured in cm using a digital caliper. Weight was measured for all flaked stone artifacts to the nearest centigram using a digital scale.

Challenges in Flaked Stone Artifact Analysis

One aspect of debitage analysis that cannot be ignored is the improbability, using any system, to positively identify all debitage correctly. A debitage assemblage can be affected by countless taphonomic processes including "trampling, recycling, the construction of overlying cultural features, bioturbation, cryoturbation, and so forth" (Rinehart 2008:387). As Rinehart (2008:386) points out, "It is possible that more than one process could have produced any one flake type and it is equally possible that one analyst's finishing flake is another's biface reduction flake." Similarly, not all flaked stone tools will be identified correctly nor will their uses necessarily be interpreted the same between analysts (Frison and Bradley 1980:59-63; Grace 2012). Individual biases due to background, training, and experience are ever present and likely to be reflected in final analyses. Subsequently, the conclusions and interpretations I draw from observations are based on firsthand typological and technological experience, as well as published findings concerning lithic technology and analysis, experimental archaeology, and social and economic contexts related to flaked stone artifacts.

It should also be acknowledged that a single lithic material (e.g., chert, chalcedony, obsidian, etc.) can be highly variable in color, texture, and pattern. In fact, samples collected from within the same source area can be as variable as samples collected from across different source areas (Odell 2004:24). Pedernal chert, for example, can range from “white to pearly gray through translucent or black, with reds, pinks, browns, and yellows also fairly common. The material is often banded, streaked, mottled, and/or spotted” (Newman 1994:493). As a result, identifying significant quantities of lithic material types is what is most important in archaeological contexts, rather than identifying every single piece of material correctly, which is virtually impossible. It should be recognized, then, that a small portion of lithic materials may be misidentified or, more likely, not identified beyond general types (e.g., chert or calcedony) as compared to specific types (e.g., Pedernal or Madera chert). Therefore, the counts and weights of identified lithic materials give very close approximations to the overall abundance and relative importance of these lithic materials as tool stones to the residents at LA 20,000, but data (e.g., counts and weights) should not be viewed as absolutes.

Analytical Techniques

Debitage Attribute Analysis

Due to the fairly low number of lithic debris available for study (N=285), I decided to conduct debitage analysis at the individual artifact level. Although this was a time consuming and arduous task, by recording specific attributes for each individual piece of debitage in the assemblage, a more complete and accurate interpretation of lithic practices hopefully could be made (Andrefsky 2001, 2005; Morrow 1997; Rinehart 2008). Because no single attribute or method of lithic analysis is particularly suitable to characterize the range of data that may be represented in a lithic assemblage, a combination of approaches to debitage analysis was used to provide for a “more accurate and comprehensive perspective of archaeological flaking debris” and an “effective means of extracting sound and behaviorally relevant information”

(Morrow 1997:51). Following Silliman (2003) and Rinehart (2008), debitage was not identified as to its assumed method of reduction (e.g., hard hammer percussion, soft hammer percussion, pressure flaking) or function (e.g., core reduction flake or biface thinning flake) "due to the ambiguities surrounding such identifications" (Silliman 2003:134). Rather, an approach creating a specific set of analytical attributes and a hierarchical classification of lithic debitage and flaked stone tools was applied (Andrefsky 2001, 2004). By examining relationships between various attributes, lithic reduction strategies practiced at LA 20,000 can be established. Furthermore, analyzing debitage in terms of attributes and not merely equating debitage to an assumed method of reduction or function "can better illustrate the range of choices people made and derive more nuanced interpretations for why people produced lithic materials the way they did" (Rinehart 2008:387).

Attributes recorded include material type, artifact type and condition, size, weight, platform type, flake termination, amount of dorsal cortex, dorsal flake scars, and evidence of thermal alteration (Ahler 1989; Andrefsky 2004:110–135; Morrow 1997; Shott 1994).

Material Type

Several generalized lithic materials were recognized in this analysis and follow conventional categorizations including chalcedony, chert, basalt, limestone, quartz, quartzite, silicified wood, and obsidian. Any siliceous materials with a cryptocrystalline structure (i.e., varieties of cherts, chalcedonies, and silicified wood) that could not be confidently identified were defined as a cryptocrystalline silicate (CCS) material. When provincial materials were identified, their specific regional type names (e.g., Pedernal chert or Madera chert) were used.

Lithic materials were also classified as either local or nonlocal depending on how distant their source was from LA 20,000. Lithic materials were considered local if a source was located within 15 km of the site and nonlocal beyond that. A 15 km distance is based on ethnographic studies which suggest that the maximum distance hunter-gatherers will walk comfortably in a day is 20 to 30 km round trip (Kelly 2013:97).

Debitage Type and Condition

Debitage was divided into products of flakes, angular shatter, and bipolar flakes, with flakes categorized as complete, broken/proximal, or fragments following definitions established by Sullivan and Rozen (1985). Early experiments had suggested that flake completeness proportions within an assemblage corresponded to specific lithic reduction strategies (Sullivan and Rozen 1985), but subsequent experiments have shown that, regardless of reduction strategy, flake type (e.g., complete, broken, or fragment) is significantly influenced by such variables as lithic material (Amick and Mauldin 1997), flake size (Prentiss 1998), and even flintknapper experience. Pairing lithic materials with their respective debitage types simply demonstrates how materials relate to flake completeness and does not reflect or infer any specific reduction strategy.

Size, Dimensions, and Weight

As lithic reduction proceeds from parent material to finished tool "flakes tend to get shorter, narrower, and thinner" (Morrow 1997:65). This is not surprising since the more a piece of lithic material is worked, the smaller it becomes. In turn, the smaller the flakes become that can be removed. However, debitage size as a stand-alone metric is not reflective of any one form or stage of reduction (Andrefsky 2004:127). Like angular shatter, flake size is dependent on several variables including the size of the parent piece, reduction technique, material type, and applied force (Ahler 1989; Andrefsky 2004; Morrow 1997; Stahle and Dunne 1982; Whittaker 1994). Still, intensive lithic reduction generally yields more small flakes than minor or moderate reduction. Looking at debitage size in combination with other attributes also provides “a more holistic examination of flaking debris” (Morrow 1997:63).

Debitage size was determined by placing each flake ventral side down (largest surface side down in the case of angular shatter) in the center of a two-dimensional graph depicting a sequentially numbered series of concentric circles. The initial circle has a diameter of 0.5 cm, followed in turn by circles with diameters of 1 cm, 2 cm, 3 cm, 4 cm, and 5 cm. The debitage is placed in the smallest diameter circle possible without touching the edge and then assigned to that size class. Any piece of debitage which falls outside this graph is given the size class of >5 cm. This technique follows that suggested by Andrefsky (2004:100-101) and supplies a size range that defines the maximum dimension of the flake, regardless of orientation.

The dimensions of complete flakes were measured as maximum length (distance from platform to distal end), maximum width (straight line distance perpendicular to the length line at the artifact’s widest point), and maximum thickness (straight line distance from the dorsal side to the ventral side perpendicular to the length line at the artifact’s thickest point).

Platform Type

Many researchers consider platform remnants to provide the most reliable indication of reduction strategies prevalent in a flaked stone assemblage (Callahan 1979; Dibble 1997; Odell 1989; Whittaker 1994). Because of this idea, striking platforms were separated into five distinct types: cortex, flat, crushed, complex, and abraded (Andrefsky 2001; Morrow 1997).

Cortex, flat, and crushed platforms are generally assumed to be indicative of early or expedient methods of lithic reduction, while complex and abraded platforms are generally associated with, but not limited to, later lithic reduction and/or represent more investment in tool manufacture/maintenance. While striking platforms can be modified by abrasion or retouch at any time during the reduction process to aid in the removal of flakes from both cores (early reduction) and tools (late reduction), in general, complex and abraded striking platforms tend to increase in overall frequency over the production sequence because these platforms are typically prepared more carefully than early core reduction platforms (Andrefsky 2004; Morrow 1997; Odell 2001). For flakes that lacked platform remnants, type was recorded as not applicable. Missing platforms indicate that a flake was broken either during manufacture or by post-manufacture processes (e.g., trampling).

Flake Termination

Flake termination refers to the condition or form of the distal end of a flake and was classified as either feathered, stepped, hinged, axial, or indeterminate. Flake terminations were indeterminate when they had either been modified or could not be discerned due to effects of post-depositional processes. This attribute is used primarily as a defining characteristic for broken versus complete flakes and identifying bipolar flakes in this analysis.

Dorsal Cortex

Cortex is the natural outer surface of a piece of raw lithic material. It can either be the remnant bedrock matrix in which the material formed or the result of weathering (physical and/or chemical). Along with the bipolar reduction of small nodules, which can keep cortex intact on flake tools (Kuijt et al. 1995:124), the presence of dorsal cortex on debitage is generally associated with early lithic reduction (Mauldin and Amick 1989:70; Shott 1994:80). Consequently, as the amount of lithic reduction increases, the proportion of cortical flakes should decrease. Similarly, the amount of cortex presence on cores should also decrease with increased reduction (Odell 2001:121). Dorsal cortex was recorded on a four-tiered ordinal percentage scale: none, < 50% cortex, ≥ 50% cortex, and 100% dorsal cortex present (after Andrefsky 2004:104).

Dorsal Flake Scars

The number of flake scars present on the dorsal surface of a flake may provide information pertaining to reduction stage since an increase in reduction should result in a greater number of dorsal flake scars. A four-tiered ordinal scale was used to identify the number of dorsal flake scares on flakes: 0 = no flake scars; 1 = one flake scar; 2 = two flake scars; 3 = more than 2 flake scars (Andrefsky 2004:106-107).

Stone Tool Attribute Analysis

In addition to the attributes mentioned above, attributes also recorded for flaked stone tools include artifact morphology, function, culturally produced edge damage and wear patterns, presence of striations, edge angle measurements on all informal and formal tool edges demonstrating use, and evidence of thermal alteration. All tools were recorded as either complete or fragmentary; when fragmentary, the portion was recorded if it could be identified. On multidirectional cores and non-flake tools, length was defined as the artifact's largest measurement, width was the longest dimension perpendicular to the length, and thickness was perpendicular to the width and was typically the smallest measurement. Edge angles on informal and formal tools were measured using a goniometer and then grouped into three categories: angles < 30 degrees; angles 30 ≥ 60 degrees; and angles > 60 degrees. This was done to offset the propensity of edge angles to be measured inconsistently.

Use-Wear Analysis

The aim of use-wear analysis is to determine the most likely way a flaked stone tool was used, as well as the type of material the tool was used on. The main assumption being that when a certain use motion is employed on a certain material, distinct damage and wear traces will be produced along the edges and surfaces of the tool that was used (Grace 2012; Keeley 1980; Odell and Odell-Vereecken 1980; Tringham et al. 1974). Since there is no single diagnostic feature that can be used to identify a tool's specific use (Grace 2012; Kooyman 2000; Shea 1992), this study "does not rely on any single variable being diagnostic, but on the agreement of all the variables which lead to a logically consistent functional reconstruction" (Grace 2012:43).

Since other processes (e.g., trampling, soil movement, or even inadequate post-excavation storage) may also result in edge damage and wear traces that could be mistaken as evidence of cultural use (Grace 2012), the mere presence of edge damage and wear traces on flaked artifacts was not explicitly attributed to use. Instead, I employed a more conservative standard following criteria put forth by Grace (2012:65): 1) patterning of fractures (a regular, consecutive pattern is characteristic of use-wear, while a random oriented pattern is characteristic of unintentional damage); 2) placement of fractures (the location of patterned fractures on just one edge and absent elsewhere most likely represents use); 3) edge morphology (edge angle and shape have to have the functional capability to sustain and be consistent with the types of fractures observed, usually meaning no extreme scoops or projections are present); 4) other corroborative features (the presence of polish, striations, and/or rounding). While these criteria are not absolute truths (Grace 2012; Kamminga 1982; Odell and Odell-Vereecken 1981; Shea 1991), they do help to increase the confidence level when classifying and attributing edge damage to cultural use. Therefore, unless edge damage on debitage was conclusively determined to have resulted from cultural use, it was considered incidental damage, and the artifact was not classified as an informal tool. Only when edge damage met two or more of the criteria above were artifacts categorized as informal tools. Although applying these criteria may have resulted in the omission of a few actual informal tools from the recognized flaked stone tool assemblage, they also prevented the addition of non-used debitage from inflating tool numbers and influencing the range and relative importance of activities carried out at the site.

For interpretive purposes, analysts have divided the hardness of worked materials into three categories (soft, medium, and hard) based on the resistivity of the worked material to flaked stone tools. Soft materials include meat, plants, woody plants, bark, and fresh hide. Medium materials consist of soft woods (e.g., ash, pine, alder), fish, soaked antler, dry hide, soft stone, and horn. Hard materials include dry antler, bone, hard woods, shell, and stone. The associated worked materials that constitute these categories have been derived from numerous experiments entailing hundreds of tools used by numerous people (Grace 2012:88).

Unfortunately, since processing of soft materials rarely creates visible scarring or edge-wear, it is expected that these types of worked materials will likely be underrepresented in the flaked stone tool assemblage. Furthermore, while working medium and hard materials with flake stone tools does often leave evidence of use-wear, these worked materials do not always result in consistent or discernable edge damage. Even flaked stone tools used on hard materials have been shown to sometimes display only minor or even no edge-wear if the tool edge is robust (Grace 2012; Vaughan 1985). This means that it is not always possible to identify all pieces of debitage that were used as flaked stone tools. For these reasons, it is likely that only a small portion of expedient flaked stone tools will be identified in any lithic debitage assemblage. Invariably, some utilized debitage will go unrecognized.

The ability of an analyst to correctly recognize and identify all variables in analysis is not perfect and use-wear studies often use subjective terms which may be interpreted in different ways by different analysts (Grace 2012; Odell and Odell-Vereecken 1980). To minimize subjectivity, I use established terms and descriptions specific enough to allow for comparisons of results produced by different analysts. I also follow established criteria and recorded variables in a systematic way in order to keep observations between tools consistent. Finally, because use-wear analysis is an interpretive technique, the terms most probable or most likely are used when interpreting results. It has been acknowledged that the conclusions reached from use-wear analysis evidence is seldom indisputable and it is possible that the same evidence could be interpreted differently by another researcher to attain a different conclusion, "a situation not uncommon in archaeology" (Grace 2012:88).

For this analysis all flaked stone artifacts were analyzed for use-wear following standard low-power (10x-50x) microscopy procedures (see Grace 2012; Odell and Odell-Vereecken1980; Tringham et al. 1974). Artifacts were hand-held under a binocular microscope and manipulated in ways that allowed light from an external source to reflect off an artifact's surface at different angles to allow for better observation of use-wear traces. I recorded attributes related to edge morphology (edge angles and edge shapes), edge fractures (types and distributions), striations (presence/absence and orientation), rounding (presence/absence), and polish (presence/absence), as well as the locations (lateral, distal, proximal, etc.) and surfaces (dorsal, ventral, or both) on which these use-wear attributes occurred. I then compared the characteristics and patterns of use-wear variables observed on the analyzed artifacts with published results of experimentally generated patterns (Broadbent and Knutsson 1975; Grace 2012; Keeley 1980; Keeley and Newcomer 1977; Kononenko 2011; Odell and Odell-Vereecken 1980; Tringham et al. 1974) to determine suggested tool motion (e.g., unidirectional, bidirectional, rotational, or striking), tool function (e.g., cutting, scraping, whittling, incising, boring, or piercing), and hardness of worked materials (e.g., soft, medium, hard). Finally, I hypothesized possible worked materials, although with low confidence. In this analysis intentionally altered tools are referred to as “modified”, while unintentionally altered tools are referred to as “utilized.” See Appendix B for individual informal tool debitage attributes, Appendix C for a full data presentation of informal tool use-wear analysis and more details concerning the approach to analysis, and Appendix D for individual informal tool use interpretations.

Obsidian Sourcing Analysis

To better understand flaked stone tool technology, raw material procurement, landscape use, and possible social interactions, I conducted nondestructive X-ray fluorescence (XRF) analysis on all obsidian artifacts. XRF is an established method used to characterize obsidian trace elemental composition to determine geologic source (Shackley 2005, 2011). In New Mexico, geologic locations of primary and secondary obsidian sources are well documented, as are the trace elemental composition for the obsidian sources (Baugh and Nelson 1987; Glascock et al. 1999; Hughes 1988; Shackley 1995, 2005; Steffen 2005). All known source assignments were made by comparing the trace elemental ppm values and ratios for each LA 20,000 sample to those from known baseline source samples reported in Baugh and Nelson (1987), Liebmann 2017, and Shackley (1995, 2019). Analysis took place at the Fiske Center for Archaeological Research at the University of Massachusetts Boston under the supervision of Dennis Piechota.

A total of 46 obsidian artifacts from the LA 20,000 flaked lithic assemblage were geochemically analyzed. Of these, 45 (98%) are discussed. One flake of uncertain temporal/cultural affiliation recovered away from the main site area near a proposed *torreon* was removed from analysis. See Appendix E for details on technique and full data presentation for all sampled artifacts.

Spatial Analysis

ArcGIS 10 was used to analyze the distribution of flaked stone artifacts at LA 20,000. Flaked stone artifact density by excavation unit was spatially plotted horizontally across the main site area to identify flaked stone concentrations and locate activity areas relating to flaked stone reduction, production, and use at the site. Specifically, this distribution analysis sought to determine areas where lithic activities did and did not take place and the type(s) of lithic activities that occurred at these locations. A distribution map of flaked stone artifacts, a nearest neighbor raster map of flaked stone artifacts, and maps depicting spatial autocorrelations and cluster analyses of flaked stone artifacts normalized by ceramics were produced. See Appendix F for details on technique and analysis.

Since the midden had already been identified as different from other site areas and its pattern of deposition is unlike other site deposits (both inside and outside of structures), I excluded the midden from the dataset to focus on spatially patterning the flaked stone artifact distributions in non-midden areas. As a secondary deposit, the midden does not reflect the primary use or manufacture of stone tools and any flaked stone artifacts recovered from this area cannot be assumed to be in their primary context. Also, because a large portion (33%) of flake stone artifacts are clustered within the midden area, including it would skew the results of any spatial analysis and there is no reason for identifying it based on distributional analysis. Instead, the flaked stone midden assemblage is analyzed separately and then compared to non-midden assemblages.

CHAPTER 4

FLAKED STONE ANALYSIS AND RESULTS

Assemblage Overview

The flaked stone assemblage at LA 20,000 represents roughly five decades of lithic production and use from an unknown number of individuals, likely of multiple ethnic/cultural affiliations. Artifacts analyzed consist of a total of 317 objects: 285 pieces of lithic debitage and 73 flaked stone tools (Table 1 and Table 2). The eight strike-a-light flints (one piece of angular shatter, three bipolar flakes, and four flakes) and 32 informal tools (7 pieces of angular shatter, 6 bipolar flakes, and 19 flakes) are pieces of lithic debitage that show evidence of utilization or slight modification and, in the case of flakes, retain their striking platforms and so are included in both the debitage counts and the flaked stone tool counts. Formally defined flakes (complete, proximal, and fragments) make up 53.3% of the debitage assemblage, while angular shatter and bipolar flakes comprise the remaining 46.7%. Formal tools consist of seven bifaces (one complete, six fragments), four projectile points, and one hafted drill. Cores consist of five multidirectional, five bipolar, and one unidirectional core. There are 32 pieces of altered debitage (unintentionally=11, intentionally=21) that functioned as informal tools and one unidentified tool fragment. Seventeen flaked stone tools can be definitively associated with Spanish introduction and include nine gunflints and eight strike-a-light flints. Tools, in general, are not uncommon and comprise 23% of the total flaked stone assemblage.

Table 1. Lithic Debitage Assemblage Site LA 20,000.						
Material	**Angular Shatter**	**Bipolar Flake**	**Complete Flake**	**Proximal Flake**	**Flake Fragment**	**Total**
Obsidian	9	-	8	8	8	**33**
	27.3%	-	*24.2%*	*24.2%*	*24.2%*	***11.6%***
Pedernal Chert	4	2	7	4	1	**18**
	22.2%	*11.1%*	*38.9%*	*22.2%*	*5.6%*	***6.3%***
Chert, Chalcedony, Other [1]CCS	*82*	*23*	*45*	*36*	*13*	***199***
	41.2%	*11.6%*	*22.6%*	*18.1%*	*6.5%*	***69.8%***
Quartz	3	2	5	3	1	**14**
	21.4%	*14.3%*	*35.7%*	*21.4%*	*7.1%*	***4.9%***
Quartzite	1	-	3	-	1	**5**
	20.0%	-	*60.0%*	-	*20.0%*	***1.8%***
Limestone	4	-	2	4	2	**12**
	33.3%	-	*16.7%*	*33.3%*	*16.7%*	***4.2%***
Fine Grained Volcanic	1	-	-	-	-	**1**
	100%	-	-	-	-	***0.4%***
Basalt	1	-	-	-	-	**1**
	100%	-	-	-	-	***0.4%***
Other Sedimentary	1	-	1	-	-	**2**
	50%	-	*50%*	-	-	***0.7%***
Total	**106**	**27**	**71**	**55**	**26**	**285**
Total %	***37.2%***	***9.5%***	***24.9%***	***19.3%***	***9.1%***	***100%***

[1]CCS=cryptocrystalline silicate

Table 2. Flaked Stone Tool Assemblage Site LA 20,000.							
Material	**Cores**	**Formal Tools**	**Informal Tools**	**Gunflint**	**Strike-A-Light Flint**	**Unidentified**	**Total**
Obsidian	4	8	10	-	-	-	**22**
	18.2%	*36.4%*	*45.5%*	-	-	-	***30.1%***
Pedernal Chert	-	2	2	1	2	-	**7**
	-	*28.6%*	*28.6%*	*14.3%*	*28.6%*	-	***9.6%***
Nonlocal Chert	-	1	-	-	-	-	**1**
	-	*100%*	-	-	-	-	***1.4%***
Chert, Chalcedony, Other [1]CCS	6	1	17	8	5	1	**38**
	15.8%	*2.6%*	*44.7%*	*21.1%*	*13.2%*	*2.6%*	***52%***
Quartz	-	-	2	-	1	-	**3**
	-	-	*66.7%*	-	*33.3%*	-	***4.1%***
Quartzite	-	-	1	-	-	-	**1**
	-	-	*100%*	-	-	-	***1.4%***
Basalt	1	-	-	-	-	-	**1**
	100%	-	-	-	-	-	***1.4%***
Total	**11**	**12**	**32**	**9**	**8**	**1**	**73**
Total %	**15.1%**	**16.4%**	**43.8%**	**12.3%**	**11.0%**	**1.4%**	**100%**
Total % Flaked Stone Assemblage	**3.5%**	**3.8%**	**10.1%**	**2.8%**	**2.5%**	**0.3%**	**23%**

[1]CCS=cryptocrystalline silicate

Lithic Material Sources at and around LA 20,000

While high-quality lithic materials can be found throughout north-central New Mexico, they do not have uniform distributions. By determining the types of lithic materials available for use in the vicinity of LA 20,000 questions pertaining to raw material availability, lithic reduction technology, procurement strategies, stone tool use, mobility, and even geographical and social ties can be addressed. Examination of lithic material sources is therefore important in order to make inferences regarding the use of both the lithic and social landscapes by inhabitants of LA 20,000.

LA 20,000 lies at the western extent of the Santa Fe embayment near the southwest margin of the Española Basin, a geologic depression bordered by the Jemez Mountains on the west and the Sangre de Cristo Mountains on the east. The sediments that fill the basin, collectively referred to as the Santa Fe Group, were derived from the erosion of these surrounding highlands (including the Cerrillos Hills to the south), deposits of the ancestral Santa Fe River, and minor volcanic flows and ashes (Johnson et al. 2015:23). These and other nearby sedimentary and volcanic deposits provided both Spanish and Native American inhabitants of the area with a variety of geologic resources needed for stone tool production, architectural materials, and even items of personal adornment.

The ridge to the north and directly above the main site area is composed of Galisteo Formation deposits that are capped by Ancha Formation ancestral Santa Fe River sediments (Johnson et al. 2015) (Figure 3). The Galisteo Formation is composed of "red to brownish-yellow sandstone, red mudstone, and conglomerate clasts including white, gray, and black chert pebbles, gray limestone cobbles and pebbles, red granite, schist, and occasional petrified wood" (Sawyer et al. 2002:12), while Ancha Formation deposits "consist of poorly sorted, clast- supported, slightly cobbly, pebble gravel, sandy pebble gravel, pebbly sand, and silty sand. Clasts are mostly granitic along with minor mafic metamorphic rocks, quartzite, and vein quartz" (Sawyer et al. 2002:5), as well as pebble cherts (Kelley 1980:11). Within a few hundred meters to the east and southeast of the site lie exposed sedimentary deposits of well-cemented, light gray volcanic derived conglomerates, sandstones, and minor lava flows of the Espinaso Formation (Johnson et al. 2012:25; Sawyer et al. 2002:11). These three geologic formations (Galisteo, Ancha, and Espinaso) provide abundant lithic materials on and around LA 20,000 that would have been common and immediately available for use by inhabitants.

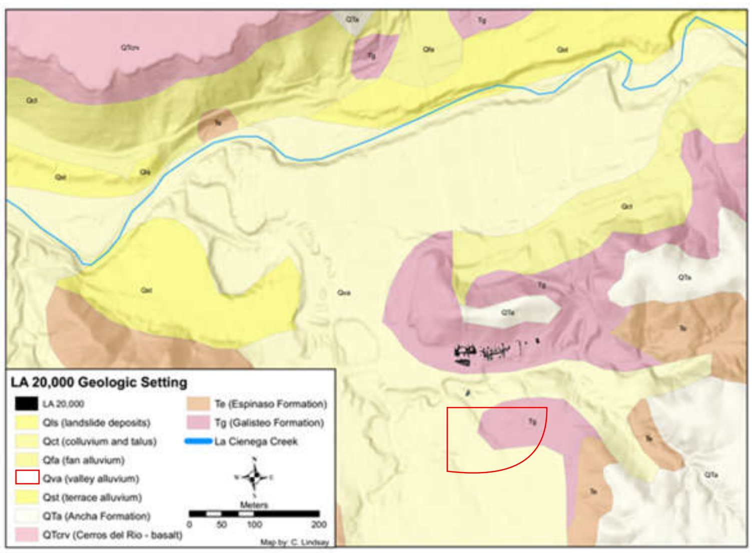


Figure 3. Site LA 20,000 Geologic Setting.

Other lithic resources located beyond the immediate vicinity of the site are also present. A basalt-capped mesa top formed by lava flows and dikes of the Cerros del Rio volcanic field lies approximately 600 m to the northwest of LA 20,000 (Figure 3). The confluence of the Santa Fe River and La Cienega Creek is located approximately 1.46 km slightly north of west of the site, and both water courses transport cherts, silicified wood, quartzite, and quartz from the Sangre de Cristo Mountains and Santa Fe embayment. Roughly 2 km to the southeast of LA 20,000 a remnant volcanic cone, Cerro de La Cruz (Figure 1), would have provided a fine-grained, dark gray mafic volcanic cobble source similar to a basalt called limburgite (Compton 2017:135; Johnson et al. 2015). Approximately 5 km due south of LA 20,000 lies the northern end of the Cerrillos Hills, which consist of volcanic and sedimentary formations, and to the west and northwest of the site lie additional volcanic and sedimentary rocks that would have also provided materials for stone tool production (e.g., sandstone, siltstone, andesite, basalt, and silicified wood).

Finally, more distant lithic resources requiring over a day's travel to procure include secondary deposits of obsidian and Pedernal chert from Rio Grande river gravels located over 20 km to the west-northwest of LA 20,000 near Cochiti Pueblo, as well as primary deposits of these same materials located even farther away in the Jemez Mountains – the nearest primary obsidian deposits being over 40 km northwest of the site at Bear Springs Peak and Rabbit Mountain, while primary Pedernal chert deposits occur around 75 km north at Cerro Pedernal and the San Pedro Parks area (Church 2000; Moore 2001b:64; Newman 1994; Shackley 2002).

Along with obsidian, Pedernal chert has been an important tool stone in the region for at least 13,000 years. Complete and fragmented Clovis points, Folsom points, and Archaic projectile points and tools manufactured from Pedernal chert have been found in and around the Jemez Mountains, and Pedernal chert is often abundant at Puebloan sites (Larson et al. 2017:97; Newman 1994:493-494; Smith and Huckell 2005:428). Clear evidence also exists that people exploited redeposited Pedernal chert pebbles and cobbles ubiquitous in "alluvial deposits southward into the Albuquerque basin, westward into the San Juan basin, and eastward into the Española basin" (Smith and Huckell 2005:427). Unfortunately, there are "uncertainties about geological origin of the chert, its diverse visual and textural properties, widespread occurrence in secondary geological contexts" (Smith and Huckell 2005:430).

Flaked Stone Material Analysis

Cherts, chalcedonies and other CCS materials comprise nearly 70% of the debitage assemblage and 52% of the flaked stone tool assemblage (Table 1 and Table 2). Individually, each of the other lithic materials contribute to less than 12% of the debitage assemblage and, other than obsidian (30.1%), less than 10% of the flaked stone tool assemblage. Flaked stone material type counts, frequencies, and weights identified at the site are summarized in Table 3. By total counts and frequency, locally available cherts, chalcedonies, silicified wood, and other CCS materials make up nearly 68% of the flaked lithic assemblage, while all other lithic materials contribute less than 15% individually. Three nonlocal materials found on-site include obsidian, Pedernal chert, and a nonlocal chert. Combined, they contribute to slightly over 21% of the total flaked stone assemblage. Based on material type frequencies, the flaked lithic assemblage at LA 20,000 appears to be dominated by locally available materials (79%), with a few nonlocal materials also present contributing to a not unsubstantial portion of the assemblage (21%).

Table 3. Material Type Frequencies. Comparison of Total and Average Flaked Stone Material Weights with and without Cores.						
Raw Material		**Total Count/ Frequency**	**Total Weight All (g)**	**Total Weight No Cores (g)**	**Average Weight All (g)**	**Average Weight No Cores (g)**
Nonlocal	Obsidian	45	78.14	56.21	1.74	1.37
		14.2%	*6.7%*	*5.6%*		
	Pedernal Chert	21	78.83	78.83	3.75	3.75
		6.6%	*6.7%*	*7.9%*		
	Nonlocal Chert	1	0.52	0.52	0.52	0.52
		0.3%	*0.04%*	*0.05%*		
Local	Chert, Chalcedony, Other CCS	214	700.66	600.89	3.27	2.89
		67.5%	*60.0%*	*60.0%*		
	Quartz	14	50.19	50.19	3.59	3.59
		4.4%	*4.3%*	*5.0%*		
	Limestone	12	99.51	99.51	8.29	8.29
		3.8%	*8.5%*	*9.9%*		
	Quartzite	5	95.41	95.41	19.08	19.08
		1.6%	*8.2%*	*9.5%*		
	Basalt	2	49.71	4.41	24.89	4.41
		0.6%	*4.3%*	*0.4%*		
	Sedimentary	2	14.57	14.57	7.29	7.29
		0.6%	*1.2%*	*1.5%*		
	Fine Grained Volcanic	1	0.93	0.93	0.93	0.93
		0.3%	*0.1%*	*0.1%*		
	Total	**317**	**1168.47**	**1001.47**	**8.07**	**5.51**
		100%	***100%***	***100%***	**-**	**-**

Another way of comparing quantities of different lithic raw materials is to look at the total weight of artifacts. Weight may more accurately represent material abundance than does simple flake counts. To correct for the bias created by the presence of a few large cores of certain materials, Table 3 also includes average and total weights and percentages by raw material without cores. In total, nearly 1.17 kg of flaked stone artifacts were recovered from excavations at LA 20,000. When total weights and percentages are compared to total numbers, cherts, chalcedonies, silicified wood, and other CCS materials continue to dominate the flaked stone artifact assemblage, with all other lithic materials far behind. Obsidian drops from second place by count to fifth place by total weight, suggesting that the modest number of obsidian artifacts are, in general, fairly small and light. Basalt and quartzite show the opposite trend and actually have the greatest average weights, respectively, suggesting that the smaller number of pieces are generally larger than those of the other raw materials. However, one very large core of basalt skews the average for that material type; without that core, the remaining basalt artifact (a single piece of angular shatter) is only 4.41 g. While cherts, chalcedonies, silicified wood, and other CCS materials represent 60% of the total material weight, this group of materials actually has the second lowest average artifact weight for all materials represented by more than one artifact. Furthermore, when the weight of six cores are removed from this category's average weight calculation, the material class maintains its overall position in relation to average artifact weight. Taken together, this suggests that along with obsidian, this group of materials was one of the most heavily reduced at the site. These findings are consistent with what is usually discerned from flaked stone analysis - coarser materials (e.g., basalt and quartzite) cannot be knapped as finely as high-quality CCS-type materials and obsidian, for example, so they are more commonly used for large, robust tools, rather than for delicate ones. It is not surprising, then, to find that high-quality CCS-type materials and obsidian were the only materials used for formal tools and the vast majority of flaked stone tools in general (Table 2).

Debitage Analysis

In debitage analysis, the goal has often been "to re-create the sequence of events in the reduction of lithic raw materials that ultimately led to the manufacture and/or repair of a finished tool" (Rinehart 2008:386). Flaked stone debitage is often seen as representing a step or a series of steps taken in a reduction sequence during the manufacture of a flaked stone tool

(Andrefsky 2004; Shott 1994). However, flaked stone production did not merely follow a reduction sequence protocol; it also "existed within a continuum in which a myriad of factors may have affected decisions at any juncture" (Rinehart 2008:386). These "myriad of factors" include material quality (e.g., homogenous vs included), material size (e.g., large vs small), material availability (e.g., local vs distant), and even individual skill (e.g., novice vs expert) (Amick and Mauldin 1997; Andrefsky 2004). If analysis and interpretation of flaked stone are simply limited to sequential modes of reduction or pre-determined typologies, then the ability to understand these factors may potentially be inhibited (Rinehart 2008:386).

Debitage assemblages, therefore, are more than just the byproducts of lithic tool manufacture; they also reflect choices about process (Rinehart 2008). Flaked stone production is a reductive process where individuals had to make decisions at certain points and time about breaking down larger pieces of stone into pieces of useable form and function while under constraints of various factors. Flaked stone debris is the byproduct of those decisions. If individual pieces of debitage represent single choices made at specific moments, then an "entire debitage assemblage is the aggregate of those choices, potentially encoding the patterned behaviors of people as they produced lithic raw materials" (Rinehart 2008:387). By identifying and analyzing the flaked stone attributes within the debitage assemblage, the choices made by the individuals who produced and used the flaked stone assemblage can be discovered and better understood.

Debitage Attributes

Debitage Type and Condition

Debitage type counts and relative percentages (Table 4) show that flakes (complete, proximal, and fragments) make up 53.3% of the debitage assemblage, while amorphous angular shatter and bipolar flakes make up 37.2% and 9.5%, respectively. Lithic reduction experiments conducted by Prentiss (1993, 1998), Jeske and Lurie (1993), Kuijt et al. (1995), Amick and Mauldin (1997), and Morrow (1997) have demonstrated that angular shatter is typically correlated with either poor material quality or early reduction and/or bipolar reduction activities and is rarely produced during tool manufacture. Combining the number of bipolar flakes with angular shatter results in an overall debitage typology that is generally associated with early reduction and/or bipolar reduction and suggests that these practices represent a substantial portion of the lithic activities carried out at LA 20,000. The high frequency of quality lithic materials (Table 3) in the assemblage rules out poor materials. While lack of skill has been argued for the use of bipolar reduction (Patterson and Sollerberger 1976), the presence of well-made gunflints and formal tools does not support this idea.

Table 4. Debitage Types.

Debitage Type	Count	Percentage
Angular Shatter	106	37.2%
Bipolar Flake	27	9.5%
Complete Flake	71	24.9%
Proximal Flake	55	19.3%
Flake Fragment	26	9.1%
Total	**285**	**100%**

Because later reduction practices and tool manufacture are generally carried out with more care and control than earlier lithic reduction, fewer pieces of angular shatter are usually produced. This suggests that flake to angular shatter ratios should be indicative of reduction activities. A low flake to shatter ratio should indicate early reduction, while a high flake to shatter ratio should suggest late reduction or tool manufacture. This reasoning is obviously a bit unsophisticated since the amount of angular shatter produced is also dependent on other factors such as reduction technique (e.g., hard hammer vs soft hammer), material type (e.g., basalt vs obsidian), the amount of applied force, and even individual skill (e.g., novice vs expert) (Amick and Mauldin 1997; Jeske and Lurie 1993). Regardless of these factors, there should be a general tendency for the ratio of flakes to increase as lithic production of an artifact progresses. Late stage reduction and tool manufacture/repair should produce a higher ratio of flakes than early stage reduction and expedient practices. At LA 20,000, complete and proximal flakes supply 126 pieces to the debitage assemblage, while angular shatter provides 106 pieces. Flake fragments are not included in this ratio as they may have the effect of double counting a flake. Complete and proximal flakes have platforms that conclusively represent a single flake, while flake fragments can represent the broken portions of proximal flakes. The resulting flake to angular shatter ratio of 1.19 is a nearly equal ratio and thus reflects early reduction practices. This low ratio supports previous angular shatter-bipolar flake findings and suggests that early reduction or expedient practices were substantial at that site, while any late stage reduction or tool manufacture was not extensive.

Flake Size

Comparing size grades of complete flakes found at the site, Table 5 shows that as complete flakes decrease in grade size so too does their average length, width, and thicknesses. Experiments carried out by Morrow (1997:65) have shown that the ratio between flake thickness and flake width decreases as bifacial reduction progresses from earlier to later stages (i.e., flakes become thinner relative to their width). Based on this evidence, it should be expected that if bifacial reduction was occurring on-site, then the thickness-to-width ratios of complete flakes should show a regular decline when grouped by size from large flakes to small flakes. When grouped by size, average flake thickness-to-width ratios did not show a regular decline from large to small flakes. Instead, these ratios were found to be fairly consistent. While the largest average thickness-to-width ratio (0.33) is associated with the largest complete flake size group (flakes greater than 5 cm), subsequent average thickness-to-width ratios of 0.25, 0.26, 0.27, and 0.27 for decreasing flake sizes were found (i.e., size 5, 4, 3, and 2, respectively). If anything, average thickness-to-width ratios tend to increase after the largest complete flake size group (size 5+). Because thickness-to-width ratios did not show a regular decline from large to small flakes, but a consistent patterning in general, it is unlikely that bifacial tool manufacture or repair was occurring on-site with any regularity or magnitude.

Table 5. Size Grade of Complete Flakes by Average Measurements.

Size Grade (cm)	Number Complete Flakes	Average Weight (g)	Average Max Length (cm)	Average Max Width (cm)	Average Max Thickness (cm)	Average Thickness: Width
1	0	-	-	-	-	-
2	28	0.52	1.25	1.30	0.35	0.27
3	23	2.23	2.01	2.15	0.58	0.27
4	12	6.47	3.14	2.89	0.76	0.26
5	5	8.19	3.57	3.45	0.85	0.25
5+	3	39.96	4.93	4.21	1.39	0.33
Total	**71**	-	-	-	-	**-**

Differences in flake size have not only been linked to types of lithic reduction, but also to the intensity of lithic reduction. Along with later stage bifacial reduction, more intensive reduction has also been found to result in an increased occurrence of smaller flakes in an assemblage (Ahler 1989; Morrow 1997; Prentiss 2001). While complete small flakes (size 2) make up a sizeable amount (39%) of the site's complete flake assemblage, thickness-to-width ratio findings indicated that this is not the result of bifacial reduction and/or maintenance. Instead, the presence of bipolar flakes and cores and small amorphous cores on-site suggest that the incidence of complete small flakes is likely due to the reduction of small-sized parent materials and the intensive reduction of their byproducts to acquire useable pieces of debitage.

Platforms

Comparing flake platform typologies and frequencies in Table 6, platforms indicative of early stage or expedient methods of lithic reduction (cortex, flat, and battered/crushed) comprise over 80% of flake platform typologies, while platforms associated with later stage reduction or more investment in flaked stone tool production/repair (complex and abraded) constitute less than 20% of the flake platform typologies. This frequency of platform types indicates that early stage and/or expedient methods of production were the prevalent lithic reduction activities practiced on-site and implies a reduction strategy where the production of flakes, as opposed to the shaping of the core, was the primary objective. While platforms associated with later stage reduction and/or more investment in flaked stone tool production were observed, they contribute to less than one-fifth of the flake platform typology. Therefore, it does not appear that later stage reduction and/or flaked stone tool production was a substantial activity associated with flaked lithic practices carried out at LA 20,000.

Table 6. Platform Types and Frequencies.		
Platform	**Count**	**Percentage**
Abraded	9	*5.9%*
Battered	7	*4.6%*
Complex	21	*13.7%*
Cortex	32	*20.9%*
Crushed	25	*16.3%*
Flat	59	*38.6%*
Total	**153**	***100%***

To see if there is any variability in the overall debitage assemblage as it may relate to reduction strategies, the debitage and platform categories were combined into three distinct groups (Table 7). Group 1 is composed of bipolar flakes and complete and proximal flakes that display attributes generally associated with early or expedient methods of reduction (cortex, flat, and battered/crushed platforms). Group 2 is made up of complete and proximal flakes with attributes generally associated with later reduction and/or tool maintenance (abraded or complex platforms). Group 3 includes all debitage with no observed platform (flake fragments and angular debris). These results are comparable to those derived from the examination of platform types (Table 6) alone, suggesting that the overall debitage assemblage is reflective of early and/or expedient reduction debris.

Table 7. Debitage Groups.		
Debitage Group	**Count**	**Percentage**
Group 1	123	*43.2%*
Group 2	30	*10.5%*
Group 3	132	*46.3%*
Total	**285**	***100%***

Cortex

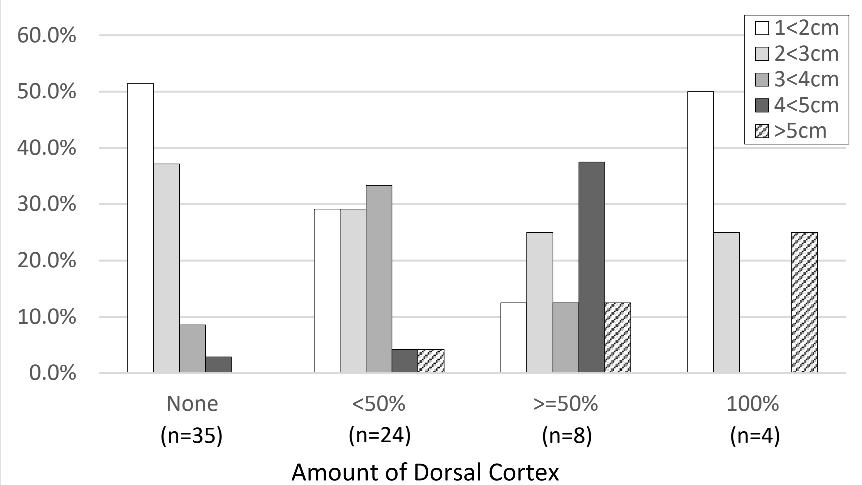
Dorsal cortex amounts for each debitage type is presented in Table 8. Data shows that cortex is present on nearly 39% of all debitage. This indicates that earlier stage lithic reduction is well represented in the overall debitage assemblage and that this aspect of lithic reduction occurred at LA 20,000. Furthermore, over 15% of the debitage has at least 50% or more dorsal cortex present, indicating that initial reduction of lithic materials likely took place at the site as well. When angular shatter and bipolar flakes (both generally associated with early and/or expedient lithic reduction strategies) are removed from the number of pieces of debitage without cortex, the percentage of debitage without cortex drops dramatically from 61% to 32%. This 32% reflects the percentage of complete flakes, broken flakes, and flake fragments that do not have dorsal cortex (N=91).

Table 8. Type of Debitage by Amount of Cortex.

Debitage Type	Amount of Cortex				Total
	None	<50%	≥50%	100%	
Angular Shatter	69	22	11	4	**106**
	24.2%	*7.7%*	*3.9%*	*1.4%*	***37.2%***
Bipolar Flake	15	4	5	3	**27**
	5.3%	*1.4%*	*1.8%*	*1.1%*	***9.5%***
Complete Flake	35	24	8	4	**71**
	12.3%	*8.4%*	*2.8%*	*1.4%*	***24.9%***
Broken Flake	35	16	2	2	**55**
	12.3%	*5.6%*	*0.7%*	*0.7%*	***19.3%***
Flake Fragment	21	1	4	0	**26**
	7.4%	*0.4%*	*1.4%*	*0%*	***9.1%***
Total	**175**	**67**	**30**	**13**	**285**
Percentage	***61.4%***	***23.5%***	***10.5%***	***4.6%***	***100%***

When only complete flakes are considered, 49% have no dorsal cortex, while 51% have some dorsal cortex present. When complete flakes are broken down by amount of dorsal cortex and flake size, Figure 4 indicates that only about 51% of all complete flakes lacking dorsal cortex are in the small (< 2 cm) size category. If formal tool production was carried out in any significant amount, this percentage should be much higher. This lends support to the interpretation that there was a lack of formal tool production at LA 20,000 and that these flakes were produced from smaller size cores, rather than just a later stage of reduction.

Figure 4. Combined Percentage of Dorsal Cortex and Size for all Complete Flakes.



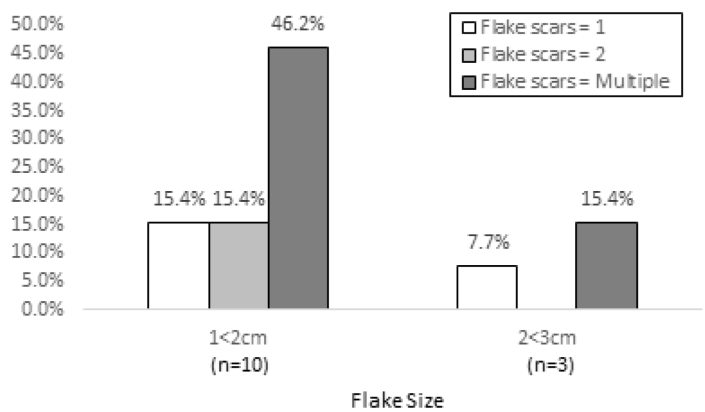
Of complete and proximal flakes without dorsal cortex (N=35 and N=35, respectively), 44 have platforms that are associated with early stage reduction techniques, while 26 have platforms that are associated with later stage lithic reduction (complex and abraded) (Table 9). So, out of 285 pieces of debitage only 26 (9.1%) display any indications that could be associated with later stage lithic reduction or tool maintenance (e.g., abraded or complex platforms with no dorsal cortex). However, since striking platforms can be modified by abrasion or retouch at any time during the reduction process to aid in the removal of flakes from both cores (early stage reduction) and tools (late stage reduction), even these flakes could have resulted from core platform modification that was done to help facilitate the removal of flakes from cores and not with later stage lithic reduction and/or tool maintenance.

Table 9. Type of Platform by Amount of Dorsal Cortex.						
Platform Type	**Amount of Dorsal Cortex**				**Count**	**Percentage**
	None	**<50%**	**≥50%**	**100%**		
Abraded	7	1	1	0	**9**	***5.9%***
Battered	4	2	1	0	**7**	***4.6%***
Complex	19	2	0	0	**21**	***13.7%***
Cortex	0	20	6	6	**32**	***20.9%***
Crushed	19	4	2	0	**25**	***16.3%***
Flat	35	16	5	3	**60**	***38.6%***
Total	**84**	**45**	**15**	**9**	**153**	**-**
Percentage	***54.9%***	***29.4%***	***9.8%***	***5.9%***	**-**	***100%***

Unfortunately, further analysis of these 26 flakes is problematic given that half of them are broken. Of the broken flakes, 10 platforms are complex and three are abraded. Therefore, the following analysis of the 13 complete flakes and platform types likely associated with later stage lithic reduction (Complex=9, Abraded=4) as they relate to attributes of flake size and number of flake scars is given cautiously due to such a small sample size.

Figure 5 shows that 77% of these flakes are small (< 2 cm) and that over 61% of the flakes have multiple flake scars (more than two), while approximately 23% have only one flake scar. When only considering the 10 small flakes, over 46% of these have multiple flake scars. Taken together, this suggests that the majority of these 13 flakes with abraded or complex platforms having no dorsal cortex are very likely associated with later stage lithic reduction and/or tool repair. Even owing to the likelihood of a few misinterpreted flakes, and assuming that the other 13 broken flakes with similar platforms would reflect similar flake size and flake scar attribute patterns if complete, it appears that no more than 10% of the flaked stone debitage assemblage would be associated with later stage lithic reduction and/or tool repair. This further supports the interpretation that expedient lithic reduction was primarily carried out at LA 20,000, and that later stage lithic reduction and/or tool repair, while occasionally performed, was not carried out in any substantial amount.

Figure 5. Complete Non-Cortical Flakes with Modified Platforms by Flake Size and Flake Scar Counts.



Local versus Distant Lithic Material Reduction

To determine if different reduction strategies were employed for local versus distantly acquired materials, previous reduction strategy indicators were divided into local and distant material categories. Table 10 shows flake to angular debris ratios and numbers of complete and proximal flakes for local and nonlocal lithic materials. Overall, flake to angular debris ratios are highest for the nonlocal materials and lowest for the locally available materials. However, the very low ratios for all material types suggests that early stage lithic reduction methods and/or expedient strategies were being employed for both local and nonlocal materials at the site, and little if any tool manufacture was occurring (Moore 1994:310,312).

Table 10. Complete and Proximal Flake to Angular Debris Ratios by Material Source.			
Material Type	**Complete and Proximal Flakes**	**Angular Debris**	**Flake: Angular Debris**
Nonlocal Materials	27	13	2.08
Obsidian	*16*	*9*	*1.78*
Pedernal Chert	*11*	*4*	*2.75*
Local Materials	99	93	1.06
Total All Materials	**126**	**106**	**1.19**

While expedient reduction strategies appear to have been employed for all lithic materials at the site regardless of origin, Chi-Square analysis comparing flake to angular debris ratios by material source (local vs. nonlocal) was found to be fairly significant ($X^2 = 3.3885$ (1df), $p = .0657$). The reason for this variation may be that nonlocal lithic materials were more carefully or systematically reduced in an attempt to conserve or maximize return due to their limited availability relative to local materials and/or their small nodule size. This difference may also reflect repair or recycling of formal tools on-site since nonlocal materials of obsidian and Pedernal chert comprise over 83% of formal tools (Table 2).

In Table 11 platform data were divided into local and nonlocal material categories. Percentages of obsidian flakes with modified platforms are higher than those for local materials, while percentages of Pedernal chert flakes with modified platforms are lower than those for local materials. This may be just as much a result of sample size as reduction strategy, since there are only 27 flakes of nonlocal materials with platforms represented in the assemblage. When obsidian and Pedernal chert counts are combined, the nonlocal material percentages for modified (22%) and unmodified platforms (78%) are nearly identical to those for local materials, indicating that similar reduction strategies were employed for both local and nonlocal materials.

Table 11. Platform Types for Complete and Proximal Flakes by Material Source.

Material Type	Modified Platforms	Unmodified Platforms	Totals
Obsidian	5	11	**16**
	31%	*69%*	***13%***
Pedernal Chert	1	10	**11**
	9%	*91%*	***9%***
Local Material	24	75	**99**
	24%	*76%*	***78%***
Totals	**30**	**96**	**126**
	24%	**76%**	**100%**

To test if differential reduction strategies were employed for obsidian alone, as may be suggested by the higher modified platform percentage, Chi-Square analysis was performed. The difference between obsidian and non-obsidian lithic material reduction with respect to platform preparation was found not to be significant ($X^2 = 0.5593$ (1df), $p = .455$). The difference between obsidian and only local materials for this analysis was also found not to be significant ($X^2 = 0.3578$ (1df), $p = .549$). Both results suggest that a similar early stage and/or expedient lithic reduction strategy was employed for both obsidian and non-obsidian materials at LA 20,000. Since there are only 16 flakes of obsidian with platforms present in the assemblage, this higher modified platform percentage may simply be the result of sample size or reflect obsidian material properties allowing for easier recognition of flake features. Alternatively, this difference may also reflect the repair of formal tools on-site since obsidian comprises over 66% of the formal tool assemblage (Table 2).

Table 12 shows dorsal cortex percentages for formally defined flakes by material source. Overall, percentages of non-cortical flakes for nonlocal materials are higher than those of local materials. Chi-Square analysis indicates that the difference between local and nonlocal lithic material reduction with respect to the amount of dorsal cortex present on flakes was found to be high ($X^2 = 4.495$ (1df), $p = .034$). However, when Chi-Square analysis was performed for obsidian versus local material flakes with respect to dorsal cortex the difference was not found to be very significant ($X^2 = 2.0003$ (1df), $p = .157$). This p-value still implies that there is roughly an 84% chance that the differences observed between obsidian and local material flakes with respect to dorsal cortex may reflect differences between lithic materials rather than just chances associated with sampling. It is possible that this difference may be associated with bipolar reduction. The presence of three bipolar obsidian cores indicates that at least some obsidian was brought onto the site as unreduced or partly reduced large pebbles and subsequently reduced using bipolar reduction. Bipolar strategies are often employed under specific lithic material constraints, including raw material scarcity and/or small nodule size. Both scenarios apply to obsidian at LA 20,000. Due to this combination of material scarcity and small nodule size, it is likely that obsidian was more intensively reduced than locally available materials and this intensive reduction may account for the relatively small percentage of obsidian cortical flakes. Additionally, this difference may also reflect the repair or recycling of obsidian tools on-site.

Table 12. Amount of Cortex for Flakes by Material Source.						
Material Type	**Flake Type**	**Amount of Dorsal Cortex**				**Total**
		None	**<50%**	**≥50%**	**100%**	
Obsidian	Complete	4	4	-	-	**8**
	Broken	6	2	-	-	**8**
	Fragment	7	1	-	-	**8**
	Totals	**17**	**7**	**-**	**-**	**24**
		71%	***29%***	-	-	***16%***
Pedernal Chert	Complete	5	2	-	-	**7**
	Broken	4	-	-	-	**4**
	Fragment	1	-	-	-	**1**
	Totals	**10**	**2**	**-**	**-**	**12**
		83%	***17%***	**-**	**-**	***8%***
Local Material	Complete	26	18	8	4	**56**
	Broken	25	14	2	2	**43**
	Fragment	13	0	4	0	**17**
	Totals	**64**	**32**	**14**	**6**	**116**
		55%	***28%***	***12%***	***5%***	***76%***
All Materials	**Total**	**91**	**41**	**14**	**6**	**152**
	Total %	***60%***	***27%***	***9%***	***4%***	***100%***

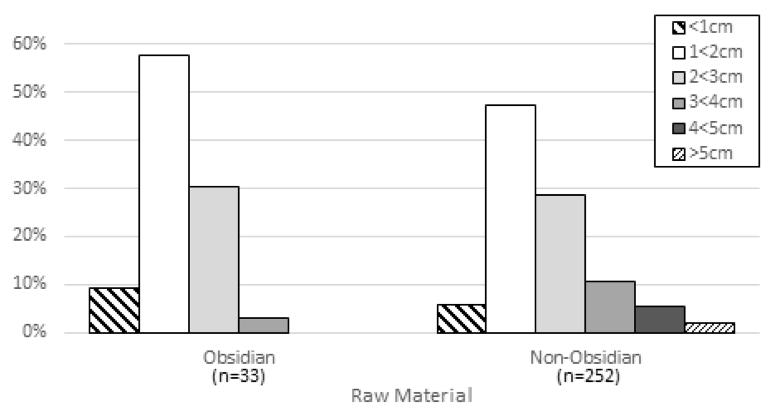
Table 13 displays any indications that could be associated with later stage lithic reduction and/or tool repair by combining modified platforms with complete and proximal flakes that lack dorsal cortex and comparing these by material source. The numbers are very similar to those given in Table 12 which compared platform data for local and nonlocal material categories; the only difference being the loss of four modified platforms from the local material category which have dorsal cortex. Not surprisingly, like Table 12, percentages of non-cortical obsidian flakes with modified platforms are higher than those for local materials, while percentages of non-cortical Pedernal chert flakes with modified platforms are lower than those for local materials. Again, this may be as much a result of sample size as reduction strategy, since there are only 27 flakes of nonlocal materials with platforms represented in the assemblage. When obsidian and Pedernal chert counts are combined the nonlocal material percentages for modified and unmodified platforms for non-cortical flakes are 22% and 78%, respectively. These percentages are very similar to those found for local materials, indicating that similar reduction strategies were employed for both local and nonlocal materials.

Table 13. Platforms for Complete and Proximal Non-Cortical Flakes by Material Source.			
Material Type	**Modified Platforms**	**Other Platforms**	**Total**
Obsidian	5	11	**16**
	31%	*69%*	***12.7%***
Pedernal Chert	1	10	**11**
	9%	*91%*	***8.7%***
Local Material	20	79	**99**
	20%	*80%*	***78.6%***
Total	**26**	**100**	**126**

To test if different reduction strategies were employed for obsidian alone, as may be suggested by the higher modified platform percentage, Chi-Square analysis was performed. The difference between obsidian and non-obsidian lithic material reduction with respect to modified platforms for complete and proximal flakes that lack dorsal cortex was found not to be significant ($X^2 = 1.261$ (1df), $p = .261$), suggesting that similar early stage and/or expedient lithic reduction at LA 20,000 was employed for both obsidian and non-obsidian materials. Again, this may simply be the result of sample size (obsidian flakes with platforms N=16), as well as a result of obsidian material properties which allow for easier recognition of flake features. Conversely, higher obsidian modified platform percentages may truly reflect the repair and/or recycling of formal tools, but further indicate that this type of on-site activity was limited.

When comparing overall debitage size for obsidian and non-obsidian lithic materials, Figure 6 indicates that obsidian and non-obsidian materials follow a general size pattern distribution for all pieces less than 3 cm in maximum dimension. Interestingly, only one piece of obsidian debitage (3%) is larger than 3 cm, while 19% (N=46) of non-obsidian debitage are larger than 3 cm. However, Chi-square analysis between obsidian and non-obsidian materials by small (< 2 cm) and large (> 2 cm) debitage size was found not to be very significant (X^2 = 2.1439 (1df), p = .143). Although this suggests that similar forms of reduction for all materials likely took place on-site (expedient and/or early stage), the higher overall proportion of smaller obsidian flakes coupled with the high percentage of obsidian noncortical flakes previously noted may point to the maintenance of obsidian tools. The lack of larger obsidian debitage supports the idea of smaller original core size.

Figure 6. Percent of Debitage Size for Obsidian and Non-Obsidian Materials.



Finally, the percentage of dorsal flake scar counts for complete obsidian (N=8) and non-obsidian flakes (N=63) reveals that complete obsidian flakes possess greater multiple flake scarring than non-obsidian complete flakes, 75% versus 54%, respectively. Chi-square analysis reveals that this difference is not significant (X^2 =1.2765 (1df), p=.259). However, the results of this comparison should be taken with caution due to small sample size.

Debitage Summary

The majority of flaked stone reduction/production at LA 20,000 involved raw materials available proximate to the site. Two clear exceptions are obsidian and Pedernal chert from the Jemez Mountain and Rio Grande River areas. Debitage assemblage attributes examined as indicators of reduction strategy are summarized in Table 14. Some attributes are better predictors than others, but when combined they provide a good indication of the reduction strategy utilized at LA 20,000. Results indicate that early or expedient lithic reduction dominates the LA 20,000 flaked stone debitage assemblage and was likely the main strategy employed at LA 20,000. However, it must be emphasized that all stages of reduction were observed. This is evident from the presence of cores to the few late stage reduction flakes attributed to tool repair identified in the assemblage. Thus, this analysis has only determined the lithic reduction strategies on which occupants of LA 20,000 focused.

Table 14. Summary of Flaked Stone Reduction Strategy Indicators.

Attribute	Result	Reduction Strategy Indicated
Flake/Angular Debris Ratio	1.19	Expedient
% Modified Platforms	19%	Expedient
% Cortical Flakes	40%	Expedient
% Late Stage Reduction Flakes	9%	Expedient

To determine if different reduction strategies were employed for local or distantly acquired materials, the same reduction strategy indicators were divided into local and nonlocal material categories. Chi-Square analysis indicates that expedient reduction strategies were employed for both material groups. Slight variations in flake to angular debris ratios, cortical flake percentages, and dorsal flake scar percentages between local and nonlocal materials were observed, however. Although still expedient, these variations may indicate attempts at more careful or systematic reduction of nonlocal materials in an attempt to conserve or maximize return due to their limited availability relative to local materials and/or their small nodule size, as well as indicate their more intensive reduction. Bipolar reduction may have been the strategy more often used on nonlocal materials to achieve these objectives and might account for these variations. Conversely, local and nonlocal material variations may indicate the repair or recycling of formal tools given that over 83% of these are made from nonlocal obsidian and Pedernal chert. However, even if this is the case, overall debitage analysis results still indicate that this type of on-site activity was limited and not carried out in any substantial amount.

Flaked Stone Tool Analysis

A total of 73 flaked stone tools were identified from the LA 20,000 assemblage (Table 15). These consist of 32 expedient tools, 12 formal tools, 11 cores, 9 gunflints, 8 strike-a-light flints, and 1 indeterminate tool fragment of unknown form and function. Locally available cherts, chalcedonies and other CCS materials make up 50.7% of the flaked tool assemblage, while other materials of probable local origin (quartz, quartzite, basalt, and silicified wood) comprise an additional 8.3%. The remaining 41% are nonlocal lithic materials of obsidian, Pedernal chert, and an unidentified nonlocal chert. XRF analysis (discussed later) indicates that all obsidian tools derive from two geochemical sources located in the Jemez Mountains.

Table 15. Flaked Stone Tools by Material Types.										
Tool Class	**Obsidian**	**Chert Chalcedony Other CCS**	**Pedernal Chert**	**Quartz**	**Quartzite**	**Basalt**	**Silicified Wood**	**Nonlocal Chert**	**Total**	**Total Percent**
Non-Flake Tool	4	3	-	-	-	-	-	-	**7**	**9.6%**
Bipolar Flake Tool	-	5	1	-	-	-	-	-	**6**	**8.2%**
Flake Tool	6	8	1	2	1	-	-	-	**18**	**24.7%**
Uniface	-	1	-	-	-	-	-	-	**1**	**1.4%**
Biface	6	1	1	-	-	-	-	-	**8**	**11.0%**
Projectile Point	2	-	1	-	-	-	-	1	**4**	**5.5%**
Core	4	6	-	-	-	1	-	-	**11**	**15.1%**
Gunflint	-	7	1	-	-	-	1	-	**9**	**12.3%**
Strike-A-Light Flint	-	5	2	1	-	-	-	-	**8**	**11.0%**
Unknown	-	1	-	-	-	-	-	-	**1**	**1.4%**
Total	**22**	**37**	**7**	**3**	**1**	**1**	**1**	**1**	**73**	**-**
Total %	**30.1%**	**50.7%**	**9.6%**	**4.1%**	**1.4%**	**1.4%**	**1.4%**	**1.4%**	**-**	**100%**

Most cores (64%) are of locally available lithic materials, while obsidian constitutes the only nonlocal core material (36%). Similarly, most expedient tools (63%) are made from locally available materials, with the remaining expedient tools being made from obsidian (31%) and Pedernal chert (6%). Conversely, the vast majority of formal tools (92%) are made from nonlocal materials of obsidian, Pedernal chert, and a nonlocal chert. The lone exception is a thermally altered chalcedony biface fragment. Based on material type frequencies, the flaked stone tool assemblage at LA 20,000 is comprised mostly of locally available materials (59%) with few nonlocal material types present but contributing to a somewhat substantial portion of the assemblage (41%). Although obsidian makes up less than 12% of the debitage assemblage (Table 1), it is over 30% of the flaked stone tool assemblage. Similarly, Pedernal chert makes up just over 6% of the debitage assemblage but contributes nearly 10% to the flaked stone tool assemblage. Due to their low rates of occurrence in the debitage assemblage, the procurement and reduction of obsidian and Pedernal chert does not appear to have been a fundamental element of lithic practices conducted at LA 20,000. Instead, it appears that formal tools made from these distant raw materials were manufactured off-site and brought to the site as finished, or nearly finished, tools. The presence of a projectile point made of an unidentified nonlocal chert and morphologically most similar to a Harrell-type Plains arrow point (discussed later) also supports this assertion. Overall, the flaked stone tool assemblage at LA 20,000 suggests an expedient technology utilizing a variety of locally available materials, as well as two nonlocal materials, for use of debitage as informal tools when necessary or convenient, while formal tools made of nonlocal materials appear to have been curated and transported from areas of manufacture to areas of utilization.

Flaked Stone Tools

The types of flaked stone tools recovered from LA 20,000 provide insight into the kinds of practices carried out by the people who lived there. Because cores and informal tools were often discarded immediately after use, they generally remained at or near their area of use. Unfortunately, the recognition of informal tools and their functions is often difficult because only a certain percentage of such tools will have observable evidence of use. Conversely, formal tools are easily identifiable and were often multi-purpose tools that could be used, depending on their size, for various activities such as scraping, cutting, sawing, piercing, or boring. Regrettably, most formal tools were removed from areas of use to be reused elsewhere (unless they were broken, lost, or no longer useful), making direct evidence of formal tool use often deficient (Andrefsky 2004; Moore 2001a).

Cores

Eleven cores (six multidirectional, four bipolar, and one unidirectional) were recovered from excavations at LA 20,000 (Table 16, Figure 7). All are small (<5 cm in maximum dimension), expedient in form, and types present are common in expedient assemblages. Core materials consist of obsidian, chert, chalcedony, and a fine-grained basalt. Cortex is present on 10 cores, with two obsidian cores (Core-7 and Core-10) having water-worn cortex indicating procurement from a stream deposit, likely the Rio Grande River.

Table 16. Cores.

Artifact	FS #	Type	Material	Max Length (cm)	Max Width (cm)	Max Thickness (cm)	Mass (g)	Flake Scars	Cortex
Core-1	89	Multi-directional	Chert	3.8	3.4	2.2	21.66	8	1
Core-2	171	Multi-directional	Obsidian	2.5	1.5	0.8	2.61	5	1
Core-3	200	Multi-directional	Chert	2.5	1.9	1.4	7.64	7	1
Core-4	135	Bipolar	Chert	1.7	2.1	1.8	6.07	7	3
Core-5	167	Multi-directional	Chalcedony	3.6	2.8	2.0	14.82	6	1
Core-6	209	Uni-directional	Chalcedony	3.0	4.6	1.8	16.6	6	1
Core-7	F-0-1990	Bipolar	Obsidian	2.1	1.7	1.0	3.24	10	1
Core-8	206	Multi-directional	Chalcedony	4.0	4.2	1.8	32.98	6	1
Core-9	39	Bipolar	Obsidian	2.6	3.1	0.9	7.92	10	0
Core-10	1J-54	Bipolar	Obsidian	3.7	1.8	1.3	8.16	3	3
Core-11	92-0-2	Multi-directional	Basalt	4.3	4.5	2.0	45.3	14	1

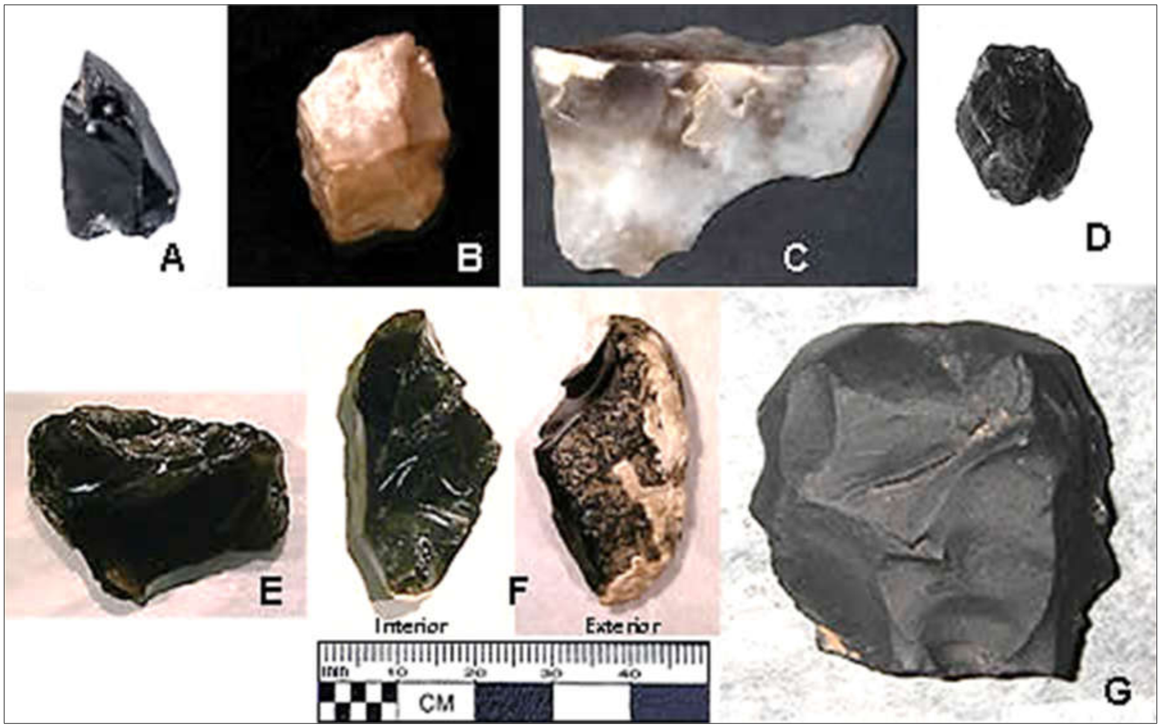


Figure 7. Examples of Cores from LA 20,000. A) Core-2; B) Core-3; C) Core-6; D) Core-7; E) Core-9; F) Core-10; G) Core-11.

According to Patterson (1987:51), multidirectional and amorphous cores can result from a variety of manufacturing situations. These situations include 1) where large flakes were not needed, such as when small projectile points were the principal manufacturing product; 2) where specialized flaked stone tools were not used; 3) where there was an abundance of lithic raw materials available so efficient lithic reduction was not necessary; or 4) where limitations in raw material size, shape, and/or quality required a lithic reduction strategy where small pieces of raw material or harder grades of raw material could be easily reduced. With respect to LA 20,000, the last situation appears to be most likely. Small core sizes along with dorsal cortex on all but one suggests that cores likely started out small since more intensive reduction should result in the removal of most or all dorsal cortex.

Table 17 shows core type by average size (Core-2 was excluded from calculations since it is not a complete multidimensional core). If bipolar reduction was a strategy utilized under lithic material constraints (material scarcity, size, and/or shape), then bipolar cores should be smaller than other cores found at LA 20,000. Average length, width, thickness, and mass measurements reveal that bipolar cores are, in fact, smaller on average than all other core types found at the site. Mass measurements display this best with multidirectional and unidirectional cores being 3.86 and 2.61 times as large on average than bipolar cores, respectively. Also important is that 75% of bipolar cores are of nonlocal obsidian, while only 25% are of locally available chert. Conversely, nearly all multidirectional cores are of locally available materials, while only one multidirectional core fragment is made of a nonlocal obsidian. Taken together, these results support the premise that bipolar reduction was a strategy used at LA 20,000 to address lithic material constraints like raw material scarcity and/or small nodule size; especially as it relates to nonlocal obsidian.

Table 17. Core Type by Average Size.

Core Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
Bipolar	2.5	2.2	1.3	6.35
Multidirectional	3.6	3.4	1.9	24.48
Unidirectional	3	4.6	1.8	16.6

Like debitage analysis results, both the types and limited number of identified cores (N=11, 3.5% of the total flaked stone assemblage) indicate that what flaked stone tool manufacture did occur on-site was both informal and limited. Most cores were reduced on-site by opportunistically removing flakes from surfaces, without attempts to maintain a uniform shape or platform area; their main purpose being to provide flakes or debris that could be used as tools, and not to be made into tools themselves. Their small size, retention of cortex, and occurrence with bipolar strategies also suggest that lithic reduction was employed under material constraints and/or simply out of necessity when a cutting or scraping implement was needed for immediate and expedient use (Andrefsky 2004; Morrow 1997). This is reflective of an expedient core reduction and tool production technology.

Informal Tools

A total of 32 informal tools were identified in the flaked stone assemblage (Table 18). Locally available raw materials were most often used as informal tools (62.5%), with nonlocal obsidian and Pedernal chert also occurring (37.5%). Flake tools are by far the most common type (56.3%), while unifaces are the least (3.1%). Informal tools account for the majority (nearly 44%) of the flaked stone tool assemblage (Table 15) but result in just 11% of the total debitage assemblage exhibiting evidence of tool use. While this 11% is a relatively low percentage, processing soft materials rarely creates visible scarring or edge-wear, and working medium and hard materials does not always result in discernable edge damage (Grace 2012). Consequently, it is likely that only a small portion of informal tools were identified in the LA 20,000 assemblage, and these do not reflect the full range of informal tools at the site.

Table 18. Informal Flaked Stone Tools.

Material	Non-Flake Tool	Bipolar Flake Tool	Flake Tool	Uniface	Total
Obsidian	4	-	6	-	**10** ***31.2%***
Chert Chalcedony Other CCS	3	5	8	1	**17** ***53.1%***
Pedernal Chert	-	1	1	-	**2** ***6.3%***
Quartz	-	-	2	-	**2** ***6.3%***
Quartzite	-	-	1	-	**1** ***3.1%***
Total	**7**	**6**	**18**	**1**	**32**
Total %	***21.9%***	***18.75%***	***56.25%***	***3.1%***	***100%***

A summary of debitage attributes associated with informal tools (Appendix B) shows that early reduction flakes were most often selected for use (25%). Angular shatter and bipolar flakes were next in use, making up nearly 22% and 19% of the assemblage, respectively. Late reduction flakes were rarely used, contributing to only 6% of the informal tool assemblage. These data reflect an expedient lithic technology focusing on the presence of readily accessible materials for use as informal tools and supports conclusions reached by debitage and core analysis.

Following methods presented by Grace (2012), the altered edges of each informal tool were evaluated as to their type and location of damage, edge morphology, and edge angle (Appendix C). From the 32 informal tools, 56 different used edges and edge angles were recorded (Table 19). Most informal tools have either one (47%) or two (38%) use-edges, with unimarginal (64%) and bimarginal (34%) alteration being most common. Interestingly, one edge displays alternating retouch (i.e., dorsal retouch and ventral retouch along the same edge, but not in the same place). The most frequent use-edge shape is straight (54%), and the most common use-edge angles (50%) occur between 30-60 degrees. Striations were observed on only 16 (29%) of the edges, with transverse orientations being the most prevalent (75%). Oblique, parallel, and combination parallel and transverse striations were also observed. Edge fractures include feather, snap, step, hinge, and crushed (Appendix C) and vary with the way the tool was used, the type of material it was used on, and the type of lithic material from which it was made (Grace 2012; Kooyman 2000; Odell and Odell-Vereecken 1980).

Table 19. Informal Tool Attributes.			
Attributes		**Count**	**Percent**
Number of Used Edges	1	15	47%
	2	12	38%
	3	3	9%
	4	2	6%
	Total	**32**	**100%**
Edge Modification	Unimarginal	36	64%
	Bimarginal	19	34%
	Alternating	1	2%
	Total	**56**	**100%**
Edge Shape	Straight	30	54%
	Convex	13	23%
	Concave	4	7%
	Pointed	6	11%
	Irregular	2	4%
	Straight w/ Projection	1	2%
	Total	**56**	**100%**
Edge Angle	≤30	9	16%
	30<60	28	50%
	≥60	19	34%
	Total	**56**	**100%**
Striations	Transverse	12	75%
	Oblique	2	13%
	Parallel	1	6%
	Parallel + Transverse	1	6%
	Total	**16**	**100%**

Informal Tool Use Interpretations

Suggested wear motions were identified for 43 of the 56 used edges (Table 20) and include unidirectional (N=35), bidirectional (N=3), rotational (N=3), and striking (N=2). Eleven used edges display no wear motion pattern, and the patterns of two used edges could not be determined. Of the 32 expedient tools, 21 (66%) have edges that were intentionally altered to produce a specific shape or edge angle, while 11 (34%) appear to have been used as-is, without intentional modification. Use interpretations for individual informal tools are given in Appendix D**.** Wear motion patterns were established by matching corroborative observations made from variables, such as edge morphology, edge-wear damage (e.g., fracture type, fracture pattern, edge fracture amount, etc.) and striation patterns (Appendix C).

Table 20. Suggested Informal Tool Motions and Functions.

Suggested Motion	Suggested Function	Count	Percent
Unidirectional	Cutting	4	9.3%
	Scraping	20	46.5%
	Incising	6	14%
	Whittling	1	2.3%
	Cutting + Whittling	2	4.7%
	Whittling + Shaving	2	4.7%
Bidirectional	Cutting	3	7%
Rotational	Boring	2	4.7%
	Piercing	1	2.3%
Striking	Undetermined	2	4.7%
Total		**43**	**100%**

Correlations between these variables also allowed identification of the most probable function(s) of a tool to be made. Edge wear analysis suggests that informal tools were produced for a variety of functions (Table 20). Scraping (47%), cutting (21%), and incising (14%) appear to have been the most common uses, with whittling/shaving, boring, and piercing also occurring. Although the function(s) of the two artifacts with striking motions could not be determined with any confidence due to their fragmentary nature, possibilities include use as either gunflints or pecking stones. However, any assertion of one function over the other would be pure conjecture. Informal tools were likely used on materials of variable hardness, with analysis showing materials of soft to medium (34.4%) and medium hardness (28.1%) being most likely (e.g., plants, woody plants, soft wood, fish, leather). Harder materials (e.g., dry wood, antler, bone, shell, soft stone) were likely also worked, but less frequently (18.8%). The hardness of worked materials could not be determined for five expedient tools (15.6%) and one tool displayed no use wear. Eight informal tools appear to have served more than one function (Appendix D).

Formal Tools

The 12 formal tools identified in the LA 20,000 flaked stone tool assemblage consist of 7 bifaces, 4 projectile points, and 1 hafted drill (Table 21). Formal tools account for less than 17% of the flaked stone tool assemblage and less than 4% of the entire flaked stone artifact assemblage (Table 2). Four of the formal tools are complete, while eight are incomplete (five identifiable and three unidentifiable portions). Ninety-two percent of formal tools are made from three nonlocal lithic materials, while the remaining tool is made of a thermally altered chalcedony of probable local availability. However, it is also possible that this tool is manufactured from Pedernal chert, but thermal alteration makes material identification uncertain. Such lack of variability in raw materials demonstrates that distant high-quality lithic materials were deliberately selected and preferred for formal tools. Debitage analysis findings indicate that formal tools, especially those made of nonlocal materials, were likely manufactured off-site and brought to LA 20,000 as preforms or bifaces, which were then retouched and sharpened, or as finished products for use on site.

Table 21. Formal Flaked Stone Tools.									
Tool	**Field Spec Number**	**Tool Type**	**Material**	**Max Length (cm)**	**Max Width (cm)**	**Max Thickness (cm)**	**Weight (g)**	**Width: Thickness Ratio**	**Portion**
BF-1	30	Hafted Biface	Obsidian	2.0	1.2	0.4	0.71	3	Blade
BF-2	235	Biface	Chalcedony	3.0	3.1	0.7	6.63	4.43	Medial
BF-3	42	Hafted Biface	Obsidian	2.9	1.9	0.5	2.54	3.80	Near Complete
BF-4	119	Biface	Obsidian	3.3	2.1	0.5	3.89	NA	Fragment
BF-5	51-258	Biface	Obsidian	3.2	1.7	0.9	3.35	NA	Fragment
BF-6	52-183	Biface	Obsidian	0.9	0.7	0.2	0.14	NA	Distal
BF-7	AY12A-24	Biface	Pedernal Chert	3.3	3.2	1.5	17.1	NA	Fragment
Drill-1	171	Hafted Drill	Obsidian	2.0	1.6	0.7	2.06	2.29	Complete
PP-1	4	Projectile Point	Obsidian	1.5	1.2	0.3	0.63	4	Proximal
PP-2	11-3	Projectile Point	Pedernal Chert	2.3	1.3	0.3	0.67	4.33	Complete
PP-3	1K-172	Projectile Point	Obsidian	3.3	1.8	0.5	2.05	3.60	Blade
PP-4	197	Projectile Point	Chert	2.7	1.1	0.2	0.52	5.50	Complete

Bifaces

General bifacial tools (Table 21, Figure 8) consist of the following: BF-1) the blade portion of an obsidian biface that has been re-notched and likely hafted for use in cutting material such as leather, rawhide, or some material of similar hardness; BF-2) the medial portion of a heat-treated chalcedony biface that was likely used as a combination tool to cut, scrape, and incise/groove materials of medium relative hardness; BF-3) a nearly complete side-notched obsidian biface that exhibits reworking at its distal end and was likely used as a hafted knife to cut soft to medium hard materials; BF-4) the unknown portion of an obsidian biface fragment exhibiting a perverse fracture; BF-5) an obsidian biface fragment that was intentionally broken and reused as a spokeshave; BF-6) the distal end of an obsidian biface displaying an impact fracture suggesting that the artifact is likely the remnant of a projectile point; and BF-7) an early stage Pedernal chert biface fragment with unimarginal micro-flaked edge modification and transverse abrasion.

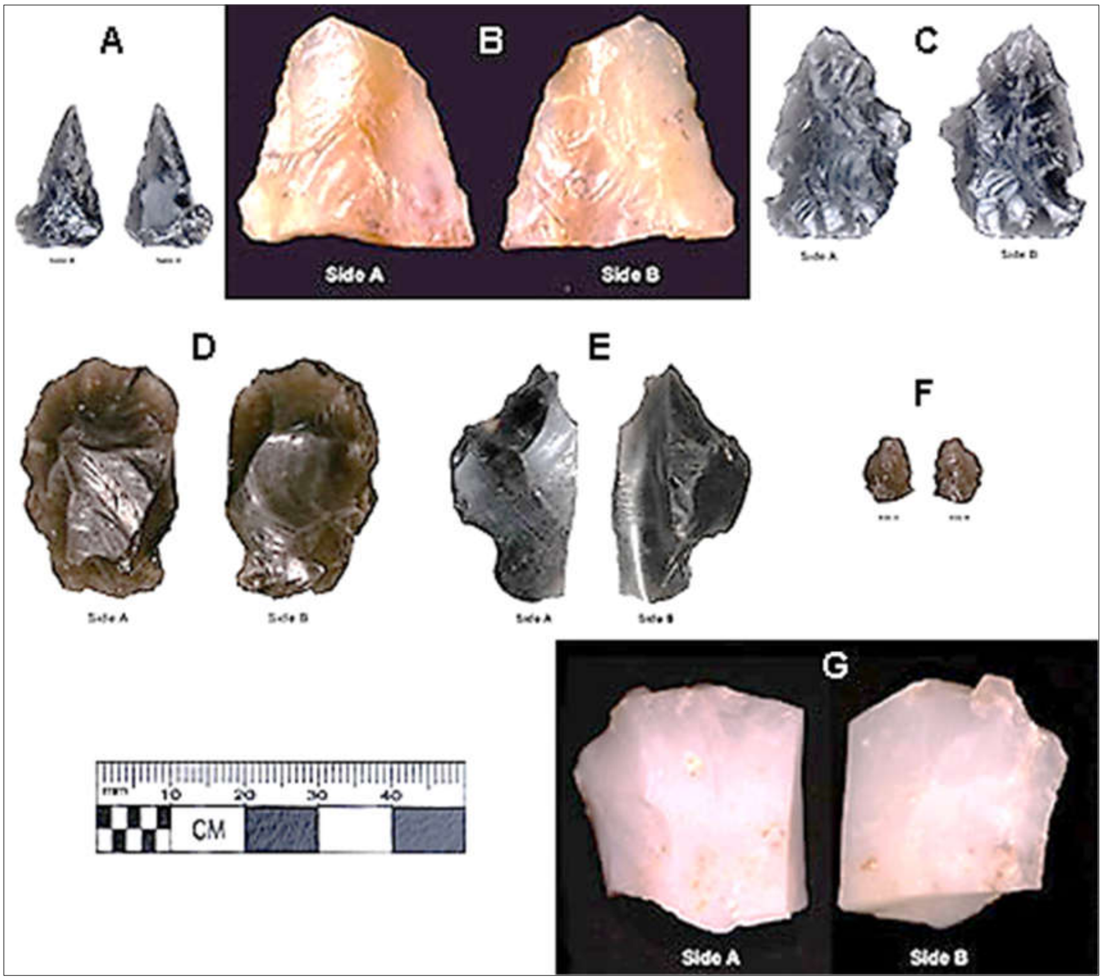


Figure 8. Bifaces from LA 20,000. A) BF-1; B) BF-2; C) BF-3; D) BF-4; E) BF-5; F) BF-6; G) BF-7.

Projectile Points

Projectile points include two complete and two broken examples (Table 21, Figure 9). All are nonlocal materials of obsidian, Pedernal chert, and a chert of unknown provenance. All diagnostically assigned point typologies are contemporaneous with 17th-century New Mexico.

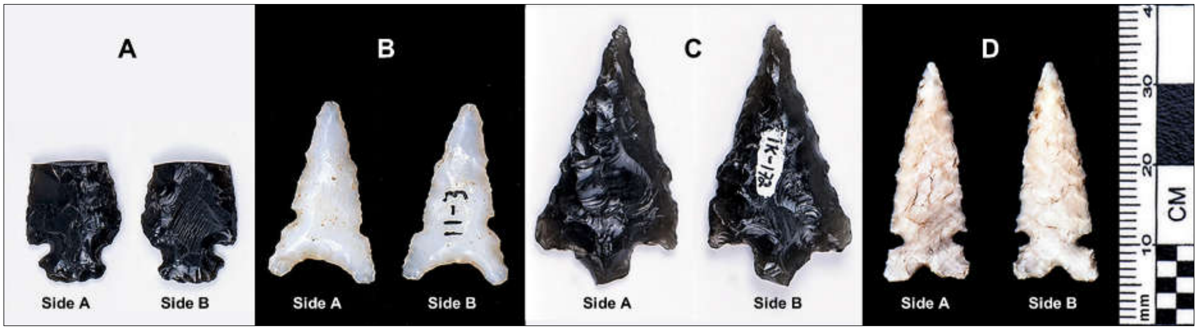


Figure 9. Projectile Points from LA 20,000. A) PP-1; B) PP-2; C) PP-3; D) PP-4.

PP-1 is the proximal portion of an obsidian corner-notched arrow point that has a convex base and a hinge fracture located at its distal end. The dorsal surface of the artifact is fully flaked facially and exhibits random flake scars, while the ventral surface is only flaked along margins. The base of the artifact is too damaged to assign a definitive type, but this small corner-notched point is likely associated with local Puebloan groups (Justice 2002:246-255).

PP-2 is a complete Pedernal chert Pueblo side-notched arrow point with a concave base. The side notches are slightly offset and very shallow and, similar to PP-1, it is randomly flaked facially on its dorsal surface, while only marginally flaked on its ventral surface. This point type dates from approximately 1150-1600 A.D. (Justice 2002:289-299) and occurs contemporaneously with PP-4 (discussed below).

PP-3 is the blade and neck portion of an obsidian projectile point that exhibits random flaking patterns on both faces, as well as asymmetrical blade margins suggesting resharpening. Since its base is missing, no typological classification can be made. Interestingly, the weight of the artifact is more than three times that of either complete point, suggesting it may be the remnants of a dart point and reflect the scavenging and recycling of an older and larger artifact. The point has crushed edges with step fractures and some parallel striations are present. This wear may indicate that the artifact was secondarily used to cut materials of medium hardness.

However, this type of wear has also been shown to be produced by impact against a variety of materials and may simply be indicative of edge damage accrued over general projectile point use (Dockall 1997). For this reason, functional interpretation is made with caution.

PP-4 is a complete triangular-shaped arrow point with parallel side notches and a distinct central basal notch. The projectile point is made from a brownish-white and light gray chert of nonlocal origin. The artifact is extremely thin (0.2cm) and both of its facial surfaces display random flaking patterns. This projectile point is most morphologically similar to Awatovi Side Notched (name employed in western New Mexico and Arizona), Harrell (name employed in the southern Plains), and Sierra or Desert Side Notched (name employed in the Great Basin and Colorado Plateau) types. There is no special attribute that can be used to differentiate between these similar tri-notched points, and all range from roughly the same period (1250-1900 A.D.). In New Mexico, this style of point has been associated with Athabaskan groups (Navajo and Apache) and Numic-speaking peoples (e.g., Ute) who are believed to have moved into the region around the 13th century (Justice 2002:315-319). The presence of this projectile point may reflect the presence of an Athabaskan affiliated person (or possibly Ute) at LA 20,000, or, at a minimum, provide evidence of trade between inhabitants of LA 20,000 and Native groups.

Drill

One bifacial drill (Drill-1) was recovered at LA 20,000 (Table 21, Figure 10). The drill is complete, made of obsidian, and appears to have been produced from a large piece of debitage shatter or biface fragment. It has broad, shallow notches present at its lateral margins and exhibits an overall random flaking pattern. The lateral margins and proximal end are heavily abraded and both the dorsal and ventral surfaces exhibit crushing along most flake scar ridges, suggesting that the drill was hafted for use. The point of the drill is crushed, and torsion flake scars occur on the distal end of the drill, as do transverse striations. Striations and fracture patterns suggest that Drill-1 was used in a back-and-forth rotating motion on materials of medium hardness such as green bone, wood, dry hide, soft stone, or shell.

Figure 10. Drill-1.

Based on analysis, the people at LA 20,000 clearly selected and preferred nonlocal, high-quality materials for use as formal tools. Obsidian was the dominant tool stone chosen for bifacial tools with Pedernal chert and a nonlocal chert also contributing to this category. Several of the biface fragments also seem to indicate the practice of tool reuse and/or recycling. No other portions of the broken artifacts were recovered from site excavations and the portions that were recovered continued to be utilized after breakage. It may be that some of these artifacts were procured from older sites in the area, brought to the site already broken, and used essentially for the same purpose and/or subsequently used for a new purpose (as evidenced by the heat-treated Pedernal chert biface’s multiple uses). Debitage analysis supports this idea since evidence of tool manufacture and maintenance of nonlocal materials on-site is limited.

Indeterminate Tool (FST-31)

A small wedge/triangular-shaped remnant of a radially fractured tool of unknown form and function recovered from heavy fraction processing was identified in the flaked stone assemblage. This indeterminate tool fragment measures 0.9 cm x 1 cm x 0.5 cm (LxWxT), weighs 0.35 g, and is made of a dark and light brown chalcedony. The intact margin has an edge angle of 55 degrees with three macro-flake scars (two feather and one step) present on its dorsal surface suggesting edge modification. Continuous unimarginal step and hinge micro-flake scars are also present dorsally and five randomly oriented macro-flake scars are present on the profile of one broken edge. This fragment is heavily patinated and all of its edges/ridges are sub-angular in form. The fragment is too small and weathered for accurate identification, but, overall, appears to be the remnant of a tool that has been radially fractured. Radial fracture is a specific form of bipolar reduction used to intentionally break flakes or tools in order to produce small useable wedge-shaped tools with thick, damage-resistant edges and is often indicative of tool recycling (Amick 2007:240; Jennings 2011:3644).

Strike-A-Light-Flints

It is important to note that strike-a-light flints can often resemble flaked stone scrapers or spokeshaves. While use-wear attributes associated with each of these classes of flaked stone tools are usually distinct enough to allow for accurate tool differentiation (Moore 2001:77), the identification of flaked stone artifacts as strike-a-light flints is made with caution.

Eight strike-a-light flints were identified in the flaked stone assemblage at LA 20,000 providing evidence for the presence of this fire-starting method. Strike-a-light flint wear pattern and edge shape types follow that provided by Moore (2004:196) and are shown in

Table 22, along with other informative attributes. In total, 15 edges on 8 pieces of flaked stone debitage exhibit damage attributable to strike-a-light flint use. Four artifacts have one utilized edge, two have two, one has three, and one has four though no metal adhesions were observed on any of them. All strike-a-light flints are made of siliceous materials and it appears that existing edge morphology determined selection for use because none of the artifacts display any evidence of intentional shaping or sharpening on their edges; any alterations appear to be the result of utilization (Figure 11).

Table 22. Strike-A-Light Flint Attributes.

Tool	FS #	Material	Debitage Type	# Tool Edges	Edge Wear Pattern Type	Edge Morphology	Edge Angle
SALF-1	481	Quartz	Bipolar Flake	1	Type 6	Shape 2	85
SALF-2	19	Chalcedony	Flake	1	Type 6	Shape 5	63
SALF-3	1-47	Pedernal Chert	Flake	1	Type 6	Shape 5	75-85
SALF-4	1-12	Chalcedony	Flake	2	Type 7	Shape 1	70
					Type 6	Shape 2	70
SALF-5	F-60-295	Pedernal Chert	Bipolar Flake	2	Type 6	Shape 5	40 + 60
					Type 5	Shape 2	70
SALF-6	AY11A-19	Chalcedony	Bipolar Flake	4	Type 7	Shape 5	45
					Type 5	Shape 1	60
					Type 7	Shape 5	45
					Type 6	Shape 2	35
SALF-7	112	CCS	Flake	3	Type 1	Shape 5	60
					Type 1	Shape 5	68
					Type 1	Shape 2	68
SALF-8	167	Chert	Angular Shatter	1	Type 6	Shape 2	89

Type 1 Unidirectional retouch, mainly unidirectional wear: mostly stepping, with some feathered microflakes. Abrasion and metal adhesions may also be present.
Type 5 No retouch, minimal use only: battering, some stepping and feathering. Metal adhesions may also be present.
Type 6 No retouch, unidirectional wear only: stepped or feathered microflakes. Abrasion and metal adhesions may also be present.
Type 7 No retouch, bidirectional wear only: stepped or feathered microflakes. Abrasion and metal adhesions may also be present.
Shape 1 Straight.
Shape 2 One or more concavities.
Shape 5 Straight and concave segments on same edge.

Figure 11. Strike-A-Light Flints from LA 20,000. A) SALF-1; B) SALF-2; C) SALF-3; D) SALF-4; E) SALF-5; F) SALF-6; G) SALF-7; H) SALF-8.

Three basic utilized edge shapes were identified on the strike-a-light flint artifacts. These edge shapes consist of straight and concave segments on the same edge (Shape 5) constituting nearly 47% of the total, edges with one or more concavities (Shape 2) comprising 40% of the total, and straight edges (Shape 1) making up a little more than 13% of the total. Most edges (N=12, 80%) show light use (Types 5, 6, and 7) consisting of wear with no retouch, while a smaller number (N=3, 20%) exhibit heavier use (Type 1) with both retouch and wear present. Utilized edge angles on strike-a-light flints range from 35 to 85 degrees and appear to be related to wear patterns. Flints with bidirectional wear (Type 7) have a smaller mean edge angle of 53 degrees than flints with marginal wear (Type 5), 65 degrees, or unidirectional wear (Types 1 and 6), 65.3 degrees. According to Moore (2001b:76), this relationship is likely due to the way in which edges were selected and struck. As he explains, marginally used edges possibly began their use-lives with steep angles similar to their mean measurements, while unidirectional and bidirectional edges may have begun at shallower angles. As these shallower edge angles were used micro-debris was inadvertently removed and the edges became steeper.

At around 65 degrees strike-a-light flint edges with unidirectional wear seem to dull during use rather than undergo continual re-sharpening by incidental flaking. In contrast, edges with bidirectional use-wear appear to stabilize at a lower edge angle of roughly 58 degrees. Apparently, inadvertent bidirectional use creates an edge that is stronger and more resistant to splintering at a lower angle (Moore 2001b:76-77). It seems likely, then, that final edge shapes and edge angles were determined both by the original edge angles of the flaked stone and the amount of use the pieces of debitage were subjected to. One likely reason for strike-a-light flints having been minimally used or having a short use-life at LA 20,000 is that materials suitable for such use were immediately available on-site. Flints could simply be used a few times and discarded without having to be reprocessed.

Gunflints

Of the nine gunflints recovered at LA 20,000 (Table 23, Figure 12), six are complete and three are fragmentary. Most gunflints (N=6) are squared and bifacially flaked, two are spall-type, and one is squared with unifacial flaking, but its opposite face is missing from either manufacture error or use breakage making its true form uncertain. Complete bifacially flaked gunflints average 3.1 cm x 2.25 cm x 0.92 cm (LxWxT) and 8.24 g, while complete spall-type average 3.07 cm x 2.25 cm x 1.15 cm (LxWxT) and 8.98 g. The average measurements of length and width for these two different gunflint types are essentially identical, while differences in average thickness and weight likely reflect the more intensive reduction associated with bifacial production.

Table 23. Gunflints from LA 20,000.								
Tool	**Field Spec #**	**Material**	**Max Length (cm)**	**Max Width (cm)**	**Max Thickness (cm)**	**Weight (g)**	**Portion**	**Type**
Gunflint-1	1-6	Chert	3	2.95	0.97	10.18	Complete	Bifacial
Gunflint-2	50	Chalcedony	2.67	1.92	0.81	5.3	Complete	Bifacial
Gunflint-3	160	CCS	3.15	2.3	1.2	9.91	Complete	Spall-type
Gunflint-4	160	Chalcedony	3.6	2.25	1	11.15	Complete	Bifacial
Gunflint-5	1L-84	Silicified Wood	3.1	1.8	0.9	6.34	Complete	Bifacial
Gunflint-6	269	CCS	1.9	1.8	0.9	3.28	Fragment	Bifacial
Gunflint-7	1J-60	Pedernal Chert	2.9	2.2	1.1	8.04	Complete	Spall-type
Gunflint-8	1J-62	Chert	1.76	1.2	0.78	1.12	Fragment	Bifacial
Gunflint-9	4-P-1c	Madera Chert	2.86	2.75	0.95	8.12	Fragment	Indeterminate (unifacial or bifacial)

Figure 12. Gunflints from LA 20,000. A) Gunflint-1; B) Gunflint-2; C) Gunflint-3; D) Gunflint-4; E) Gunflint-5; F) Gunflint-6; G) Gunflint-7; H) Gunflint-8; I) Gunflint-9.

Like strike-a-light flints, all gunflints are manufactured from siliceous materials. Two are made from provincial materials (Gunflints 7 and 9) and eight of the nine are made from lithic materials available within 15 km of the site; indicating production of these artifacts on at least a regional, if not local scale. According to Moore (2004:191-192), squared bifacial gunflints are the most common type found in New Mexico and reflect the type of gunlock (the miquelet lock) popular in Spain and its colonies from roughly A.D. 1600 until the mid-1800s. Gunflints are also frequently manufactured from regionally local materials, signaling that gunflint production was not uncommon among the Spanish colonists of the area. This coupled with evidence for reduction of these materials on-site from flaked stone debitage analysis hints at the possibility that some gunflint manufacture may have occurred at LA 20,000. For example, three of the bifacial gunflints (Gunflint-2, -5, and -6) are rectangular "pillow-shaped" and display similar flake scar patterns (also similar to Gunflint-9 and expedient tool FST-6), while one gunflint (Gunflint-1) is square with substantially more flake scars and manufacturing attributes more similar to other formal flaked stone tools recovered at the site (e.g., projectile points and bifaces). This would seem to indicate different manufacturing techniques, as well as possibly different manufacturers (Durst 2009; Kenmotsu 1990:98-102; Kent 1983; Witthoft 1966). The three "pillow-shaped" gunflints (as well as Gunflint-9 and FST-6) may be attributable to Spanish colonist manufacture, while Gunfint-1 may have been made by an Indigenous Puebloan or Plains person.

Bend-Break and Radial Fracture Tools

A sub-category of flaked stone tools present at LA 20,000 consists of broken flakes and bifaces that exhibit use along a broken edge. These broken edges were produced intentionally or incidentally through either bend-break or radial fracture. Intentionally produced bend and radial fractures on flakes and bifaces have been identified in Late Pleistocene (Rasic 2011:151-154) and Folsom assemblages (Frison and Bradley 1980) continuing through historical times. In bend-break fractures, the flake or biface is bent beyond its tensile strength either through use, impact, or during manufacture causing the artifact to snap transversely (Frison and Bradley 1980:43-44). Although radial fractures can also result during manufacture, they most often occur from intentionally striking the center of a flake or biface resting upon a flat surface. The force of the blow causes the piece to fracture into three or more pieces from the center outward in a radial pattern (Frison and Bradley 1980:44; Jennings 2011:3645). Bend-breaks and radial fractures resulting from deliberate impact can represent a specific form of bipolar reduction and may be indicative of raw material or tool recycling (Amick 2007; Frison and Bradley 1980; Goodyear 1993; but see Rasic 2011).

At LA 20,000 nine flaked stone artifacts were intentionally broken using direct impact. Five of these were broken to produce small useable tools with robust, near 90-degree damage-resistant edges for scraping and/or sharp points for grooving and incising. These intentionally broken objects consist of three bend-break tools (FST-32, BF-2, and BF-5) and two radial fracture tools (FST-20 and FST-24). The four remaining artifacts display no indications of use-wear and include one piece of angular shatter (FS# 99-3a) and one flake (FS# B48-161) with intentional bend-breaks and one bipolar flake (FS# 0-10) and one indeterminant tool remnant (FST-31, discussed earlier) with radial fractures.

Intentional breakage, rather than incidental formation through lithic reduction, trampling, or use is demonstrated by cones of force and/or eraillure scars along broken edge surfaces, as well as impact spalls and/or crushing at the point of applied force. Use-wear, rather than post-depositional damage, is demonstrated by some combination of the following: continuous and/or clustered macro- and micro-fractures typically confined along the bend-break edge, intentional edge modification, edge rounding, and/or transverse striations. Wear patterns suggest a possible use of bend-break and radial tools in shaving, scraping, and shaping of wood and bone, perhaps for tool handles or spindle whorl shafts, as well as to process softer materials such as fibrous plants or animal skin. Where margins and/or fractures meet to form a point, oblique striations and crushing on these points indicate use in engraving/incising of hard materials.

Tool Reuse and Recycling

Since bipolar technology is frequently associated with the reduction of small raw material packages (e.g., pebbles and cores) it may not necessarily reflect lithic recycling of discarded debitage or tools. Similarly, bend-breaks can occur as a result of tool use, abuse, or during manufacture and therefore do not necessarily indicate reuse/recycling unless associated with other attributes. Evidence that more strongly signals raw material or tool reuse/recycling would include the occurrence of radial fracturing, retouch/repair of tools (e.g., noticeably asymmetrical blade margins, beveled edge(s), or removal of patina from edges/surfaces) (Andrefsky 2008:200; Harper and Andrefsky 2008:181), and multi-use tools.

Overall, 20 artifacts were found to exhibit evidence of reuse, recycling, or multifunctional use (Table 24) and together make up 6% of the flaked stone assemblage. These include the five intentional bend-break and four radial fractured artifacts previously discussed, three formal tools displaying evidence of reuse or resharpening, and eight informal tools that appear to have served more than one function (Appendix D). Unfortunately, it is not possible to determine if these eight informal tools were used for different purposes during the same use episode, or if they were reused for different tasks after being initially discarded. Thus, the inclusion of these eight multifunction informal tools within the recycle/reuse category may be inflating the presence of this economizing behavior. Regardless, analysis indicates that, while not substantial, at least some flaked stone artifacts were retooled, reused, and/or recycled.

Table 24. Evidence of Reuse and/or Recycling.

Field Spec #	Artifact	Material	Attributes
0-10	Bipolar flake	Chalcedony	Radial fracture
1K-130	Uniface-1	Chalcedony	Multiuse
1K-172	PP-3	Obsidian	Asymmetrical margins
1-18	FST-16	Obsidian	Multiuse
2-4	FST-32	Obsidian	Bend-break
13	FST-8	Quartz	Multiuse
30	BF-1	Obsidian	Re-notched; Asymmetrical margins
42	BF-3	Obsidian	Reworked distal end
51-258	BF-5	Obsidian	Bend-break
53	FST-1	Quartz	Multiuse
64-1	FST-31	Chalcedony	Radial fracture
64-B4-4 (88)	FST-24	Obsidian	Radial fracture
99-3a	Angular shatter	Obsidian	Bend-break
162	FST-27	Chalcedony	Multiuse
235	BF-2	Chalcedony	Bend-break; Multiuse
243	FST-3	CCS	Multiuse
251	FST-4	Chalcedony	Multiuse
297	FST-20	Obsidian	Radial fracture
B48-161	Flake	Obsidian	Bend-break
BY0A-3	FST-23	Pedernal Chert	Multiuse

While debitage analysis suggests that bipolar reduction was practiced more as a strategy to utilize small material packages rather than strictly as a method of material conservation or as a response to differential availability of lithic materials, it is likely that similar strategies of reduction (e.g., bend-break and radial fracture) were practiced as a way to further reduce existing tools in order to provide new and different tool forms. If people at LA 20,000 were attempting to conserve flaked stone tools because such items were scarce or considered important commodities, the assemblage should exhibit some form of this behavior, possibly through the intensive (getting the most out of items through reuse) and/or extensive (extending the use-life through recycling) use of artifacts or through an increased use of broken edges. Regardless of the circumstance, all these scenarios should result in a high incidence of broken tools (Odell 1996).

Of the 12 formal tools (Table 21), 8 are broken and 4 are complete or near complete. Of the broken tools, three are too fragmented to enable classification by portion or to calculate width to thickness ratios (BF-4, BF-5, and BF-7). Because tools often break even when not used intensively/extensively, the degree of fragmentation of these three biface fragments were used as a measure of extreme intensive/extensive use. Doing this results in 25% of formal tools being considered intensively and/or extensively used as represented by extreme fragmentation. Considering intentional breakage, only three previously existing flaked stone tools (two bifaces (BF-2 and BF-5) and one indeterminant tool remnant (FST-31)) appear to have been intentionally broken to provide new and different tool forms/functions. Of these, only BF-2 and BF-5 (17% of formal tools) display use of intentionally broken edges.

Finally, as previously discussed, only three formal tools (25%) display evidence of reuse or repair (BF-1, BF-3, and PP-3). Taken together, five formal tools exhibit at least some attribute(s) suggestive of formal tool conservation, but only three (BF-1, BF-2, and BF-5) appear to have been used so extensively to have been recycled into different tool forms/functions. It is important that the assemblage, like most, is likely biased given the tendency of people to discard broken tools and keep tools that were still intact, often taking intact tools with them to be reused elsewhere (Andrefsky 2004; Moore 2001a).

Even though the sample size is small (N=12), an investigation of flaked stone tool economizing behavior indicates that formal tools at the site were not heavily conserved. This suggests that formal tools were not likely considered overly scarce nor relatively important commodities. If they had been considered in these terms, it is likely that individual formal tools would exhibit higher proportions of intensive and/or extensive use, along with a higher frequency of utilized broken edges.

Flaked Stone Tool Summary

A total of 73 flaked stone tools were identified from the LA 20,000 artifact assemblage: 32 expedient tools, 12 formal tools, 11 cores, 9 gunflints, 8 strike-a-light flints, and 1 tool fragment of indeterminate form and function. The preponderance of multidirectional cores with random flake removal scars indicates that raw materials were used almost exclusively out of convenience or necessity to produce flakes that were themselves used as informal tools and is reflective of an expedient core reduction and tool production technology. Based on material type frequencies, the flaked stone tool assemblage is comprised of mostly locally available raw materials with few nonlocal material types present but contributing to a somewhat substantial portion of the assemblage.

Due to their low rates of occurrence in the debitage assemblage, the procurement and reduction of obsidian and Pedernal chert does not appear to have been a fundamental element of lithic practices conducted at LA 20,000. Instead, it appears that formal tools made from these distant materials were manufactured off-site and brought to LA 20,000 as preforms or bifaces, which were then retouched, or as finished products for use on site. Conversely, a variety of locally available materials were expediently reduced on-site for use of debitage as informal tools when necessary or convenient.

Edge wear analysis suggests that expedient tools were produced for a wide variety of tasks including cutting, whittling/shaving, scraping, boring, piercing, and grooving/incising that could have been used in the working of various materials such as plants, wood, bone, stone, and leather. Interestingly, a few flaked stone artifacts were found to have been broken intentionally using direct impact to produce small useable tools with robust, near 90-degree damage-resistant edges for scraping and/or sharp points for grooving and incising. Although 20 artifacts were found to exhibit evidence of reuse, recycling, or multifunctional use, combined these artifacts make up an unsubstantial 6% of the flaked stone assemblage. Similarly, an investigation of flaked stone tool economizing behavior indicates that formal tools at LA 20,000 were not heavily conserved; suggesting that formal tools were not considered overly scarce nor relatively important commodities to site residents.

However, the small number of projectile points on-site may signify their use as a trade good between site residents and Indigenous peoples. If so, these artifacts could have served a few functions. For one, they may indicate the practice of hunting wild game. However, faunal remains of ungulates are rare at LA 20,000, suggesting that these animals were not heavily relied upon (Opishinski 2019), although initial butchering conducted at kill sites and the "schlepp effect" (Daly 1969:149) needs to be considered. Secondly, they could have served as weapons for defense or warfare. Flaked stone projectile points have been recovered at many Spanish sites and the use of stone point-tipped arrows, as well as bows and arrows in general, by Spanish colonists and militia has been documented (Moore 2004). If these artifacts are not representative of trade goods, they may also reflect the presence of Puebloan or Plains laborers on-site or the collection of artifacts by *estancia* residents from surrounding areas. Besides serving strictly functional roles associated with hunting, defense, or warfare, flaked stone projectile points may have also served non-utilitarian social and symbolic functions such as hunting/war ritual items, as medicinal objects/safeguards against danger, in death rituals, in games/community activities, and as special curated, gathered, or exchanged items (Harper and Andrefsky 2008:180-181; Sedig 2014).

Strike-a-light flints and gunflints, European technologies generally associated with Spanish colonist use, especially during the early colonization of New Mexico, were also identified on-site. Although steel strike-a-lights (*chispas*) are rarely recovered in archaeological assemblages (Moore 2001b:73) and none were recovered at LA 20,000, the presence of strike-a-light flints does provide evidence for the existence of this fire-starting technology on-site. All strike-a-light flints are made of siliceous materials, display no evidence of intentional shaping or sharpening on their edges, and appear to have been minimally used. Such short use-life suggests that lithic materials suitable for use were immediately available on-site and not particularly scarce. Strike-a-light flints were simply used a few times and discarded without having been retooled or repurposed.

Like strike-a-light flints, all gunflints are manufactured from siliceous materials, and their presence at LA 20,000 provides evidence for a technology that otherwise might have gone undetected in the site's archaeological record, firearms. Spanish firearms at this time included pistols, shotguns (*escopetas)*, longarms (*arquebuses*), blunderbusses, and muskets (*mosquetes*), among others, which would have been used in hunting, defense, and warfare

(Curtis 1927:121-123; Lavin 1965). While the specific type of firearm(s) used at the site could not be determined, the type of gunlock used was likely the miquelet lock; the most popular in Spain and its colonies (Moore 2004:190). The miquelet lock produces greater damage to the edge of gunflints than other flintlocks (Kenmotsu 1990), so requires gunflints with a sturdy edge. Squared and bifacial gunflints meet this requirement and are the most common gunflint types reported in New Mexico, as well as found at LA 20,000. Along with bifacial gunflints, a few spall-type gunflints are also present at the site. The occurrence of gunflints made from both provincial and local materials indicate the production of these artifacts on at least a regional, if not local, scale. However, gunflints lack any signs of uniformity related with mass production or acquisition from large-scale distribution. Instead, evidence for reduction of gunflint material types on-site from debitage analysis hints at the likelihood that some gunflint manufacture occurred at the *estancia*. In addition, differing flake scar patterns among gunflints suggest not only the use of different production techniques, but also likely different manufacturers as well (Spanish and Indigenous people) (Durst 2009; Kenmotsu 1990; Kent 1983; Witthoft 1966). Beyond function, the presence of gunflints may also offer evidence that the owner(s) of LA 20,000 was wealthier or had better access to goods than other colonists since firearms were presumably expensive and difficult to acquire in 17th-century New Mexico (Moore 2004).

Based on flaked stone tool analysis, the people who lived and worked at LA 20,000 clearly selected and preferred nonlocal, high-quality raw materials like obsidian for use as formal tools, while more often choosing to exploit locally available lithic materials for expedient tool manufacture. Since formal tools were likely transported from areas of manufacture to the site, it is highly probable that these implements were made by local Indigenous peoples who either brought them to the site for use as laborers or traded them to the Spanish colonists. It is also possible that *estancia* residents collected some flaked stone tools from previously inhabited Indigenous sites located within the surrounding area for subsequent use. The co-occurrence of different flaked stone tool technologies associated with both Indigenous and Spanish/European cultural origins, as well as different manufacturing styles and the presence of both local and nonlocal lithic materials, suggests that both Spanish and Puebloan/Plains peoples were likely responsible for the production and use of flaked stone tools at LA 20,000.

CHAPTER 5

OBSIDIAN SOURCING

Obsidian was not locally available at LA 20,000 and the nearest sources, geologically, are found in secondary deposits of alluvial gravels located along the Rio Grande approximately 25 km west-northwest of the site. In contrast, primary deposits of obsidian are found over 40 km to the north, west, and southwest of the site throughout the Jemez Mountains. Due to spatial proximity, it was assumed that most obsidian artifacts, if not all, would derive from alluvial gravel deposits and obsidian artifacts recovered on-site would match the geochemical signatures of obsidian found in these deposits. Understanding the provenance of obsidian from the site provides necessary context for technological analyses in terms of understanding the kinds of reduction strategies used to process the obsidian and how those strategies compared to those of other lithic materials found on-site as discussed previously. Questions concerning obsidian more specifically include: what kinds of material packages did peoples associated with LA 20,000 bring back to the site (e.g., pebbles, cores, bifaces, or finished products); was obsidian conserved and/or recycled, or used uneconomically; did reduction and/or use strategies vary by obsidian geochemical type; and what do answers to these questions ultimately tell us about daily life at LA 20,000?

XRF Analysis and Results

In XRF analysis, the proportions of Fe (iron), Rb (rubidium), Sr (strontium), Y (yttrium), Zr (zirconium), and Nb (niobium) are commonly used to discriminate individual obsidian source groups using bivariate plots to separate the sources visually. Comparing the trace elemental values for each of the LA 20,000 samples to those from known baseline source samples reported in Baugh and Nelson (1987), Liebmann (2017) and Shackley (1995, 2019), the most precise discrimination among geochemical sources was achieved through biplots of Sr to Y and Nb to Zr. These bivariate plots reveal the presence of four distinct obsidian geochemical source groups at LA 20,000. These include Cerro Toledo Rhyolite (CTR; also called Cerro Toledo, Rabbit Mountain, or Obsidian Ridge), Valles Rhyolite (VR; also called Cerro del Medio or Valle Grande), El Rechuelos Rhyolite (ERR; also called Polvadera Peak), and Canovas Canyon Rhyolite (CCR; also called Bear Springs Peak), all of which are located within the Jemez Mountains. The clear separation of sources found in this assemblage results in a confident source assignment for all analyzed artifacts (Appendix E).

Source names used hereafter refer to geological terminology (Cerro Toledo Rhyolite; Valles Rhyolite) versus geographic location (Rabbit Mountain; Cerro del Medio, respectively). Besides primary geologic sources, three of these (CTR, ERR, and CCR) are also available in secondary gravel deposits along the Rio Grande and other major tributaries, while secondary deposits of VR obsidian are only present within the Valles Caldera (Church 2000). As a result, CTR, ERR, and CCR obsidians could have been procured from secondary sources located nearer to LA 20,000, but obtaining VR obsidian would have required travel into the Valles Caldera or some form of indirect procurement (Liebmann 2017:651-652).

Figure 13 shows the primary and potential secondary deposit source areas for obsidians recovered at LA 20,000. The black circles signify both the location and horizontal extent of geologically mapped primary obsidian deposits, while the dark gray shading designates areas that either contain or have the potential to contain secondary deposits of useable obsidian. Secondary deposits of obsidian that are of poor quality or too small to be useable have been excluded from the map. However, "Deposits with usable obsidian are not ubiquitous inside the shaded areas…. The large shaded areas representing downstream deposits from [CCR] are broadly defined and give an impression of a greater extent and abundance of artifact-quality obsidian than these secondary deposits actually contain" (Ramenofsky et al. 2017b:160-161).

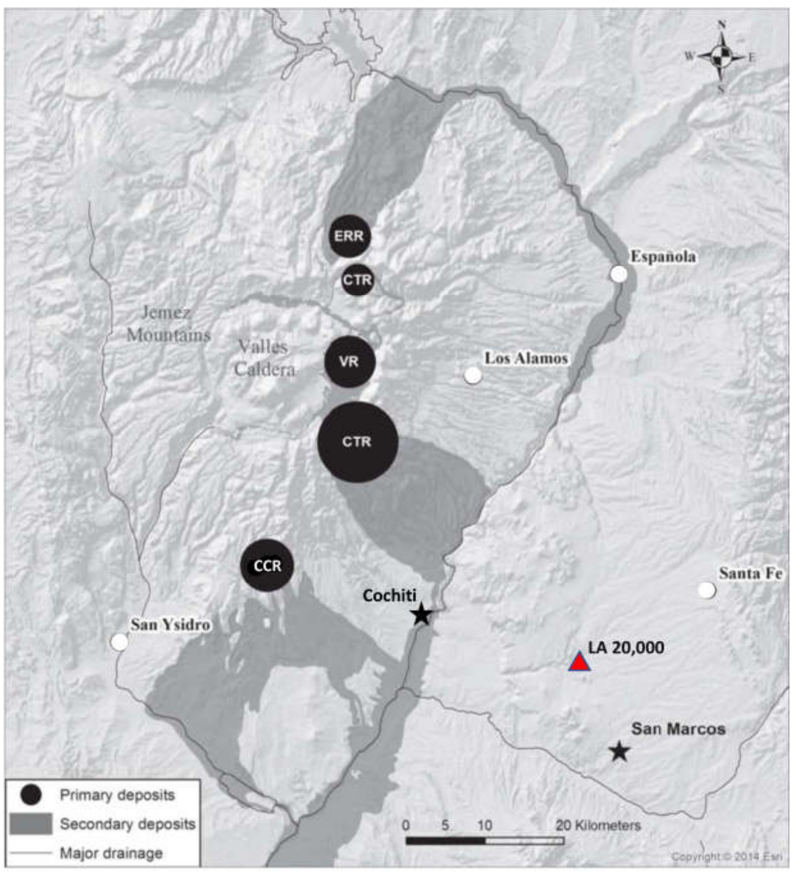


Figure 13. Geographic Distribution of LA 20,000 Sourced Obsidian Geochemical Groups. (Adapted from Ramenofsky et al. 2017b:160).

Counts and weights by obsidian geochemical type are summarized in Table 25. CTR is the most abundant making up nearly 76% of the total count and over 71% of the total weight. VR is the next most abundant by both count and weight, while ERR and CCR contribute minimally to the obsidian assemblage, as each is represented by a single flake. Although CTR is by far the most common obsidian type present, its average weight per piece is less than that of VR, which has the heaviest average weight of all obsidian types. The abundance of CTR makes sense given that its secondary deposits are located only some 25 km away from the site. Although located nearly the same distance away, CCR is not frequently found in archaeological contexts due to its very small nodule size (most is less than 2 cm in diameter). This effectively results in CCR's inability to contend with larger and higher quality gravels of CTR, as well as VR, and ERR sources (Shackley 2005).

Table 25. Counts and Weights of Obsidians by Source.

Source	**Count**	**Count %**	**Total Weight (g)**	**Weight %**	**Average Weight (g)**
CTR	34	75.6%	55.68	71.3%	1.64
VR	9	20.0%	20.79	26.6%	2.31
ERR	1	2.2%	0.26	0.3%	0.26
CCR	1	2.2%	1.41	1.8%	1.41
Total	**45**	**100%**	**78.14**	**100%**	**1.74**

Distance can also be used to explain the lack of ERR in the obsidian assemblage at LA 20,000 since its primary source is the farthest from the site. This greater distance likely results in any ERR secondary deposits occurring with CTR and CCR being outnumbered by those materials due to the closer proximity of their primary sources, as well as in smaller ERR nodule size due to frequent breakage associated with fluvial transport over such a great distance. While relative frequencies of these three obsidian types (CTR, CCR, and ERR) can be easily explained in terms of spatial contexts, the relative abundance and large weight of VR in the assemblage is not so straight forward. Unlike other obsidian sources, location does not offer a viable explanation for VR since it must be procured either directly or through a trade relationship.

Technological Analysis of Obsidian Geochemical Sources

To investigate whether reduction and/or tool production varied by geochemical group, whether any specific geochemical group was conserved through reuse or recycling, and if geochemical groups were brought to the site in different forms, the technological variability of the sourced obsidians was examined, as was evidence provided by informal and formal tools. The same methods and definitions used to describe the entire flaked stone assemblage are also used to describe the obsidian assemblage to ensure suitable comparison between all analyses.

As shown in Table 26 and Table 27, CTR and VR are most abundant in both weight and frequency across all obsidian artifact types. In terms of counts across all geochemical types, debitage was most common, accounting for over 73% of the entire obsidian assemblage, while tools constitute nearly 49% of the obsidian assemblage. In terms of obsidian tools, informal tools are most common, followed by formal tools and cores.

Table 26. Obsidian Debitage Assemblage from Site LA 20,000.

Source	Angular Shatter	Complete Flake	Proximal Flake	Flake Fragment	Total	Total Weight (g)	Average Weight (g)	Dorsal Cortex
CTR	8	8	6	5	**27**	**33.96**	**1.26**	6
	29.6%	*29.6%*	*22.2%*	*18.5%*	***81.8%***	***81.3%***		*22.2%*
VR	1	-	-	3	**4**	**6.13**	**1.53**	1
	25%	-	-	*75%*	***12.1%***	***14.7%***		*25%*
ERR	-	-	1	-	**1**	**0.26**	**0.26**	0
	-	-	*100%*	-	***3%***	***0.6%***		*0%*
CCR	-	-	1	-	**1**	**1.41**	**1.41**	1
	-	-	*100%*	-	***3%***	***3.4%***		*100%*
Total	**9**	**8**	**8**	**8**	**33**	**41.76**	**1.27**	**8**
	27.3%	***24.2%***	***24.2%***	***24.2%***	***100%***	***100%***		***24.2%***

Table 27. Obsidian Flaked Stone Tool Frequencies and Weights.								
Source		**Non-Flake Tool**	**Flake Tool**	**Biface**	**Projectile Point**	**Drill**	**Core**	**Total**
CTR	Count	3	6	1	2	1	3	**16**
	Count%	*18.8%*	*37.5%*	*16.7%*	*12.5%*	*16.7%*	*18.8%*	***72.7%***
	Weight (g)	7.27	10.81	3.89	2.68	2.06	14.01	**40.72**
	Average Weight (g)	2.42	1.80	3.89	1.34	2.06	4.67	**2.55**
VR	Count	1	-	4	-	-	1	**6**
	Count%	*16.7%*	-	*66.7%*	-	-	*16.7%*	***27.3%***
	Weight (g)	3.03	-	6.74	-	-	7.92	**17.69**
	Average Weight (g)	3.03	-	1.69	-	-	7.92	**2.95**
Total Counts		**4**	**6**	**5**	**2**	**1**	**4**	**22**
		18.2%	***27.3%***	***22.7%***	***9.1%***	***4.5%***	***18.2%***	***100%***
Total Weight (g)		**10.30**	**10.81**	**10.63**	**2.68**	**2.06**	**21.93**	**58.41**
Total Average Weight (g)		**2.58**	**1.80**	**2.13**	**1.34**	**2.06**	**5.48**	**2.66**

Obsidian Debitage by Source

As shown in Table 26 above, obsidian debitage is dominated by the CTR geochemical group, with CTR debitage nearly seven times more common than VR debitage, the second most common group. ERR and CCR are rare and each contributes just a single flake to the assemblage. Based on the frequencies of debitage types by source, it appears that reduction strategies varied by source and that only CTR was reduced with any real consequence at LA 20,000. CTR is the only source represented by all debitage types with angular shatter and complete flakes most common, followed by proximal flakes and flake fragments. Debitage frequencies for VR, ERR, and CCR are far lower overall and VR is the only other source to display any variety, though limited, in debitage type. Although CTR debitage is by far the most common, its average weight per piece is less than that of VR and CCR. It also has a higher incidence of angular shatter than other source types. Finally, Table 26 also shows that while dorsal cortex was recorded on just 24% of all obsidian debitage, like other comparisons, most counts occur in CTR, with VR and CCR each having only one flake with dorsal cortex. These attributes suggest that CTR may have been more readily reduced than other source types, as well as less carefully or economically utilized. Such distinct differences in debitage types, frequencies, weights, and presence of dorsal cortex between geochemical groups lends support to the interpretation that CTR nodules were likely the only obsidian type reduced on-site with any prevalence.

Looking at platform types associated with complete and proximal obsidian flakes by source, Table 28 reveals that CTR is the only source with modified platforms (all complex), further indicating that CTR was likely the only obsidian type reduced with any real, though limited, prevalence at LA 20,000. The ERR proximal flake has a crushed platform, while the CCR proximal flake has a cortical platform. In spite of the ERR flake's broken status and crushed platform, other attributes including the flake's extremely low weight (0.26 g), extreme thinness (0.19 cm), multiple dorsal flake scars (>2), and lack of dorsal cortex, suggest that this flake is likely the product of late stage reduction or tool repair. Unfortunately, the CCR flake's other attributes are less clear-cut, leaving interpretations concerning its associated stage or method of reduction less certain. Regardless, the extremely low number of modified platforms suggests that late stage reduction and/or formal tool production or repair was not common at LA 20,000. The higher frequencies of unmodified platforms for CTR supports the inference of expedient reduction methods, especially for this geochemical group.

Table 28. Platform Types for Complete and Proximal Obsidian Flakes by Source.			
Source	**Modified Platforms**	**Unmodified Platforms**	**Totals**
CTR	5	9	**14**
	35.7%	*64.3%*	***87.5%***
VR	-	-	**0**
ERR	-	1	**1**
CRR	-	1	**1**
Total	**5**	**11**	**16**
	31.3%	***68.7%***	***100%***

Obsidian Tools by Source

There are 22 flaked stone tools in the obsidian assemblage (Table 27) having an average weight across all geochemical groups of 2.66 g. As in the debitage assemblage, the distribution by obsidian geochemical group is weighted toward CTR and VR. In fact, these two sources account for 100% of all obsidian tools, with CTR tools being over 2.5 times more common than VR tools. Obsidian's brittle property causes it to break easily and dull quickly; thus, it is not to a durable material for working very hard materials. Conversely, its glass-like nature results in extremely sharp edges making it an exceptional material for cutting materials of soft to medium hardness.

CTR materials include three cores, nine informal, and four formal tools. Of the cores, two are bipolar and one is multidirectional (Table 29). CTR cores average 4.67 g. While all have cortex present, two appear to be water-worn (Core-7 and Core-10). CTR informal tools average 2.01 g, with flake tools outnumbering non-flake tools and weighing less on average than non-flake tools, 1.80 g vs. 2.42 g, respectively (Table 27). Cortex is present on three CTR informal tools and all are flake tools (Table 30). CTR formal tools consist of one biface fragment, one hafted drill, and two projectile point remnants (one proximal portion and one blade portion) (Table 31). The biface fragment weighs 3.89 g, while the two incomplete projectile points total 2.68 g in weight, averaging 1.34 g. The hafted drill is complete and weighs 2.06 g. In comparison, VR materials include one bipolar core, one informal non-flake tool, and four formal tools. The bipolar core weighs 7.92 g and the non-flake tool weighs 3.03 g, neither has cortex present (Table 29 and Table 30, respectively). The four formal tools are all bifaces and include three fragments and one near complete artifact (Table 31). Two of the bifaces retain evidence of hafting. The four bifaces total 6.74 g in weight, averaging 1.69 g.

Table 29. Obsidian Cores.

Source	Tool	Field Spec #	Type	Max Length (cm)	Max Width (cm)	Max Thickness (cm)	Weight (g)	Flake Scars	Cortex
CTR	Core-2	171	Multidirectional	2.5	1.5	0.8	2.61	5	<50%
	Core-7	F-0-1990	Bipolar	2.1	1.7	1.0	3.24	10	<50%
	Core-10	1J-54	Bipolar	3.7	1.8	1.3	8.16	3	>50%
VR	Core-9	39	Bipolar	2.6	3.1	0.9	7.92	10	0

Table 30. Expedient Obsidian Tools by Debitage Attributes.

Source	Tool	Field Spec #	Debitage Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)	Platform	Cortex
CTR	FST-16	1-18	Complete Flake	1.4	2.2	0.4	1.26	Crushed	0
	FST-21	206	Complete Flake	3.1	1.7	0.8	3.12	Crushed	<50%
	FST-15	TP-3	Complete Flake	2.4	2.7	0.4	2.27	Flat	<50%
	FST-19	F-64-1990	Broken Flake	1.8	1.4	0.6	1.52	Flat	<50%
	FST-32	2-4	Broken Flake	2.2	1.8	0.4	1.75	Flat	0
	FST-17	0-15	Flake Fragment	1.8	1.5	0.4	0.89	-	0
	FST-20	297	Angular Shatter	2.2	1.5	0.5	0.92	-	0
	FST-28	168	Angular Shatter	2.8	2.3	0.9	5.91	-	0
	FST-29	379	Angular Shatter	1.2	1.0	0.4	0.44	-	0
VR	FST-24	64-B4-4(88)	Angular Shatter	0.6	2.5	2.05	3.03	-	0

Table 31. Formal Obsidian Flaked Stone Tools.

Source	Tool	Field Spec #	Tool Typology	Max Length (cm)	Max Width (cm)	Max Thickness (cm)	Weight (g)	Width/ Thickness Ratio	Portion
VR	BF-1	30	Hafted Biface	2.0	1.2	0.4	0.71	3	Blade
	BF-3	42	Hafted Biface	2.9	1.9	0.5	2.54	3.80	Near Complete
	BF-5	51-258	Biface	3.2	1.7	0.9	3.35	NA	Fragment
	BF-6	52-183	Biface	0.9	0.7	0.2	0.14	NA	Distal
CTR	BF-4	119	Biface	3.3	2.1	0.5	3.89	NA	Fragment
	Drill-1	171	Hafted Drill	2.0	1.6	0.7	2.06	2.29	Complete
	PP-1	4	Projectile Point	1.5	1.2	0.3	0.63	4	Proximal
	PP-3	1K-172	Projectile Point	3.3	1.8	0.5	2.05	3.60	Blade

Obsidian cores are rare and account for slightly over 18% of the LA 20,000 obsidian tool assemblage (Table 27, Table 29, Figure 7), with bipolar cores most common. Cortex is present on 75% of cores, while one core has none. As would be expected by obsidian debitage analysis results, cores are not evenly represented across geochemical sources. CTR constitutes 75% of cores, while VR comprises the other 25%. CTR cores are also lighter on average than VR cores (4.67 g vs. 7.92 g, respectively). This suggests that CTR was more readily reduced than VR, despite the heaviest and least reduced core (Core-10) being of CTR. Given that roughly half of the original pebble of Core-10 is present, the core's small size (maximum length of 3.7 cm) directly reflects the initial small size of the parent nodule, supporting the premise that bipolar reduction was a strategy used to solve problems associated with small lithic resources. The CTR multidirectional core (Core-2) appears to have been used to further extract useable pieces of material from a previously discarded piece of shatter, providing evidence for the recycling and conservation of some obsidian material at the site. Water-worn cortex on two CTR cores indicates that these cores, as well as CTR material in general, likely originated from secondary deposits of Rio Grande gravels and were brought to LA 20,000 as raw material to be reduced on-site. In contrast, the lone VR core not only lacks cortex but appears to have resulted from recycling a bifacial tool or expended core through bipolar technique. In this case, bipolar reduction was not only used to compensate for small material size, but also as a strategy to overcome material scarcity.

Taken as a whole, the higher frequency and variety of CTR core types (though still rare), as well as dorsal cortex, points to limited on-site reduction of nodules of this more proximate nonlocal source material, with extremely limited on-site reduction of even more distant VR source material that likely came into the site as general bifaces or finished products. Examining obsidian core types by source also reveals the strategies individuals at LA 20,000 used to solve problems associated with both small lithic parent materials and material scarcity using bipolar techniques and the recycling and conservation of obsidian materials.

Informal tools of utilized or modified debitage are the most common types of obsidian tools, accounting for over 45% of the total, with CTR accounting for 90% of these. These tools are generally small, with an average weight across all geochemical groups of 2.11 g. Flake tools outnumber non-flake tools and, as would be expected, weigh less on average than non-flake tools (Table 27). Cortex is present on 30% of informal tools and all are flakes of CTR material (Table 30). If the presence and absence of cortex on informal tools is used to consider the economical use of obsidian, the higher frequency of absence of cortex (70%) suggests that obsidian, as a material, was used in a conservative manner. Conversely, the fact that all cortex occurs on CTR materials and the distribution of informal tools by geochemical group is heavily weighted toward CTR may suggest that this source was more readily reduced than other source types, as well as less carefully or economically utilized.

In terms of use, obsidian informal tools have a total of 16 altered edges with 13 of these displaying unidirectional, bidirectional, or rotational wear motion patterns (Appendices C and D). Three altered edges display no wear motion patterns. Of the 10 obsidian informal tools, 8 have edges that were intentionally modified to produce a specific shape or edge angle, while 2 appear to have been used as-is, without intentional modification. Edge wear analysis suggests that expedient obsidian tools were made for a wide variety of tasks including cutting, scraping, boring/piercing, and grooving/incising that could have been used in the working of various materials such as plants, wood, and leather. One tool (FST-16) appears to have served more than one function (cutting and scraping), while all other informal obsidian tools appear to have served a single function.

Formal tools account for slightly over 36% of the obsidian tool assemblage and have a total weight of 15.37 g, and average 1.92 g across all types and source groups (Table 27). Two of the formal tools are complete (or near complete), while six are incomplete (Table 31). Formal tool counts are evenly distributed across CTR and VR sources, but tool types are not. CTR is represented by a variety of formal tool types, while VR is only represented by general bifaces. However, two VR bifaces (BF-1 and BF-6) may be projectile point remnants.

The five obsidian bifaces (Table 31, Figure 8) weigh a total of 10.63 g, with an average weight of 2.13 g. Fragmentary bifaces outnumber complete bifaces four to one. Four bifaces are made from VR material, while only one is made from CTR. Unfortunately, the fragmentary nature and limited number of bifaces does not allow for meaningful comparison across source groups. The two incomplete CTR obsidian projectile points (Table 27) contribute to roughly 9% of the obsidian flaked stone tool assemblage and include proximal (PP-1) and blade (PP-3) portions weighing 0.63 g and 2.05 g, respectively (Table 27, Figure 9). The weight of the proximal point section is in line with the weights of complete projectile points recovered on-site (a Pedernal chert Pueblo side-notch point with concave base weighing 0.67 g and a Harrell-type point of nonlocal chert weighing 0.52 g), while the blade portion is more than three times the weight of either complete point. Such a discrepancy may be indicative of the artifact being the remnants of a dart point and reflect the scavenging and recycling of an older and larger artifact, or it may simply be reflective of an attribute associated with the artifact's dual function as a projectile and cutting implement. The CTR bifacial drill (Drill-1) is complete, but crude in form, and likely hafted and used in a back-and-forth rotating motion (Table 31, Figure 10).

Obsidian Artifacts Summary

Technological descriptions of obsidian artifacts by geochemical type add depth to understanding strategies associated with obsidian procurement, use, and discard by *estancia* household members and laborers during the roughly 50-year occupation of LA 20,000. As might be expected by its closer proximity, CTR was the most commonly utilized obsidian material. Surprisingly, VR, the most time-consuming obsidian to procure based on geographic location and geological source, was the second most prevalent source across all technological categories and, in terms of weight, was heavier on average than equivalent forms of CTR. Although ERR and CCR materials were also present in the obsidian assemblage, they were both extremely rare and only present within the obsidian debitage category.

In terms of raw material size, obsidian nodules and cores are small, and flaked stone analysis indicates that the overall reduction strategy was expedient. Expediency is demonstrated through a lack of prepared cores, the low frequency of flakes with modified platforms, and a scarcity of formal tools. Although expedient, the core reduction strategies used at LA 20,000 do not point toward an extravagant or wasteful use of obsidian. Instead, cores, debitage, and tools show evidence of reuse and recycling, and the absence of cortex is far more common than presence. In fact, even small pieces of angular shatter and flake fragments have evidence of tool use. In general, obsidian appears to have been utilized for a variety of tasks and conserved as a lithic material.

Based on XRF analysis, the only obsidian type that appears to have been brought to LA 20,000 as pebbles/nodules and reduced there was CTR. Expedient reduction of this material on-site is suggested by the diversity of cores and debitage in CTR. Evidence for other source types (VR, CRR, and ERR), suggests that they arrived on-site largely as general bifaces or finished tools. The moderate abundance of VR materials was somewhat unexpected, as was its deviation from CTR in terms of weight. Clearly, all obsidian source types did not arrive at the site in similar quantities or forms. Instead, the various obsidian types were brought to LA 20,000 in different package configurations and reduced there differently.

Obsidian Procurement Strategies

Coupling obsidian technological analyses with geochemical type provides insight for discussing how this high-quality lithic material was procured. Procurement is more than simply about acquisition; it is also a social strategy. Given the complex socio-economic context of early colonial New Mexico and the occupational history of the site, it is possible that several methods and strategies of procurement were used simultaneously or successively by the peoples of LA 20,000.

For example, all observed geochemical types could have been acquired directly by individuals traveling to source areas carrying out either targeted or embedded procurement strategies. A consideration of both travel time and distance, as well as social and/or political limitations on access to each lithic source would have likely affected how frequently, or even if, direct procurement was employed (Liebmann 2017). Because secondary deposits of CTR, CCR, and ERR are present within Rio Grande gravels (Figure 13) approximately 25 km from LA 20,000, direct procurement, either as part of a targeted or embedded strategy, seems likely for these source types. The source frequencies of obsidian at the site correspond to the ordinal frequencies of the usable obsidians in Rio Grande gravels fairly well, with CTR most common and CCR and ERR not common at all. Furthermore, obsidian debitage and tool analyses indicate CTR being procured from river gravels and reduced on-site. In contrast, this is not the case for CCR and ERR. Rather, analyses suggest that procurement from CCR primary, or CCR and ERR secondary deposits rarely took place, even though such deposits occur in proximity to and with secondary deposits of CTR, respectively. Unlike CTR, these obsidians most likely came to the site as general bifaces or finished tools.

VR obsidian is the only geochemical type that could not have been procured from secondary river gravel deposits, requiring travel to the Valles Caldera roughly 45 km away (Euclidean distance) if directly procured. As discussed by Liebmann (2017) and Ramenofsky et al. (2017b:176), exploring the possibilities of procurement for this obsidian is important for several reasons: to procure VR from the Valles Caldera would have required considerable travel costs in terms of both time and energy; socio-political factors could have affected access; and although not common, when present VR is generally heavier on average than the other geochemical types.

The possibility of direct procurement of VR from geological deposits located within the Valles Caldera by peoples of LA 20,000 is feasible. This would certainly not be the only time VR obsidian has been archaeologically documented away from its geologic source (Liebmann 2017; Shackley and Moore 2018). In fact, VR obsidian has been found in archaeological contexts as far away as the Central and Southern Plains (Baugh and Nelson 1987), as well as from other distant locations (Hughes 2019). Additionally, VR cobble sizes within the caldera are generally large (ranging from cobble to boulder size (Baugh and Nelson 1987; Shackley 2019)) which could explain the larger average size of VR artifacts at the site. However, lithic analysis of obsidian debitage and cores from LA 20,000 suggests that this type of procurement for VR material was unlikely.

Conversely, VR materials could have come to LA 20,000 through trade or down-the-line exchange as general bifaces or finished tools. Because geological sources of LA 20,000 obsidians are located mostly west and north of the site, one obvious possible trading group could have been the residents of Cochiti Pueblo. Cochiti is located roughly 25 km west of the site near the confluence of the Santa Fe and Rio Grande Rivers near available primary and secondary obsidian deposits of CTR, CCR, and ERR (Figure 13). Residents of Cochiti could have acquired VR obsidian from the caldera or traded with other groups for it (e.g., Jemez Pueblo [Liebmann 2017]), and then traded this VR in the form of tools with occupants of LA 20,000. Another, maybe not so obvious trading group could have been members of Pueblo San Marcos, located only roughly 12 km southeast of the site. Residents of San Marcos could have acquired VR in the same way as residents of Cochiti (directly or through trade), and the much closer proximity of San Marcos to LA 20,000 would have likely made trading between these two spatial groups more convenient, if socio-political circumstances between the two groups allowed.

While obsidian debitage and core analyses from LA 20,000 suggests that procurement of VR through some type of exchange was more probable than direct procurement, historical documents do not indicate that flaked stone materials were traded for by Spanish colonists, nor that forced or coercive lithic production was part of the *encomienda* system (Trigg 2005).

However, historical documents are not only lacking for pre-1680 New Mexico, but what documents do exist may not necessarily be reflective of everyday material culture or exchange transactions for common items of Native American manufacture. Payne (2012), for instance, compared testament inventories of 18th- and early 19th-century Hispanos living in the Santa Fe River valley with archaeological collections from residential sites of the same area and period, finding that documents tended to focus on imported tools and status items, while collections consisted mainly of ceramics obtained from Puebloan communities. Even though they are often the most numerous categories of artifacts found at Spanish colonial sites, "Native American material culture is only minimally acknowledged" in colonial wills or inventories (Payne 2012:179). If Spanish colonists could barter with Pueblos for ceramics in 17th-century New Mexico (Trigg 2005), it seems likely that the same mechanism could be used to acquire stone tools to substitute or approximate for any equivalent metal tools that might be lacking.

A third possibility that explains the presence of VR obsidian in its current forms at LA 20,000 is the mobility of Native American laborers moving back and forth between traditional residences or places and the site. In this type of "residential procurement" strategy, Indigenous laborers could have acquired VR obsidian in various ways at various times from traditional spaces and carried it back with them to LA 20,000 in the form of generalized or specialized tools that they knew they would likely need to perform tasks the Spanish required of them (whether paid for, coerced, or forced). Similar to exchange acquisition, a residential procurement-type strategy would also reflect the conclusions reached through obsidian lithic analysis: that VR obsidian did not come to LA 20,000 in the form of raw material nodules or reduced cores, but rather as generalized bifaces or specialized tools.

A final lithic procurement strategy that could also explain the incidence of VR at the site which also deserves mentioning, but is often overlooked, is secondary recycling. Secondary recycling, or scavenging, is a procurement strategy whereby existing flaked stone artifacts are collected from the landscape, be it contemporary or archaeological, and reused, retooled, or used as cores (Amick 2007:223). Since almost any flaked stone artifact (if large enough) can potentially function as a core from which flakes can be generated or other tool forms produced, secondary recycling basically restarts the life cycle of flaked stone artifacts - procurement, manufacture, use, maintenance, and discard - by reestablishing discarded lithic materials as once again usable resources. Ethnographic accounts of scavenging for flaked stone tools have been documented in the American Southwest among Pueblo, Apache, and Navajo peoples, as well as in the geographically adjacent Great Basin (Amick 2007).

Recognizing that surficial scatters of previously discarded flaked stone artifacts could serve as sources of raw materials and tools for later peoples suggests that any resident of LA 20,000 (permanent or migratory, young or old) could have scavenged for flaked stone artifacts off-site as part of a targeted or opportunistic strategy. Given that scavenging for flaked stone artifacts would presumably focus on collecting: "1) finished tools that exhibit considerable investment in manufacturing time (e.g., bifaces and projectile points); 2) large artifacts, which contain the potential for further reduction; and 3) pieces of debris that are suitable in shape and form for specific tasks, such as the use of small, flat flakes for arrowhead manufacture" (Amick 2007:227), such a collection strategy could help account for the frequencies of VR as bifacial tools, noncortical debitage, and recycled items present at LA, 20,000. This strategy would also help account for recycled materials made of CTR materials as well (e.g., PP-3 and

Drill-1). Even though we have no evidence of an earlier occupation at the LA-20,000 site itself, the presence of an early glaze-ware pueblo (LA 149) on the banks of Cienega Creek a short distance west of the site (Snow 2009:16) adds credence to this possibility. Using obsidian hydration dating as a relative chronometer to check for the presence of two or more hydration bands of different thickness on a single artifact (e.g., distal ends vs. hafted bases on bifaces, patinated vs. unpatinated surfaces, older vs. newer flake scars) could be used to investigate if the newest flake scars on a potentially recycled item significantly postdate the original ones that formed the piece (Amick 2007:235-240; Ramenofsky et al. 2017b:177-184; Silliman 2005). However, sample size, differential obsidian absorption rates, and thermal effects on hydration bands due to burning (Steffen 2005) would have to be accounted for.

It is important to consider the potential role secondary lithic recycling played at LA 20,000 because, in terms of economics, secondary recycling as a procurement strategy for stone tools and debitage (whether targeted or opportunistic) often yields higher returns with lower costs in terms of time, energy, and labor than does direct procurement. This often is due to acquisition costs related to the excavation, testing, and initial reduction of raw material associated with the latter (Kuhn 1995:21). Scavenging off-site for flaked stone artifacts can increase procurement yields since "materials have already been artificially concentrated, tested and often manufactured into prepared tool forms. Further benefits…include reducing the costs of travel and search for exotic and desirable raw materials and minimizing the handling costs associated with developing advanced skills (especially in tool blank production and secondary shaping)" (Amick 2007:225). Recognizing secondary recycling as a procurement strategy and considering it in terms of both economics and behavior not only provides another avenue for explaining site formation processes, but also has the potential to help provide a more complete and accurate understanding of lithic assemblage compositions and associated activities.

While the procurement of VR obsidian could have resulted through some combination of any or all of the aforementioned strategies, taking into account the social and economic contexts of early colonial Spanish New Mexico and its heavy reliance upon neighboring Puebloan and other Native American peoples for labor, the presence of VR obsidian at LA 20,000 seems likely to reflect the residential mobility of Puebloan laborers, or other local Indigenous peoples, transporting flaked stone tools to and from the site. However, due to such ambiguous results concerning the procurement of VR, more research is clearly required to better assess the acquisition of VR at LA 20,000.

In summary, XRF analysis revealed that all obsidian recovered from LA 20,000 derived from sources associated with the Jemez Mountains, requiring these nonlocal lithics to be acquired by site occupants in some manner. Flaked stone analysis indicates that CTR was likely procured from secondary deposits in Rio Grande alluvium roughly 25 km west of LA 20,000. Even though primary deposits of CCR occur in proximity to CTR and both CCR and ERR secondary deposits occur with CTR in alluvium, procurement of these obsidians rarely took place. While direct procurement of VR was possible, it did not likely occur. VR is not found in Rio Grande or other secondary deposits outside the Valles Caldera. As a result, direct procurement of VR from the caldera roughly 45 km north of the site would have required much higher travel costs in terms of time and energy. Instead, analysis indicates that VR could have been procured through some type of exchange (down-the-line exchange or direct trade), residential mobility of Puebloan laborers to and from the site, secondary recycling by site occupants, or a combination of any of these procurement strategies. Social and economic factors in early colonial Spanish New Mexico would lend support to an argument for procurement of VR related to residential mobility of Puebloan laborers to and from the site, however. Similarly, procurement of CCR and ERR is also likely related to residential mobility of Indigenous laborers since both obsidians most likely came to the site in the forms of general bifaces or finished tools.

CHAPTER 6

SPATIAL ANALYSIS

The distribution of flaked stone artifacts was analyzed to identify the location(s) of lithic related activities carried out at LA 20,000 by the people who lived and worked there. By spatially plotting flaked stone artifact distributions horizontally across the main site area it was thought that artifact concentrations would become apparent and provide insight into activity areas relating to the reduction, production, and use of flaked stone. Distribution analysis sought to determine areas where lithic activities did and did not take place and the type(s) of lithic activities that occurred at these locations.

Figure 14 depicts the horizontal distribution of total flaked stone artifacts per excavation unit area across the main site. Most places, particularly the Corral and Unit D, have especially low lithic counts. Other areas of the site, like northwest and southeast portions of the House, the area between the House and Barn, and one unit in the southern Barn area, do display higher flaked lithic concentrations, hinting that flaked stone related activities potentially took place in those areas. However, evidence of spatially segregated or specialized activity areas is not well defined. The site as a whole does not display any high-density concentrations of flaked stone artifacts indicating it unlikely that any large-scale knapping events took place on-site.

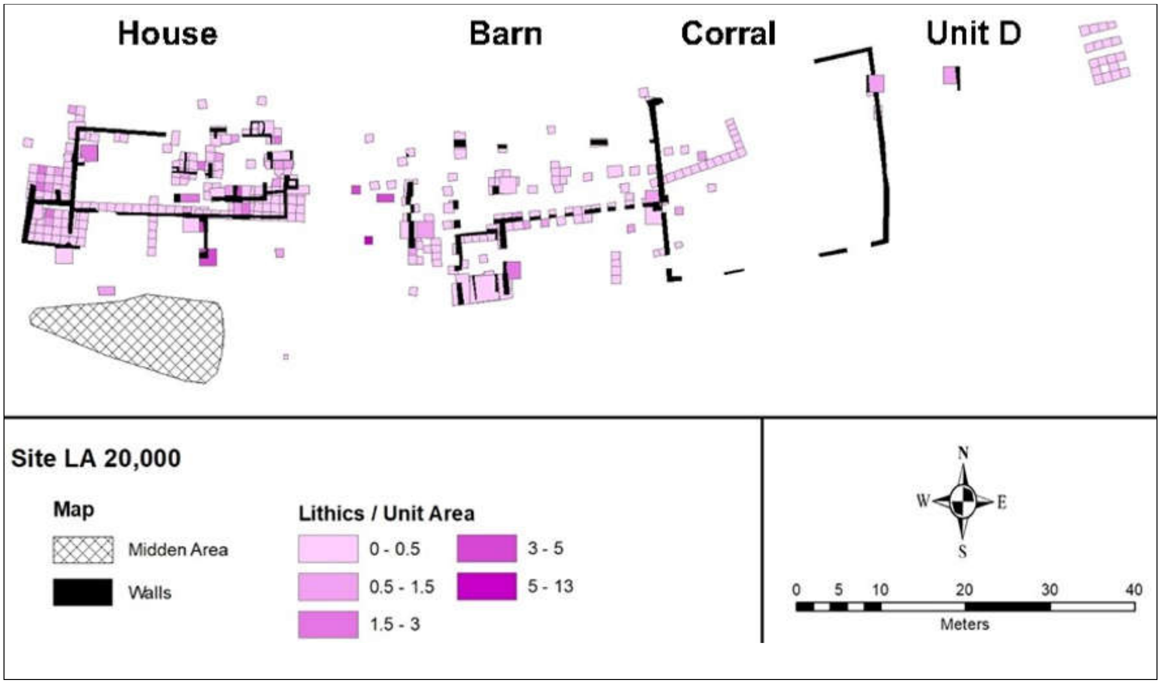


Figure 14. Flaked Sone Artifacts/Excavation Unit Area.

Additional spatial analyses (e.g., nearest neighbor, normalized artifact distributions, spatial autocorrelation, and cluster analyses) investigating potential in situ period flaked stone activity areas did not identify any specific flaked stone activity loci (Appendix F). This is possibly due in part to excavation biases related to research questions, goals, and other yet unidentified explanatory variables. Rather, analyses indicate that more excavation is needed in areas showing flaked stone artifact clustering to better understand what is going on in and around those areas before such locations can be confidently identified as areas of activity.

Spatial Analysis by Analytical Unit

Although no specific flaked stone activity loci were identified, a discussion of flaked stone artifacts by general location can still provide insights into flaked lithic related site activities. To accomplish this, flaked stone artifacts have been separated into five analytical units (AU) at LA 20,000: House, Barn, Corral, Unit D, and the Midden (Figure 14). Because the Midden is a refuse deposit, flaked stone artifacts recovered from this area cannot be assumed to be in their primary context. Instead, these artifacts are likely the result of discard during production, at the end of their use-life, or during the cleaning of activity areas or floors. Since the lithic materials deposited in the Midden area are not assumed to have been derived from the same activity, each type of artifact (debitage or tool) is treated independently.

A summary of flaked stone artifact counts by AU is shown in Table 32. A total of 212 flaked stone artifacts (67%) were recovered outside of the Midden. Of these, the House has the greatest number of flaked lithics, followed by the Barn, Unit D, and the Corral, respectively. The Midden consists of 105 total flaked stone artifacts and makes up the remaining 33% of the total flaked stone assemblage. Interestingly, it is the only AU where gunflints were recovered.

Table 32. Flaked Stone Artifact Type by Analytic Unit.

Analytic Unit	Debitage	Expedient Tool	Formal Tool	Core	Gunflint	Strike-A-Light Flint	Indeterminate	Total
House	118	15	4	4	0	3	1	**145**
Barn	47	4	1	1	0	0	0	**53**
Corral	1	1	0	0	0	0	0	**2**
Unit D	7	2	0	2	0	1	0	**12**
Midden	71	10	7	4	9	4	0	**105**
Total	**244**	**32**	**12**	**11**	**9**	**8**	**1**	**317**

To assess the relative densities of flaked stone artifacts from different areas of the site, it would be necessary to standardize flaked stone recovery rates against the total amount of excavation in each area. Unfortunately, early excavations did not prioritize well defined excavation units (EUs) or always record total depths excavated. As a result, total volumes of excavated sediments from the various AUs could not be calculated to standardize raw flaked stone counts to counts per cubic meter. Also, because the amount of excavation between AUs was so disparate in terms of both areas and volumes, standardizing flaked stone counts to other artifact counts (e.g., ceramics) is also problematic. For these reasons, flaked stone data were not standardized and relative incidences of flaked stone artifacts per AU were compared sparingly.

The flaked stone artifact distribution is not that surprising, then, given that the House had the greatest amount of excavation and the Barn the second most. The lower number of flaked stone in the Corral is interesting relative to Unit D, which also has a relatively small number of EUs, however. Although Corral EUs were more standard in size, typically 1x1m, and Unit D units were larger in a few instances, the two AUs are comparable in terms of total amount of area excavated, 26.64 m^2 for the Corral area and 27.13 m^2 for Unit D. It would not be surprising for the Corral to have a limited number of flaked lithics given that it was probably an area mainly utilized to hold livestock and not likely associated with flaked stone related activities. While the difference in flaked stone counts may relate to excavator disparities (Appendix F), the occurrence of debitage, expedient tools, and cores in Unit D could reflect the use of certain areas as smaller pens for animal husbandry activities (e.g., lamb docking, earmarking sheep or cattle, cutting pigs) (Trigg personal communication).

Table 33 shows flaked stone material type counts present in each AU. Looking again at only flaked stone artifacts located outside of the Midden, the House has the greatest diversity of lithic materials, as well as the greatest numbers of nonlocal materials (obsidian and Pedernal chert). The second greatest amount of lithic material diversity is associated with the Barn, as is the second greatest number of obsidian. The next most lithic material diverse areas are Unit D and the Corral, respectively. Comparing the proportions of lithic material types associated with the House and Barn shows the distribution of lithic material types to be fairly similar, with

Pedernal chert being the lone exception. This distribution suggests that Pedernal chert and obsidian were likely important materials related to household activities (e.g., cutting and scraping for food processing), while obsidian may have also been utilized at the Barn area for cutting related tasks. In general, local materials dominate each AU indicating that local lithic materials were the most heavily reduced and utilized across the site as a whole. Local materials also dominate the Midden flaked stone assemblage (72.4%), with nonlocal materials of obsidian (17.1%), Pedernal chert (9.5%), and a nonlocal chert (1%) also present. Midden flaked stone materials are most similar in proportions to that of the House and, to a lesser extent, the Barn as well; the major exception being the occurrence of Pedernal chert within the Midden, but not the Barn.

Table 33. Flaked Stone Material Type by Analytic Unit.

Analytic Unit	Obsidian	Pedernal Chert	Chert Chalcedony Other CCS	Quartz	Quartzite	Limestone	Other Volcanic	Other Sedimentary	Total
House	19	11	101	9	2	2	1	0	**145**
	13.1%	*7.6%*	*69.7%*	*6.2%*	*1.4%*	*1.4%*	*0.7%*	*0.0%*	*100%*
Barn	6	0	41	3	2	1	0	0	**53**
	11.3%	*0.0%*	*77.4%*	*5.7%*	*3.8%*	*1.9%*	*0.0%*	*0.0%*	*100%*
Corral	1	0	0	0	0	1	0	0	**2**
	50.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*50.0%*	*0.0%*	*0.0%*	*100%*
Unit D	1	0	6	0	0	4	1	0	**12**
	8.3%	*0.0%*	*50.0%*	*0.0%*	*0.0%*	*33.3%*	*8.3%*	*0.0%*	*100%*
Midden	18	10	67	2	1	4	1	2	**105**
	17.1%	*9.5%*	*63.8%*	*1.9%*	*1.0%*	*3.8%*	*1.0%*	*1.9%*	*100%*
Total	**45**	**21**	**215**	**14**	**5**	**12**	**2**	**2**	**317**

House Area

The House has 118 pieces of lithic debitage (51 angular shatter and 67 flakes), 15 expedient tools, 4 formal tools (three bifaces and one projectile point), 4 cores, 3 strike-a-light flints, and 1 indeterminate tool fragment (Table 32). An excavation unit (EU) in the northwest interior of the House contained the greatest artifact diversity from this area (five pieces of angular shatter, four flakes, one utilized angular shatter, one utilized flake, and one multidirectional core), while an EU at the southern exterior had the greatest number of artifacts (13 angular shatter, 3 flakes, and 1 modified flake) (Figure 14). EUs within an excavation block near the central portion of the House, parts of which are possibly associated with a cooking area, yielded 16 pieces of debitage (5 pieces of angular shatter and 11 flakes), 2 cores (1 bipolar and 1 unidirectional), 1 strike-a-light flint, and 1 modified piece of angular shatter. The exact provenience of the projectile point (PP-2) is uncertain, but it was recovered from the general House area during earlier investigations. Taken together, cores and debitage suggest that expedient reduction took place within and around the House area and the presence of expedient and formal tools suggests that activities requiring stone tool use also occurred (e.g., cutting, scraping, boring, and incising items of wood, bone, meat, and plants). Strike-a-light flints indicate that fire making activities were also likely associated with the House area.

Within the House, local lithic materials dominate (79.3%), with nonlocal materials of obsidian (13.1%) and Pedernal chert (7.6%) also present. These nonlocal materials are not clustered in any particular space but are instead distributed across the greater House area. Of the 27 flaked stone tools recovered from the House area over half (52%) are made from obsidian (N=9) and Pedernal chert (N=5) (Appendix F, Table F1), revealing the importance and deliberate selection of these low frequency, nonlocal lithic materials for use in household related activities. This is especially applicable to Pedernal chert since the Midden is the only other location that this lithic material was recovered. The other 13 flaked stone tools are made from locally available materials.

Barn Area

The Barn has 47 pieces of debitage (23 angular shatter and 24 flakes), 4 expedient tools, 1 formal tool (one biface), and 1 multidirectional core (Table 32). Of the Barn area EUs, one located near the southwest interior corner has the greatest artifact diversity (one piece of angular shatter, one modified flake, and one biface), while a southwest exterior EU has the greatest number of artifacts (six angular shatter, six flakes, and one modified bipolar flake) (Figure 14). Taken together, the core and debitage suggest that some flaked stone reduction took place within and around the Barn area and the presence of expedient and formal tools, while minimal, suggests that activities requiring stone tool use also occurred (e.g., cutting, shaving, and incising items such as wood, bone, or plants).

Within the Barn, local lithic materials are the most prevalent (88.7%), with obsidian (11.3%) being the only nonlocal lithic material present (Table 33). Of the obsidian artifacts associated with the Barn, only one is a tool, while the rest are pieces of debitage (one angular shatter and four flakes). The remaining flaked stone tools (one multidirectional core, one modified flake, one modified angular shatter, and two modified bipolar flakes) are all made of locally available materials including chert, CCS, and quartzite (Appendix F, Table F1).

Corral Area

The Corral area has the lowest frequency of flaked stone artifacts (N=2) recovered from LA 20,000: one piece of debitage (a broken limestone flake) and one expedient obsidian radial fracture tool (FST-20). However, the obsidian tool interpretation is made with caution since the area and artifact may have been subject to heavy trampling from livestock (e.g., sheep and horses). While the Corral was not as heavily excavated as the House or Barn areas, the low number of flaked stone recovered in the Corral relative to Unit D, which is comparable in terms of relative number of EUs and total amount of area excavated, suggests that very little activity requiring the reduction, production, or use of flaked stone artifacts occurred in this area. However, excavator disparities (Appendix F) may also be an explanatory factor to consider.

Unit D Area

Twelve flaked stone artifacts were recovered from Unit D - seven pieces of debitage (three pieces of angular shatter and four flakes), two expedient tools, two cores, and one possible strike-a-light flint (Table 32). Most of these artifacts were recovered from excavations conducted in 2017 from rock alignments in the western half of the area near the Corral that may represent smaller corrals or pens. While an EU adjacent to the Corral contained the most flaked stone artifacts by count (one angular shatter, four flakes, and one modified bipolar flake), a more centrally located EU had the most artifact diversity (one angular shatter, one utilized angular shatter, one multidirectional core, and one possible strike-a-light flint) (Figure 14). The exact provenience of the two remaining artifacts (one angular shatter and one multidirectional core) is uncertain, but both were recovered from Unit D during earlier investigations. The presence of two multidirectional cores and debitage suggests that some expedient reduction took place within and around Unit D and the presence of expedient tools suggests that activities requiring generalized stone tool use, possibly related to animal husbandry, while minimal, also occurred. The presence of a potential strike-a-light flint suggests fire making activities possibly associated with either livestock branding (cattle or horses) or for general use (warmth, cooking) may have also occurred in the area.

Like the Barn, local materials are most prevalent (91.7%), with obsidian (8.3%) being the only nonlocal material present in Unit D (Table 33). The obsidian artifact is a utilized piece of shatter that has steep use-edge angles (>85 degrees), suggesting it functioned as a scraper. However, artifact damage makes interpretation of worked material (e.g., wood or bone) uncertain. The remaining flaked tools are made of locally available materials including chalcedony, chert, and basalt (Appendix F, Table F1)

Midden Area

There are 105 flaked stone artifacts associated with the Midden. These include 71 pieces of debitage (22 pieces of angular shatter and 49 flakes), 10 expedient tools, 7 formal tools (3 bifaces, 3 projectile points, and 1 drill), 4 cores, 9 gunflints, and 4 strike-a-light flints (Table 32). The Midden has the greatest amount of tool diversity at the site and is the only AU where gunflints were recovered (Appendix F, Table F1).

Locally available materials are the most prolific flaked stone from the Midden (72.4%), with nonlocal materials of obsidian (17.1%), Pedernal chert (9.5%), and a nonlocal chert (1%) also present (Table 33). Obsidian artifacts consist of five formal tools (two bifaces, two projectile points, and one drill), three cores, two expedient tools, and eight pieces of debitage (two angular shatter and six flakes). Pedernal chert artifacts include one gunflint, one strike-a-light flint, and eight pieces of debitage (two angular shatter and six flakes). The other nonlocal material is a chert of unknown provenance that is represented by a Harrel-type projectile point (PP-4) (Figure 9-D). These 13 tools of nonlocal materials constitute 38% of the flaked stone tools recovered from the Midden. The remaining 21 tools are all made of local materials including chalcedony (N=10), chert (N=7), CCS (N=3), and silicified wood (N=1).

Given the proximity of the Midden to the House it is not surprising that proportions of flaked stone materials recovered within each AU are similar. The occurrence of Pedernal chert in both AUs, combined with its absence from all other areas of the site, suggests that this material, along with other lithic materials, may have been deposited in the Midden after the cleaning of House area activity spaces or floors related to the reduction, production, or use of flaked stone. Although flaked lithics recovered from the Midden are not assumed to be in their primary context, nor to have been derived from the same activity, the types and proportions of flaked stone artifacts and materials recovered from this area still provide clues to the kinds of flaked stone related activities such as procurement, reduction, production, use, recycling, and discard that occurred over the half-century of the site's occupancy. The types of flaked stone tools recovered from the midden area also reveal the importance and deliberate selection of low frequency, nonlocal, high-quality lithic materials for use as formal and specialized tools over this time span.

Sourced Obsidian by Analytical Unit

The 45 obsidian artifacts from the main site area of LA 20,000 are discussed here in terms of geochemical source types found within each AU (Table 34**).** CTR, the most prevalent obsidian, is present within every AU, but occurs most frequently in House and Midden areas. VR is the next most common obsidian and occurs within House, Midden, and Barn areas. ERR is only present within the Barn area, while CCR only occurs within the Midden area.

Table 34. Sourced Obsidian Counts by Analytic Unit.					
Analytic Unit	**CTR**	**VR**	**ERR**	**CCR**	**Total**
House	15	4	-	-	19
Barn	3	2	1	-	6
Corral	1	-	-	-	1
Unit D	1	-	-	-	1
Midden	14	3	-	1	18
Total	**34**	**9**	**1**	**1**	**45**

Most obsidian tools are located within the Midden (45%) and House areas (41%), while Barn, Corral, and Unit D areas have only one obsidian tool apiece (Table 35). CTR is the most frequent obsidian tool stone (73%), with VR obsidian tool stone also present (27%). ERR and CCR materials are not present in the obsidian tool assemblage. Overall, obsidian tool source frequencies closely mirror the overall frequencies of observed obsidian geochemical sources at the site. Table 36 shows obsidian flaked stone tool IDs by source and analytical unit.

Table 35. Sourced Obsidian Tools by Analytic Unit.					
AU	**CTR**	**VR**	**ERR**	**CCR**	**Total**
House	6	3	-	-	9
Barn	-	1	-	-	1
Corral	1	-	-	-	1
Unit D	1	-	-	-	1
Midden	8	2	-	-	10
Total	**16**	**6**	**0**	**0**	**22**

Table 36. Sourced Obsidian Tool IDs by Analytic Unit.					
AU	**CTR**	**VR**	**ERR**	**CCR**	**Total**
House	FST-15 FST-29 FST-17 FST-32 FST-19 Core-7	BF-5 BF-6 FST-24	-	-	9
Barn	-	BF-1	-	-	1
Corral	FST-20	-	-	-	1
Unit D	FST-28	-	-	-	1
Midden	BF-4 Core-2 Drill-1 Core-10 FST-16 PP-1 FST-21 PP-3	BF-3 Core-9	-	-	10
Total	**16**	**6**	**0**	**0**	**22**

Looking at AUs individually, the House obsidian assemblage (N=19) is composed of 79% CTR and 21% VR. There are 10 pieces of debitage (CTR=9 and VR=1) and 9 tools (CTR=6 and VR=3). Of the CTR obsidian, one artifact is a bipolar core, five artifacts are expedient tools, and nine are debitage (two angular shatter and seven flakes). VR obsidian artifacts include two formal tools, one expedient tool, and one distal flake fragment. The bipolar core and debitage suggest that obsidian reduction took place within the House area and the types of obsidian flaked stone tools suggest that they were produced and utilized for activities requiring expedient use (e.g., incising, scraping, and piercing items such as leather, wood, bone, or plants). One CTR (FST-32) and one VR (BF-5) artifacts are bend-break tools and one VR (FST-24) artifact is a radial fracture tool, reflecting the reuse and recycling of obsidian. These bend-break and radial fracture tools all appear to have been utilized for scraping related activities. BF-6 is the extreme distal end of a biface that displays evidence of impact fracture suggesting that this artifact may be the remnant of a projectile point. If so, the presence of this artifact suggests that it may have been brought into this area (Feature 52) within the meat of procured wild game (either in the body of the animal to be processed or in the prepared and cooked meat of the animal to be eaten), having broken off from the force of impact and remained in the flesh. Therefore, this specific area may represent a food processing space or an eating area. Comparisons with other archaeological materials from this area (e.g., ceramics, flora, and fauna) may provide clearer insights into this space.

The Barn area has six obsidian artifacts with geochemical sources of CTR (50%), VR (33%), and ERR (12%) present (Table 34). CTR artifacts consist of three pieces of debitage (one angular shatter and two flakes), VR artifacts include one biface and one flake, and the

ERR artifact is a flake. Evidence for obsidian reuse and recycling is provided by BF-1 and a CTR flake (FS# B48-161). BF-1 is a repurposed VR tool (possibly originally a projectile point) used to cut materials of medium hardness (e.g., dry hide or wood), while the CTR flake has an intentional bend break. The lone ERR artifact (FS# B15-UNK) is a late stage reduction flake that likely resulted from pressure flaking. Given the flake's attributes, as well as being the only ERR material recovered on-site, this artifact likely represents the finishing or upkeep of a tool (e.g., biface) that was brought to the site, used, retouched, and subsequently curated off-site to be used again elsewhere. Conversely, this tool may have been discarded in an area of the site yet to be excavated. Overall, types of debitage and the repurposed bifacial tool indicate that people were not producing obsidian flaked stone tools within the Barn area, but, instead, were most likely maintaining and reusing existing obsidian tools on a limited basis.

Both Corral and Unit D areas each have one CTR obsidian artifact. The Corral CTR artifact (FST-20) is a radial fracture tool modified along an edge that was likely used for scraping. The Unit D CTR artifact (FST-28) is a utilized piece of angular shatter that also likely functioned as a scraping tool. The paucity of obsidian materials recovered from these two AUs indicates that people were not producing obsidian flaked stone tools in these areas and the types of tools recovered indicate expedient use and discard.

The 18 geochemically sourced obsidian artifacts recovered from the Midden consist of 14 CTR, 3 VR, and 1 CCR. There are 8 debitage (CTR=6, VR=1, and CCR=1) and 10 tools. Most obsidian tools from the Midden are made of CTR (80%), while the remainder are of VR material (20%) (Table 35). CTR artifacts are composed of six debitage (two angular shatter and four flakes), two expedient tools, two cores, one biface, one drill, and two projectile points.

VR artifacts include one flake, one core, and one biface. The CCR object is a broken flake with a cortical platform and is the only example of this material source recovered from the entire site. The intensive use and reuse of obsidian at the site before final discard is demonstrated by Core-2 (a multidirectional core fragment), Core-9 (a bipolar core created from either a broken tool or larger core), FST-16 (a multiuse modified flake), PP-3 (a projectile point with reworked lateral margins), and BF-3 (a hafted knife with retooled distal end).

Obsidian artifacts recovered from the Midden point to the various obsidian sources exploited during the site's occupation, as well as provide insights into obsidian flaked stone related activities (e.g., procurement, reduction, production, use, recycling, and discard) that occurred at LA 20,000. The occurrence of obsidian materials within the Midden, a place of refuse and final discard, suggests that obsidian may not have been symbolically important or curated by Spanish individuals when it was no longer very functional. However, Indigenous persons may have believed differently (Liebmann 2017).

Spatial Analysis Summary

Artifact and lithic material distributions by AU suggest that some expedient flaked stone reduction took place within and around the House, Barn and Unit D areas, while the presence of expedient tools within these areas indicates that activities requiring generalized stone tool use also occurred. The limited number of flaked stone artifacts associated with the Corral, when compared to Unit D, suggests that very little activity requiring the reduction, production, or use of flaked stone artifacts occurred in this area. This may reflect the use of the Corral area being a space to hold livestock and not generally associated with flaked stone related activities. The presence of strike-a-light flints in House and Unit D AUs suggest that fire making activities likely occurred in these areas.

The results of flaked stone spatial analysis also demonstrate the differential use of raw materials by locality and quality at the site. In general, locally available lithic materials dominate each analytic unit indicating that easily accessible materials were the most heavily reduced and utilized across the site as a whole. Distributions of Pedernal chert and obsidian hint at the likely importance of these materials to household activities (e.g., cutting and scraping for food processing) in the House area, while obsidian appears to have been utilized in the Barn area for cutting related tasks. The presence of individual flakes of ERR and CCR obsidians imply that tool blanks or finished tools made of these source types were brought to LA 20,000, used, maintained, and subsequently curated off-site to be used again elsewhere; although it is also possible that these tools were discarded in areas of the site yet to be excavated. The types and proportions of flaked lithic artifacts and materials recovered from the Midden provides clues to flaked stone related activities such as procurement, reduction, production, use, recycling, and discard that occurred during the entire occupancy of the site. The types of flaked stone tools recovered from the Midden area also reveal the importance and deliberate selection of low frequency, nonlocal, high-quality lithic materials for use as formal and specialized tools over this time span. The presence of gunflints only occurring within the Midden is interesting. Not all gunflints were exhausted, nor were they deposited all at once in a single dumping episode. Instead, both exhausted and still useable gunflints were deposited at various locations and times within the Midden area. Why this is the case is uncertain and no reason for this restricted spatial occurrence is yet proposed.

CHAPTER 7

DISCUSSION AND CONCLUSION

This paper has evaluated the procurement, production, technology, and use of flaked stone artifacts at LA 20,000 to help identify activities performed at the site by the people who lived and labored there. While analyses pertaining to these topics provide a substantial amount of information regarding aspects of behavior, flaked stone artifacts represent more than just functional objects that were intentionally made or used to accomplish specialized or general tasks (Cobb 2003). They were also objects embedded in systems of social (Gero 1991; Silliman 2001), symbolic (Nassaney and Volmar 2003; Sedig 2014), and economic (Cassell 2003; Whittaker and Frat 1984) relationships. Objects are made, traded, used, repaired, altered, discarded, reused, and recycled within a wide variety of functional and social contexts by individuals acting and producing material within dynamic social settings (Dobres and Hoffman 1994; Lightfoot et al. 1998; Silliman 2004). As Cassell (2003:163) states, "Things are nothing without the social context of their existence; they are meaningless if stripped of time and place and people." Therefore, this discussion not only considers flaked stone artifacts as functional objects, but as objects embedded within social and economic contexts.

Flaked lithics found at secular colonial Spanish sites in New Mexico have generally been attributed to either contamination from earlier occupations or to reoccupation of the site by historical Native American peoples (Moore 1992:239). However, more recent archaeological investigations indicate that flaked stone tool use was not an uncommon occurrence at these sites, continuing into the 19th century (Moore 2004:179). Drawing upon ethnographic and historical sources, Moore (2004) concluded that economic conditions in New Mexico during these times may have made flaked stone tool use economically desirable since metal tools were rare, expensive, and people were generally poor. As a result, flaked stone artifacts from rural colonial Spanish sites in New Mexico have generally been investigated as to their functional role and explained as an economic response to the scarcity of metal and metal tools (Moore 1992, 2001, 2004). Lithic analysis has demonstrated that the production, maintenance, and use of flaked stone tools was occurring at LA 20,000. The next question is whether these flaked stone tools were simply replacements for metal tools or if their presence at the site implies something more.

One way to examine whether flaked stone tools were being used as replacements for metal technology could be to look at the ratio of metal to lithic tools at the site. Unfortunately, an in-depth examination of metal artifacts from LA 20,000 has not yet been undertaken, but preliminary analysis has attributed very few pieces to the 17th century with any certainty. Of the nearly 400 metal artifacts recovered, the vast majority are likely modern trash (staples, bottle caps, pull tabs, barb wire, ammunition, and miscellaneous scraps) and fulgurite. Artifacts that have been identified as 17th-century items include a bone and metal awl recovered from the midden in 1995, as well as a galloon and a decorative brass chain, both recovered in 2016 (Trigg et al. 2019, personal communication). Other artifacts like nails

(N=280), pieces of possible slag (165), pins (N=7), and tacks (N=5) may or may not relate to the 17th century and need further analysis before such determinations can be made.

The shortage of 17th-century metal artifacts associated with the site would seem to support the general view that LA 20,000, like New Mexico, was “metal poor” during this time (Moore 2004). However, the archaeological record is heavily weighted towards non-perishable items and, after hundreds of years, metals such as iron do not preserve well, often succumbing to the effects of oxidation and simply rusting away. While metal may have been a scarce resource and highly valued by colonists, it is not unreasonable to believe that metal tools would have been available during the initial construction of LA 20,000 and possibly beyond.

Historical documentation listing metal tools supplied by Oñate, as well as individual settlers, that were brought to New Mexico during initial colonization include wedges, axes, adzes, augers of various sizes, chisels of different types, small and large saws, iron hatchets, raw steel (perhaps to make or repair tools or weapons), knives, swords, firearms, horse and mule shoes, thousands of nails, horseshoeing tools, iron bars, sets of carpenter tools, wood planes, needles, scissors, thimbles, as well as other items (Bakker 1999:118-121; Snow 1993:134). If such tools reflect the prioritization of constructing buildings and the establishing of a viable colony (Bakker 1999:119), they likely would have been heavily curated. Also, after initial colonization supply trains arrived from Mexico City every two to four years bringing new colonists and goods, and illicit trade was taking place with the nearer Santa Barbara-Parral area of northern Mexico by entrepreneurs and individual colonists (Snow 1993:133-137). While metal may have been rare and expensive, it was likely obtainable through one of these channels.

Additionally, although the Spanish Crown regulated the production of iron and metal tools during this time, limiting it to approved and controlled sources and restricting the development of a metal industry in the region (Vaughan 2006:201-202), this does not mean that colonists did not try to circumvent these laws. Historical and archaeological data indicate the Spanish extraction and manufacture of metals in New Mexico during the 17th century from a variety of small-scale mining and metallurgical activities at household or community levels (Ramenofsky et al. 2008; Thomas 2008; Vaughan 2006, 2017). Archaeologically, five sites excavated in New Mexico show evidence of early colonial metal production - Palace of the Governors in Santa Fe, Pueblo San Marcos, Bethsheba Mine, Paa-ko Pueblo, and Comanche Springs (Ramenofsky et al. 2008:106; Vaughan 2006, 2017). San Marcos and Bethsheba Mine (a lead-mining site) are both located within 8 miles to the southeast of LA 20,000, while Paa-ko Pueblo and Comanche Springs are roughly 25 miles and 60 miles south of the site, respectively. Vaughan (2017:202) interprets these metallurgical activities as representing "a survival and not a wealth-production economic strategy" since imported base metals were scarce "metals were worked and/or produced to meet the day-to-day practical needs of a small mining community or for local trade." Rather than focusing on the production of precious metals, manufacture was directed to more utilitarian metal types. Moreover, slags from mining sites have been shown to be the result of repair and maintenance of iron tools instead of the manufacturing of metal (i.e., ore reduction). In fact, some slags recovered at Bethsheba Mine have been determined to be by-products of iron melting and/or iron smithing, and smelters "probably used as forges to heat iron metal, possibly for making or reworking tools, nails, horseshoes, or other iron implements" (Vaughan 2017:198-199). The potential presence of slag at LA 20,000 hints at the possibility of metal working and the site's proximity to places with metal production suggests that LA 20,000 residents had access, though maybe limited, to locally made items, so would not be completely dependent on supply trains from Mexico.

Although 17th-century metal artifacts are currently found to be rare at LA 20,000, this does not mean that these artifacts were not present, as strike-a-light flints and gunflints at the site clearly demonstrate. However, even if metal was not particularly rare at the site, it was still likely expensive and not easily acquired in the region. Because of this, LA 20,000 residents likely intensively used and recycled any metal they had into smaller and smaller pieces until pieces were no longer viable, basically using them out of existence. This intensive use and reduction would have contributed to the increased deterioration of metal artifacts and help account for their absence in the archaeological record. As would the likely removal of certain items during and after the 1680 Pueblo Revolt, either by fleeing colonists or by Indigenous peoples reaping the rewards of victory.

For the reasons mentioned above, the appropriateness of attributing the presence of flaked stone artifacts as simply an economic response to the scarcity of metal/metal tools as it applies to LA 20,000 is debatable. LA 20,000 was one of the largest and most complex rural 17th-century Spanish colonial sites in New Mexico (Snow 1992:192). Its vast size, central proximity to various pueblos, and historical records suggest that it was likely (though not yet proven to be) owned by an *encomendero*, or at least a wealthy owner (Barrett 2012; Snow 2009). The presence of imported *majolicas*, olive jars, Indigenous Mexican ceramics, and a few specimens of Chinese porcelain (Trigg et al. 2019) suggest that the site occupants were affluent enough to purchase or trade for some items. The presence of gunflints also suggests affluence since firearms likely would have been expensive to acquire and maintain. LA 20,000's apparent wealth, as well as its proximity to two locations that practiced metal production, would have likely allowed it access, or at least more access than less wealthy or less proximate colonists, to metal or metal tools (adzes, axes, nails, horseshoes, needles, scissors, knives) that were necessary for the construction, maintenance, and ensuring that the ranch's domestic, livestock, and agricultural operations were carried out. Furthermore, such items appear to have been brought during the first colonizing expeditions and were also available for trade or purchase during later times. While metal was likely rare in early colonial New Mexico, documentary sources and archaeological evidence suggest that it could have been obtained from curated materials, sanctioned and unsanctioned supplies, or locally produced items.

Additionally, if the use of flaked stone at LA 20,000 primarily marked an economic response to the scarcity of metal and metal tools, it would not be unreasonable to expect the flaked stone assemblage (debitage and/or tools) recovered at the site to be much larger. After all, the site was likely occupied for at least five decades (ca. 1630-1680 AD), yet only 404 flaked stone artifacts were recorded during all archaeological investigations, 317 of which are available and analyzed for this paper. The reduction of a single core or the production of a single tool often results in dozens, if not hundreds of pieces of debitage. Even if formalized tools were being produced off-site and then brought to the site for use (as is suggested by the results of LA 20,000's flaked stone analysis), there should be far more stone tools present if they were being relied upon to perform the daily tasks required of them to keep the *estancia* operational.

While the lack of debitage at the site can be explained by off-site manufacture, the lack of stone tools recovered from a site that would have presumably relied upon such items due to metal and metal tool scarcity is not so straight forward. Although it is possible that areas of the site containing these tools have yet to be excavated, a more likely explanation for the lack of stone tool recovery from LA 20,000 would either be the presence of metal tools for Spanish use and/or the removal of stone tools from the site by Indigenous laborers who brought and used them. If these stone tools were still functional, or desirable for some other reason, they likely would have been curated off-site to be reused, retooled, and/or recycled. Otherwise, if metal tools were lacking, these same stone tools would have remained on-site to be used again and again to perform tasks until no longer useable and then discarded on-site.

Although the sample size is small (N=12), an investigation of flaked stone tool economizing behavior appears to indicate that formal tools at LA 20,000 were not heavily conserved. This suggests that formal tools were not considered overly scarce nor relatively important commodities. If such items had been considered in these terms, it seems likely that individual formal tools would exhibit higher proportions of intensive and/or extensive use, along with a higher frequency of utilized broken edges. Instead, only three formal tools display evidence of a combination of these attributes that resulted in repurposing. If metal tools were in short supply and stone tools were being heavily relied upon as supplemental or replacement items, not only should the flaked tool assemblage likely be larger, it is also anticipated that tool users would have utilized and recycled most available formal stone tools until they were no longer useable in terms of new forms and functions.

To investigate whether the presence of flaked stone at LA 20,000 implies something more than an economic response to metal scarcity, such as the incorporation of Native Americans and their knowledge and traditions, characteristics between flaked stone artifact assemblages recovered at other Spanish and contemporary Indigenous sites in the region were examined.

Moore (2004) compared flaked stone artifacts from five components at four Spanish sites - La Fonda Parking Lot Site in Santa Fe (17th century), Santa Rosa de Lima (18th century), La Puente (18th and 19th centuries), and the Trujillo House (19th century) - in an effort to establish characteristics associated with flaked stone artifact manufacture and use at Spanish sites, and he called attention to distinctive manufacturing characteristics of Spanish flaked stone assemblages (Moore 1992:241, 2004:184). At a post-1692 Colonial Period site (LA 16769), Levine et al. (1985:77-92) observed that single-facet platform flakes were dominant, while modified platforms were lacking. This suggested that a simple core-flake reduction strategy was being utilized and that formal tool manufacturing was not taking place. Ferg (1982) found that the flaked stone assemblage at LA 25674 (another post-1692 Colonial Period site) reflected opportunistic flaking by someone either unfamiliar with flintknapping, or who possessed little skill at it. At pre-1680 Spanish colonial sites at Cochiti Reservoir, Chapman et al. (1977) observed a higher amount of bipolar reduction when compared to older local Native American sites, as well as a lack of facially retouched artifacts. Also discussing Cochiti Reservoir sites, Kemrer and Kemrer (1979:273) state that flaked stone assemblages associated with Spanish sites had a higher percentage of tools than did older Native American assemblages. Moore notes (1992:242, 2004:179) that gunflints are often the only flaked stone artifacts regarded as being manufactured and used by Spanish colonists.

Based on these previous reports and the results of flaked stone analysis of assemblages at residential Spanish sites in New Mexico, Moore concluded that certain characteristics should be present in Spanish site flaked stone assemblages. These include the dominance of a simple lithic reduction technology, the presence of bipolar reduction, a lack of formal tools, and a high occurrence of informal tools. These characteristics are indicative of an expedient lithic technology focused on the use of debitage as informal tools. Gunflints and strike-a-light flints should also occur in the flaked stone assemblage, as should evidence of the procurement and recycling of some "prehistoric" lithic artifacts (Moore 1992:241, 2004:185).

Unfortunately, such characteristics (with the exception of gunflints and strike-a-light flints) are the same criteria that have come to define flaked stone assemblages associated with Puebloan sites occurring over the last 1,500 years or so in the region (Harper and Andrefsky 2008; Parry and Kelly 1987; Railey 2010; Torres 2000). For example, Vierra (2016:263) characterizes flaked stone technology and assemblages in the Northern Rio Grande region over this time as "1) the long-term replacement of bifacial knives with simple flake tools, 2) a shift from the use of higher quality materials…for biface production to lower quality materials…for expedient flake production, 3) an increase in the variety of materials being worked, and 4) the increased use of marginally retouched and unretouched flakes." Procured and recycled flaked stone artifacts from much earlier times are also often present (Harper and Andrefsky 2008). These lithic assemblages are representative of a technological shift from formal tool production to a more expedient, core-flake tool technology that occurred during the transition from pre-agricultural to agricultural times. Explanations for this shift in lithic technologies include increased sedentism (Parry and Kelly 1987), subsistence changes and labor reorganization (Vierra 2005), increased spatial zoning (e.g., dedicated activity areas, habitation zones, and storage areas) in settlements (Harper and Andrefsky 2004:180; Whittaker and Kaldahl 2001), raw material availability (Andrefsky 1994), and the introduction of the bow and arrow (Railey 2010). To what extent these various explanations affected changes in flaked stone technology over time is still up for debate. Regardless, sedentary Puebloan flaked stone assemblages most often reflect characteristics indicative of an expedient lithic technology focused on the use of locally available materials of varying qualities, debitage as informal tools with a lack of formal tools present, the utilization of bipolar reduction, and evidence of the procurement and recycling of some much older lithic artifacts. In contrast, more mobile groups (Apache, Navajo, Ute) tend to have dense, discrete, and distinctive lithic scatters indicative of biface reduction with high flake to angular debris ratios and more smaller flakes from retouch present. Formal tools also dominate, and distinctive tool types are sometimes present (Brown and Hancock 1992; Eiselt 2006; Gunnerson 1960, 1969).

Comparing the flaked stone artifact assemblage at LA 20,000 with those of contemporary Puebloan sites in the region proved challenging. An underrepresentation of published research on post-16th century flaked stone assemblages in the Rio Grande region has resulted in a lack of data available for comparison (Larson et al. 2017:97). Fortunately, recent investigations conducted at Pueblo San Marcos (Compton 2017), a pueblo occupied from ca. 1275 AD until the Pueblo Revolt of 1680 and located approximately 12 km to the southeast of LA 20,000, provide a detailed flaked stone analysis for comparative purposes. Results of that analysis revealed that the pueblo was able to maintain a continuity of lithic practices there for over 400 years.

Similar to LA 20,000, San Marcos lithic production was found to be expedient, weighted toward local materials collected proximate to the pueblo with only obsidian and Pedernal chert constituting nonlocal lithic materials, employ bipolar reduction techniques with raw material package size being a significant variable determining core reduction strategies, and exhibit differential use of materials (e.g., bipolar cores were exclusively obsidian and Pedernal chert, obsidian was the dominant material for bifaces and projectile points, and Pedernal chert dominated the microdrill category). Fine-grained basalt, other chert, obsidian, and Pedernal chert were the most common raw materials within each occupational period and the use of these raw material categories remained consistent over time. In terms of counts, Pedernal chert was the most common material, while basalt was the most prevalent by weight. At LA 20,000 the most common materials by both count and weight were cherts and other CCS (Pedernal chert was the third most common material by count, while basalt was uncommon in both regards). Also like LA 20,000, expedient tools were most common and were manufactured from all raw materials, while bifaces were uncommon and manufactured from obsidian and Pedernal chert. Lithic recycling and the procurement of older flaked stone artifacts was also observed at both sites (Compton 2017; Ramenofsky 2017).

Unlike LA 20,000, the most common formal tools at San Marcos were microdrills. Microdrill attributes suggest standardization as they were primarily manufactured from Pedernal chert and had similar morphologies. While these tools occurred throughout the occupational history of San Marcos, their highest frequency occurred during the most recent occupation period. Given the location of San Marcos near the Cerrillos Hills and the importance of turquoise to Puebloan peoples, the microdrills are interpreted to have been used in the manufacture of turquoise beads. This increased use of microdrills for turquoise bead production following the Spanish occupation of San Marcos is thought to be associated with maintaining Puebloan identity and religious practices (Compton 2017). Considering the social and economic changes that occurred in the region beginning in the late -16th century, including the appointment of a resident priest to the pueblo by the middle of the 17th century (Ramenofsky and Schleher 2017b:3), continuity in lithic manufacture and raw material choice is noteworthy since it does not appear that the Spanish significantly affected lithic technological production there.

Other similarities between the two sites' lithic assemblages were revealed through the results of obsidian sourcing analysis. Like LA 20,000, San Marcos obsidian artifacts that could be assigned to known chemical groups were sourced to four geochemical groups from the Jemez Mountains volcanic field - Cerro Toledo Rhyolite (CTR), Valles Rhyolite (VR), El Rechuelos Rhyolite (ERR), and Canovas Canyon Rhyolite (CCR). Of the four, CTR and VR are most abundant and have the greatest weights at both sites. In terms of counts, CTR is the most common (75% at San Marcos, 75.6% at LA 20,000), while VR accounts for 18% of the sample at San Marcos and 20% at LA 20,000. Average weight per piece was heaviest for VR at both sites. CCR and ERR were present at both sites but in much smaller proportions, representing 4% and 3% at San Marcos, respectively and 2.2% for each at LA 20,000. Mean weight was also lowest for CCR and ERR artifacts at both sites (Ramenofsky et al. 2017b:161-163).

Comparing the flaked stone artifact assemblage at LA 20,000 to lithic assemblages at other Spanish and Puebloan sites in the region leads to uncertain and ambiguous conclusions. Moore has clearly demonstrated "chipped stone artifacts are not necessarily indicative of historic Pueblo or Plains Indian occupation, nor is their presence in so many assemblages evidence of earlier occupations or contamination from nearby prehistoric sites" (Moore 2001:61) and that some colonial settlers of Spanish and Mexican heritage did, in fact, practice various, if not limited forms of flaked stone tool manufacture (Moore 1992, 2001, 2004). The results of flaked stone analysis at LA 20,000 clearly fulfill all of Moore's characteristics for a Spanish site flaked stone assemblage, as well as it being highly probable that Spanish colonists at LA 20,000 did manufacture and use some of the lithic tools found at the site (e.g., gunflints, strike-a-light flints, and possibly informal tools). Yet, results also fulfill the same criteria that characterize Puebloan flaked stone assemblages in the region over the last 1,500 years or so, as well as indicate that some flaked stone artifacts (e.g., projectile points and bifaces) recovered at LA 20,000 were manufactured using techniques historically employed by Native American peoples of the region. These latter findings are further strengthened when the results of analyses are compared to those reported at Pueblo San Marcos.

Taking both Spanish and Puebloan trends in flaked stone tool manufacture and use into consideration, it seems apparent that both Native American workers (seasonal, ephemeral, and daily; volunteer, wage, conscripted, and enslaved) and Spanish members (however they were defined in the complex *casta* system of 17th-century Spanish New Mexico) of the *estancia* used some of the same flaked stone materials (e.g., Pedernal chert, other chert, and chalcedony) and flaked stone tools (e.g., strike-a-light flints), but also very different ones as well (e.g., gunflints). The use of other flaked stone materials and tools by “Native” or “Spanish” individuals is more ambiguous (e.g., obsidian and projectile points).

Trying to tease apart who made what or who used what in shared colonial spaces (e.g., within and outside of the household) that were often occupied and labored within by diverse groups of individuals who used some of the same material culture, and likely even the same specific items over the course of a day, may not only prove to be an exercise in futility, but “calls into question even classifying these objects to ‘culture’ since origins cannot capture all possible practices and meanings” (Silliman 2010:47). In fact, intermarriage and sexual relations between Spanish colonists and Native peoples during the 17th century was common enough that the “Spanish” population increasingly became a population of mestizos (individuals with mixed Spanish and Native American parentage) (Snow 1992; Trigg 2004, 2005; Trigg and Gold 2005:76), some of whom “achieved positions of authority in the colonial government while others apparently moved easily between Pueblo villages and colonists' households, further blurring the distinction between Pueblo and Spaniard” (Trigg 2004:243). In a colonial setting such as LA 20,000 it is important to appreciate how various objects and materials of everyday life passed through the hands of an unknown number of individuals of multiple ethnic/cultural affiliations.

Whether flaked stone tools were made and used by colonists or Native Americans (or both) on-site, were traded for and subsequently used by Spanish colonists, or were scavenged and utilized from earlier Native American sites by the *estancia* residents are one of many possible explanations and “reveals the material and interpretive ambiguity that often plagues the archaeological study of colonial contexts” (Silliman 2001:380). Considering only the technology, production, and waste products of flaked stone assemblages in colonial settings may provide answers pertaining to how and where artifacts were made and, to some extent, by who, but doing so misses opportunities to address "larger social questions of labor and people that made these material aspects happen" (Silliman 2006:149). Furthermore, limiting interpretations of flaked stone artifacts to their functional roles and explanations to economic responses to the scarcity of metal and metal tools disregards other economic factors and social contexts of early Spanish colonial New Mexico.

While stone tools in and of themselves do not necessarily signify or identify any one specific group of people, historical documents and recorded testimonies clearly indicate the presence of Puebloan and Plains people, especially Indigenous women, in Spanish colonial households and *estancias* (Brown 2013; Gutiérrez 1991; Hackett 1937; Scholes 1937; Trigg 2004, 2005). Taking into account the artifactual and textual evidence, along with the social and economic contexts of early colonial Spanish New Mexico and its heavy reliance upon neighboring Puebloan and other Native American peoples for labor and trade (Brown 2013; Hackett 1937; Snow 1983; Trigg 2005), the flaked stone assemblage at LA 20,000 undoubtedly reflects the Spanish colonial incorporation of Indigenous peoples, their traditions, and knowledge of flaked stone materials into daily practices. Practices that were situated within a context of social labor relations in which individuals worked and lived with respect to identity, agency, and gender.

For a sense of how important Native peoples were to the lives and economies of Spanish colonists, consider the immense quantities of Pueblo-made ceramic sherds at any given Spanish site (Trigg 2005:135). Archaeological investigations conducted at 17th-century

Spanish *estancias* in New Mexico not only reveal that from 96 to over 99% of the ceramics recovered from these sites were produced by Puebloan peoples, but Puebloan-made ceramics "usually constitute the most numerous class of artifacts recovered from early colonial sites" (Trigg 2005:141). Although the precise extent to which Spanish colonists were dependent upon Puebloan, Plains, and other Native peoples for labor and commodities is unclear, it was Native peoples who provided the labor Spanish colonists often needed to fulfil and increase their household production (Trigg 2005).

Because of this importance of Native peoples to Spanish colonial households and economies, a deliberate focus is being placed on Native Americans to bring more awareness of their roles in colonial history (see Silliman 2010). This is not done to deny, underappreciate, or minimize the roles of Spanish colonists, who themselves were an ethnically diverse group of individuals (Barrett 2012; Snow 1992; Tainter and Levine 1987:87; Trigg 2005), or to promote an anti-Spanish view, but rather to acknowledge Native Americans as other, often forgotten, members of the household who similarly constructed, inhabited, and worked at this "Spanish" site. Furthermore, I am also trying to avoid prioritizing ownership, wealth, and dominance at the expense of those individuals who "had little power to make, use, or direct material culture in colonial spaces where they labored" (Silliman 2010:38).

Without social context, presuming that finding flaked stone tools and debitage at historical sites like LA 20,000 is merely an economic response to a scarcity of metal and metal tools not only assumes that technological choices were based solely on functional efficiencies, it also dismisses the people and active choices they made within dynamic social settings (e.g., Dobres and Hoffman 1994; Lightfoot et al. 1998; Silliman 2003, 2004). Even if the lack of flaked stone tools at LA 20,000 indirectly points to the presence of archaeologically invisible metal ones, it is unlikely that those metal tools would have been equally accessible to everyone. The apparent low numbers and costly nature of metal tools in the region would have undoubtedly resulted in unequal access and use among Spanish colonists and Indigenous laborers. Moreover, some Indigenous laborers may have simply chosen to use traditional tools over metal ones for various reasons, regardless of availability (Silliman 2003:149-150; 2004:184-188). Irrespective of whether or not metal and metal tools were scarce in 17th-century Spanish colonial New Mexico, interpreting the use of flaked stone tools and technology simply as economic responses to this scarcity ignores other social, symbolic, and economic relationships that may not only be just as explanatory, but also brings back into focus the people who made these materialities appear.

Moving beyond functional interpretations (e.g., metal replacement) towards social context can serve as a way to help investigate broader topics such as gender and identity, as well as elevate the presence of Native American laborers who likely moved through the *estancia's* colonial spaces on a regular, if not daily basis. For example, at LA 20,000, Pedernal chert was restricted to two areas of the site - the House and Midden. Its restricted occurrence reveals the importance and deliberate selection of this low frequency, nonlocal lithic material for use in household (cutting and scraping for food processing and preparation, starting fires) and hunting (PP-2 and Gunflint-7) related activities. Its restricted use to the House area, specifically, may also provide a proxy to address questions concerning labor and the presence of Native American women at the *estancia* (e.g., Deagan 1996, 2003; Voss 2008).

While exceptions to the rule can always be found, in 17th-century New Mexico women in Spanish settings generally performed household "domestic" tasks related to childcare, cooking, cleaning, and seed/grain grinding, as well as the spinning of wool, weaving, and needlework, and in the case of Puebloan women, the making of ceramics (Brown 2013; Crown 2000; Gutierrez 1991; Trigg 2005). Since women often worked in residential areas, generally, and domestic spaces, specifically, it is not unreasonable to assume that Indigenous women would have manufactured and used flaked stone artifacts to perform household tasks (e.g., cutting meat, processing plant fibers, shaping spindle whorl shafts, starting fires) (Gero 1991; Sassaman 1992). Furthermore, the use of Pedernal chert in the household area, along with obsidian and other lithic materials, may represent material and technological continuity of Indigenous lithic practices. The presence of ground stone manos, metates, and sandstone *comales*, as well as spindle whorls and a ceramic polishing stone (Trigg 2005, 2019), all point to the presence of women at LA 20,000 in general, and to the practices of Indigenous women more specifically. The presence of noncultivated plants also provides evidence of Indigenous women's practices occurring at the *estancia*. Noncultivated plants suggest that Indigenous foods were present in colonists' diets and likely indicate food gathering practices of Indigenous women (Trigg 2005) who may have taken the opportunity to scavenge any nearby abandoned sites like LA 149 for discarded flaked stone materials and tools during these activities (Sassaman 1992:257).

Given the predominance of Pedernal chert as a lithic material at Pueblo San Marcos, as well as the near identical proportions of sourced obsidian materials at both LA 20,000 and Pueblo San Marcos, these lithic materials may also provide evidence for social, political, familial, and/or economic ties between the two sites, or at least open avenues of inquiry to such possibilities. As Pueblo San Marcos was a producer and exporter of certain ceramics (Ramenofsky et al. 2017a), perhaps sourcing analysis on ceramics from LA 20,000 may provide corroborating evidence for such notions.

The brief example above reveals how flaked stone materials, artifacts, and their spatial distributions can be used to address larger social questions relating to labor and people. Additional questions concerning children and the learning of technology (Larson et al. 2017), division of labor, gendered spaces and gender differences relating to flaked stone acquisition, utilization, and mobility (Arakawa 2013), trade relations and differential access to resources (Kooyman 2000; Walsh 2000), as well as non-utilitarian social and symbolic functions (Harper and Andrefsky 2008:180-181; Sedig 2014) are all aspects that can be investigated if interpretations and conclusions of flaked stone artifacts move beyond ending at technology and function and, instead, incorporate textual evidence (when available) with larger social and economic contexts associated with a time and place.

Early Spanish colonial households in New Mexico were centers for social interaction and economic production and consumption (Levine 1992:205-206; Trigg 2005). In colonial settings where diverse groups of people often shared spaces in which “indigene and colonist, Native and settler lived, worked, procreated, interacted, and negotiated a daily existence” (Silliman 2010:32), co-used objects, and participated (whether through employment, coercion, or force) in “social relations buttressed by inequality and labor” (Silliman 2010:49), rural *estancias* like LA 20,000 represent important locations of cultural interactions where Spanish colonists and Indigenous peoples often worked and lived together in multi-cultural households where colonial inequalities of status and power were actively negotiated and differential knowledge, cultural practices, and material cultures were incorporated (Payne 2012:77; Rothschild 2006; Trigg 2005). How these interactions were experienced from the "bottom up" by those individuals caught up in the colonial labor regime as reflected in the materiality of their daily practices (Silliman 2001) are the type of questions that archaeological data like flaked stone artifacts can help to answer.

APPENDIX A: DEFINITIONS

Angular shatter are pieces of debitage on which a single interior and/or dorsal surface is not identifiable (i.e., cubical, blocky, or irregularly shaped chunks of knappable material).

Bipolar flakes are identified as flakes that exhibit both proximal and distal signs of impact with shattered or pointed platforms occurring on opposing surfaces of the flake. These flakes tend to have an angular cross-section, axial terminations, lack a definitive bulb of percussion or have a sheared bulb of percussion, and display pronounced ripple marks. Another attribute that can identify a bipolar flake is the presence of both proximal and distal compression rings on the same piece of debitage (Andrefsky 2004:120-121; Kooyman 2000:56). Sometimes unique citrus-segment shaped flakes result from bipolar reduction of pebbles with circular body form. These citrus-section shaped debris are frequently recorded within archaeological assemblages and may have been specifically produced as expedient tools (Low 1997:263). Bipolar flakes are recorded separately because bipolar strategies are often employed under specific lithic material constraints, including raw material scarcity and/or small nodule size (Andrefsky 2004; Kuijt et al. 1995; Morrow 1997).

Cores are masses of lithic material that have two or more negative flake scars originating from one or more surfaces from which flakes have been intentionally removed. Their primary function is to supply lithic debitage for the use as, or the production of, flaked stone tools. Cores also occasionally functioned as cutting, chopping, and scraping tools, but none of these were identified in this assemblage. Cores were classified as bipolar, multidirectional, and unidirectional.

> **Bipolar cores** are masses of lithic material that have been reduced by placing the material on an anvil and striking it from above along its axis with a hammer. This results in a bipolar core typically bearing evidence of two points of impact. Due to the force of the impact, bipolar cores often have a shattered or pointed platform and are frequently irregularly shaped (Andrefsky 2004:120-121; Kooyman 2000:56). Bipolar cores are recorded separately because bipolar strategies are often employed under specific lithic material constraints, including raw material quality, scarcity, and/or small nodule size (Andrefsky 2004; Kuijt et al. 1995; Morrow 1997).
>
> **Multidirectional cores** have multiple striking platforms and pieces of debitage are removed from the core in more than one direction. Multidirectional cores include discoidal and amorphous forms (Andrefsky 2004:137; Odell 2004:63).
>
> **Unidirectional cores** either have a single striking platform or opposed striking platforms and pieces of debitage are removed in a single direction roughly parallel to one another (e.g., polyhedral cores, microblade cores, opposed-platform cylindrical cores).

Debitage are the discarded pieces of lithic material (i.e., angular shatter and flakes) resulting from the reduction of cores or the production of tools.

Edge alteration can result from either intentional modification to produce a specific edge shape or edge angle or through utilization, being used as-is without intentional modification. Edge alteration is recorded by surface location (dorsal, ventral, or both) as unimarginal, bimarginal, or alternating.

> **Alternating** - alteration on the dorsal and ventral surfaces along the same edge, but not in the same place.
>
> **Bimarginal** – alteration on dorsal and ventral surfaces along the same edge at the same place.
>
> **Unimarginal** – alteration on only one edge surface (dorsal or ventral), or alteration on both dorsal and ventral surfaces but not on the same edge.

Edge angle is the angle formed by a used edge.

Edge fractures (also termed flake scars) are the small negative impressions left from flakes that have been detached from the edge of debitage or a tool either during use or as the result of other non-use factors (e.g., trampling or soil movement). Macro-edge fractures are visible to the naked eye, while micro-edge fractures are observed through low magnification (i.e., 10x-50x). Edge fracture types include snap, feather, hinge, and step (Grace 2012; Keeley 1980; Kooyman 2000).

> **Feather fractures** are negative impressions of detached flakes that gradually thin out ("feather") towards the end of the flake scar and result from normal conchoidal fracture initiated by pressure or percussion against one surface of the debitage or tool edge.
>
> **Hinge fractures** are flake scars that end abruptly in a rounded termination and often result from pressure or percussion initiated more directly against the edge of debitage or a tool, rather than against a surface.
>
> **Snap fractures** are half-moon or crescent shaped fractures that leave no negative scar and often occur when bending stress causes the edge of the tool break.
>
> **Step fractures** are flake scars that end abruptly at a right-angle break and generally result from the same mechanisms that produce hinge fractures.

Edge fracture distribution refers to the grouping of flake scars and can be absent, discontinuous, clustered, or continuous.

> **Absent** – no flake scars present.
>
> **Clustered** – flake scars are concentrated on the altered edge(s) of a piece.
>
> **Continuous** – flake scars extend over the length of the altered edge(s) of a piece.
>
> **Discontinuous** – flake scars are spaced irregularly on the altered edge(s) of a piece, lacking any area of concentration or patterning.

Edge rounding is an attritional process and refers to the abrasive smoothing or dulling of a tool's edge through use. Rounding is identified by comparing the feel of a used tool edge to the generally sharper unused edge of a tool.

Edge shape is the shape of the working edge in plan view (e.g., straight, concave, convex, and pointed).

Expedient tool – see **Informal tools**.

Flakes are defined as any piece of debitage with both a single identifiable ventral and dorsal surface. Flakes were categorized by their condition based on attributes and are defined as follows (after Sullivan and Rozen 1985):

> **Broken** or **Proximal flake** – a flake that retains its striking platform, but has a step terminated distal end.
>
> **Complete flake** – an unbroken flake that possesses its striking platform, lateral margins, and has a feathered or hinge distal termination.
>
> **Flake fragment** - only the medial or distal portion of a flake is present.

Flake termination refers to the condition or form of the distal end of a flake and were classified as either feather, hinge, step, axial, or indeterminate.

> **Axial termination** - occurs when the fracture forming the flake proceeds directly through the lithic material (often bisecting the piece) to its opposite end, meeting the surface opposite the initiation face of the nucleus at almost a right angle. Axial terminations are most commonly associated with bipolar flaking and result when a nucleus is split into two or three equally sized fragments (Andrefsky 2004; Cotterell and Kamminga 1987; Odell 2004).
>
> **Feather termination** - where the distal end of the flake gradually thins, tapers, and smooths to a sharp edge.
>
> **Hinge termination** - the distal end of the flake is rounded or curved toward the dorsal surface.
>
> **Indeterminate termination** – distal ends had either been modified or could not be discerned due to effects of post-depositional processes.
>
> **Step termination** - the distal end of a flake ends abruptly at a right-angle break.

Flaked Stone Tool is any stone artifact that has been either intentionally modified or used as-is and unintentionally altered through utilization (Andrefsky 2004:9-17, 74-80; Cotterell and Kamminga 1992:130–151). This category includes cores, informal and formal tools, gunflints, and strike-a-light flints.

Formal tools are bifacial, meaning they have two opposing surfaces intentionally modified by flake removal with flake scars that extend past the immediate area of the margin edge and reach at least half-way into the interior of each surface. Formal tools have often been prepared in advance in anticipation of use, transported, and maintained (Bamforth 1986). They may also have complex flaking patterns or hafting elements (Andrefsky 2009:71). Beyond these characteristics, Goodyear (1979:4) asserts that formal tools are also flexible, possessing the qualities of long life spans, reusability, the ability to be easily rejuvenated, and the capability to be redesigned for different functions if necessary. Formal tools have not only been intentionally altered to produce specific shapes they have also undergone a great amount of effort in their production. This production effort could have either occurred over the course of one manufacturing event proceeding from initial raw material to finished product, or over the course of multiple re-tooling episodes (e.g., repairing, reshaping, recycling) (Andrefsky 2004:213). Common formal tools include general bifaces, drills, and projectile points.

> **Bifaces** are generally broad and flat with two opposing flaked surfaces that meet to form an edge that circumscribes most or all of the artifact. They were often multi-purpose tools that could be used, depending on their size, for various activities such as chopping, scraping, cutting, sawing, piercing, or boring (Andrefsky 2004:20-22).
>
> **Drills** are bifacial tools with long, narrow distal ends that were hafted and used in a rotating motion to perforate materials such as wood, shell, stone, or bone.
>
> **Projectile points** are generally symmetrical, exhibit basal modification which enabled hafting, have a pointed distal margin, and functioned as dart or arrow projectile tips. Projectile point morphological styles have changed over time and certain styles in the southwestern U.S. have been closely dated to particular spans of time in given areas using stratigraphy, C^{14}, dendrochronology, ceramic seriation, and other dating methods (Justice 2002; Whittaker 1994:262). Due to their potential as chronological markers, projectile points are described separately from bifaces.

Gunflints are flaked stone tools that were important components in early firearm ignition systems. They were used in gunlocks to produce sparks by striking a frizzen to ignite gunpowder. Types of historic gunflints include squared bifacial and spall varieties, as well as snapped blades.

Informal tools are commonly referred to as **expedient tools** because they often required little or no production effort and are viewed as tools of convenience and/or necessity that were made, used, and discarded over a relatively short duration with no intent or consideration to tool morphology (Andrefsky 2004:213). Informal tools consist of non-flake, flake tools, and unifaces.

> **Flake tools** are flakes (debitage with only one dorsal and one ventral surface) and bipolar flakes that show evidence of having been altered along one or more edges by an individual in some way.

Non-flake tools are pieces of angular shatter that show evidence of human alteration in some way in one or more places. They are not created on a flake, are non-bifacial, and are not cores.

Unifaces are artifacts that are facially flaked on only one surface (e.g., end scraper).

Platform – when present, the platform is the remnant location on a flake where a point of applied force was administered to remove the flake. Platforms were separated into five distinct types: cortex, flat, crushed, complex, and abraded.

Abraded platforms have had their platform surfaces ground or rubbed smooth as an additional step in preparation for flake removal. This has often been done to achieve more precision and better results during lithic reduction. Platforms that have been abraded are generally associated with later stages of production and/or represent more investment in tool manufacture (Andrefsky 2004:96). In general, striking platform abrasion tends to increase in overall frequency over the production sequence (Morrow 1997:62).

Complex platforms have multiple flake scars present on the platform and can have either an angular or rounded/convex surface (Andrefsky 2004:95). This platform type is most often associated with, but not limited to, later stage lithic reduction or bifacial tool manufacture because these platforms are typically prepared more carefully than early core reduction platforms (Odell 2004:126).

Cortex platforms were defined as platforms with any amount of cortical surface present on the platform. In general, because cortex is progressively removed during lithic reduction, platforms that have cortex present on their surface are generally assumed to be indicative of early stages of reduction. It is important to note that flakes with a cortex platform do not necessarily have dorsal cortex present (Andrefsky 2004:93).

Crushed platforms are platforms that have been splintered and/or battered. These platforms are generally associated with bipolar core reduction, often being the "direct result of the bipolar flaking process, wherein the core is literally pounded against a stone anvil with a hammerstone" (Morrow 1997:63).

Flat platforms are defined as smooth flat surfaces without cortex. These platform surfaces are commonly portions of flake scars and often indicate general core reduction (Andrefsky 2004:94-95).

Polish refers to a visible alteration on a stone tool's natural surface that is more reflective or shinier when compared to the surrounding surface (Grace 2012; Shea 1992). While polish can be observed at lower magnifications, it is more easily observed with high power microscopy (80x-400x) so its distribution and development are mainly studied using a high magnification approach (Grace 2012; Keeley 1980; Kooyman 2000).

Striations are linear scratches present in the surface of a tool and generally result from either abrasive particles compressing between the tool and the worked material, or some component of the worked material doing the same (Odell and Odell-Vereecken1980; Shea 1992). The orientation of striations (e.g., parallel, transverse, and oblique) in relation to the working edge axis provide strong indications as to the direction of use (Grace 2012:83-84; Odell and Odell-Vereecken 1980:98-99).

> **Oblique striations** are associated with a diagonal use motion (e.g., whittling).
>
> **Parallel striations** often result from a longitudinal motion that is parallel to the working edge (e.g., cutting).
>
> **Transverse striations** most often result from use perpendicular to the working edge (e.g., scraping or drilling/boring).

Strike-a-light flints are flaked stone tools associated with Spanish colonial fire starting technology. To start a fire, a piece of "flint" or other siliceous rock such as chert was struck against a steel strike-a-light (or *chispa*) to produce sparks to ignite tinder. The force of the impact damaged the edge of the "flint" used to strike the steel. The resultant edge alteration helps a strike-a-light flint to be identified as such in a flaked stone assemblage. Steel strike-a-lights were important Spanish tools during the early colonial period and somewhat valuable since steel was in short supply in New Mexico at that time (Moore 2004:194). Since no steel strike-a-lights were recovered in the archaeological assemblage at LA 20,000, and since tinder does not tend to preserve, the only remaining evidence of this technology is the presence of strike-a-light flints in the flaked stone assemblage. Because the use of flint and steel was one of the most common methods used to start fires at Spanish sites in New Mexico (Akins 2001; Moore 2001a, 2001b; Moore et al. 2004), strike-a-light flints should be common in Spanish assemblages since they were readily discarded when no longer useful (Moore 2001a:122, 2001b:73).

APPENDIX B: EXPEDIENT TOOL DEBITAGE ATTRIBUTES

Tool #	Field Spec #	Debitage Type	Material	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)	Platform	Cortex
FST-1	53	Complete Flake	Quartz	3.1	2.2	0.6	3.79	Flat	<50%
FST-2	78	Complete Flake	Quartzite	6.6	5	1.9	81.37	Flat	100%
FST-3	243	Bipolar Flake	CCS	1.9	1.1	0.8	1.4	Battered	<50%
FST-4	251	Bipolar Flake	Chalcedony	1.7	1	0.5	0.88	Battered	>50%
FST-5	305	Angular Shatter	CCS	2.2	2.1	0.6	2.09	NA	0
FST-6	421	Complete Flake	CCS	1.5	1.6	0.7	1.7	Cortex	<50%
FST-7	3	Angular Shatter	Chert	1.2	0.8	0.3	0.38	NA	0
FST-8	13	Complete Flake	Quartz	2.7	2.5	0.5	4.22	Crushed	<50%
FST-9	196	Broken Flake	Chalcedony	1.5	0.9	0.2	0.22	Complex	0
FST-10	269	Broken Flake	Chalcedony	2.1	2.8	0.7	4.11	Flat	0
FST-11	1K-178	Flake Fragment	Chert	3.3	2.5	0.5	4.98	NA	0
FST-12	1-43	Complete Flake	Chert	3.4	2.5	0.5	4.4	Crushed	0
FST-13	1J-39	Angular Shatter	Chert	2.6	1.3	0.4	1.14	NA	0
FST-14	14-5	Broken Flake	Pedernal Chert	2.1	1.2	0.4	0.92	Flat	0
FST-15	TP-3	Complete Flake	Obsidian	2.4	2.7	0.4	2.27	Flat	<50%
FST-16	1-18	Complete Flake	Obsidian	1.4	2.2	0.4	1.26	Crushed	0
FST-17	0-15	Flake Fragment	Obsidian	1.8	1.5	0.4	0.89	NA	0
FST-18	F-60-295	Broken Flake	Chert	2	1.8	0.5	1.77	Flat	0
FST-19	F-64-1990	Broken Flake	Obsidian	1.8	1.4	0.6	1.52	Flat	<50%
FST-20	297	Angular Shatter	Obsidian	2.2	1.5	0.5	0.92	NA	0
FST-21	206	Complete Flake	Obsidian	3.1	1.7	0.8	3.12	Crushed	<50%
FST-22	1K-130	Bipolar Flake	Chalcedony	3.8	2.2	1.2	8.24	Flat	0
FST-23	BY0A-3	Bipolar Flake	Pedernal Chert	1.5	1	0.5	0.64	Flat	0
FST-24	64-B4-4 (88)	Angular Shatter	Obsidian	0.6	2.5	2.05	3.03	NA	0
FST-25	AY2A-22	Broken Flake	Chalcedony	2.4	1.9	0.4	1.4	Complex	0
FST-26	B85-266	Bipolar Flake	Chert	2.7	1.5	0.8	4.2	Crushed	0
FST-27	162	Bipolar Flake	Chalcedony	2.2	1	0.5	1.27	Cortex	100%
FST-28	168	Angular Shatter	Obsidian	2.8	2.3	0.9	5.91	NA	0
FST-29	379	Angular Shatter	Obsidian	1.2	1	0.4	0.44	NA	0
FST-30	1J-47	Broken Flake	Chalcedony	3.2	2.4	0.6	3.71	Crushed	<50%
FST-32	2-4	Broken Flake	Obsidian	2.2	1.8	0.4	1.75	Flat	0
Uniface-1	1K-130	Complete Flake	Chalcedony	4.1	2	1	8.35	Flat	0

APPENDIX C: EXPEDIENT TOOL EDGE WEAR ATTRIBUTES

Tool	FS #	# Tool Edges	Fracture Location	[1]Macro Fracture Type	[1]Micro Fracture Type	[1]Edge Alteration	[2]Edge Angle^{0}	Edge Shape	[1]Striations
FST-1	53	2	Distal	Absent	Dorsal+Ventral: Crushing/Step, Continuous	Bimarginal	60	Pointed	Rotational/ Transverse
			Right Lateral	Absent	Ventral: Crushed + Step, Continuous Dorsal: Crushed + Step, Continuous	Bimarginal	40	Straight	Oblique
FST-2	78	1	Right Lateral	Dorsal: Feathered + Snap, Continuous	Absent	Unimarginal	15	Convex	None
FST-3	243	2	Distal	Dorsal: Feather + Step, Continuous	Dorsal: Crushed + Step, Discontinuous	Unimarginal	85	Convex	None
			Left Lateral	Absent	Ventral: Step + Snap + Feather, Discontinuous; Crushed, Continuous	Unimarginal	75	Straight	None
FST-4	251	2	Distal	Dorsal: Step, Continuous	Dorsal: Feather, Continuous	Unimarginal	80	Convex	None
			Left Lateral	Absent	Dorsal: Crushed + Step, Continuous	Unimarginal	80	Straight	None
FST-5	305	1	Distal	Dorsal: Feather, Clustered	Dorsal: Feather, Continuous	Unimarginal	65	Convex/ Pointed	None
FST-6	421	2	Left Lateral	Dorsal: Step, Continuous Ventral: Step + Feather, Continuous	Dorsal: Step, Continuous Ventral: Step, Continuous	Alternating	40	Straight	None
			Right Lateral Distal + Distal Right form point	Dorsal: Step + Feather, Continuous	Dorsal+Ventral: Crushed + Step, Clustered/ Discontinuous	Bimarginal	50	Pointed	Transverse
FST-7	3	1	Lateral Margin	Dorsal: Feather + Step + Dimpled, Continuous	Dorsal+Ventral: Crushed + Step, Continuous	Bimarginal	50	Convex	None
FST-8	13	3	Distal	Absent	Dorsal: Step + Crushed, Continuous	Unimarginal	60	Concave	Transverse
			Left Lateral	Dorsal: Step, Clustered	Dorsal: Step + Hinge + Crushed, Continuous	Unimarginal	40	Convex	Parallel + Transverse
			Right Lateral	Absent	Dorsal+Ventral: Snap + Step, Continuous	Bimarginal	35	Convex	Oblique
FST-9	196	2	Right Lateral	Absent	Dorsal: Step + Hinge + Few Snap, Continuous	Unimarginal	20	Convex	None
			Left Lateral	Dorsal: Step + Hinge, Continuous	Dorsal: Step + Hinge + Few Snap, Continuous	Unimarginal	20	Straight	None

Tool	FS #	# Tool Edges	Fracture Location	[1]Macro Fracture Type	[1]Micro Fracture Type	[1]Edge Alteration	[2]Edge Angle^0	Edge Shape	[1]Striations
FST-10	269	2	Proximal	Dorsal+Ventral: Feather + Step + Hinge, Continuous	Dorsal+Ventral: Step + Hinge, Continuous	Bimarginal	65	Convex	Transverse
			Distal	Absent	Dorsal: Feather + Step + Hinge, Continuous	Unimarginal	15	Straight	Transverse
FST-11	1K-178	4	Proximal	Dorsal+Ventral: Feather + Hinge, Continuous	Dorsal: Step + Hinge, Continuous	Bimarginal	40	Straight	None
			Right Lateral	Ventral: Feather + Hinge, Continuous	Ventral: Step + Hinge, Continuous	Unimarginal	60	Straight	None
			Distal	Ventral: Feather, Continuous	Ventral: Step + Hinge, Continuous	Unimarginal	45	Straight	None
			Left Lateral	Dorsal+Ventral: Feather + Hinge, Continuous	Ventral: Step + Hinge, Continuous	Bimarginal	30	Straight	None
FST-12	1-43	1	Right Lateral	Dorsal: Feather, Continuous	Dorsal+Ventral: Crushed + Hinge + Step, Continuous	Bimarginal	35	Straight	None
FST-13	1J-39	1	Lateral Margin	Dorsal: Hinged, Clustered	Dorsal: Crushed + Snap + Step, Continuous	Unimarginal	55-85	Straight	Transverse
FST-14	14-5	1	Left Lateral	Absent	Dorsal+Ventral: Snap + Feather + Crushed, Alternating	Bimarginal	35	Straight	None
FST-15	TP-3	4	Right Lateral	Absent	Dorsal: Step + Hinge + Crushed, Continuous	Unimarginal	25	Straight w/projection	None
			Distal	Absent	Dorsal: Step + Hinge + Crushed, Continuous	Unimarginal	40	Straight	None
			Left Lateral	Absent	Dorsal: Step + Hinge + Crushed, Continuous	Unimarginal	90	Straight	None
			Proximal	Dorsal: Feather, Cluster	Dorsal: Hinge, Clustered	Unimarginal	60	Straight	None
FST-16	1-18	2	Distal	Dorsal: Feather, Continuous	Dorsal: Step + Hinge + Crushed, Continuous	Unimarginal	45	Convex	None
			Left Lateral	Absent	Dorsal: Step + Hinge, Clustered	Unimarginal	40	Straight	None
FST-17	0-15	1	Distal	Dorsal: Feather, Clustered Ventral: Hinge, Clustered	Dorsal+Ventral: Crushed + Step + Feather, Cluster	Bimarginal	40	Pointed	None
FST-18	F-60-295	1	Left Lateral	Absent	Ventral: Hinge + Feather, Continuous	Unimarginal	80	Convex	None
FST-19	F-64-1990	1	Left Lateral	Dorsal: Feather, Continuous	Dorsal: Crushed + Step + Hinge, Continuous	Unimarginal	75	Straight	None

Tool	FS #	# Tool Edges	Fracture Location	[1]Macro Fracture Type	[1]Micro Fracture Type	[1]Edge Alteration	[2]Edge Angle^0	Edge Shape	[1]Striations
FST-20	297	1	Lateral Margin	Dorsal: Feather, Continuous	Dorsal: Step + Hinge, Continuous	Unimarginal	75	Irregular	Transverse
FST-21	206	1	Left Lateral	Absent	Dorsal+Ventral: Feather + Hinge, Continuous	Bimarginal	30	Straight	Parallel
FST-22	1K-130	2	Left Lateral	Dorsal: Feather + Hinge, Continuous	Dorsal+Ventral: Crushed + Step, Continuous	Bimarginal	60	Straight	None
			Distal	Dorsal: Feather + Hinge, Continuous	Dorsal+Ventral: Crushed + Step + Hinge, Continuous	Bimarginal	40	Straight	None
FST-23	BY0A-3	2	Left Lateral	Dorsal+Ventral: Feather + Hinge, Clustered	Dorsal+Ventral: Light Crushed + Step, Clustered	Bimarginal	35	Straight	None
			Right Lateral	Dorsal: Feather + Step + Hinge, Clustered	Dorsal: Feather + Hinge + Light Crushed, Continuous	Unimarginal	60	Straight	None
FST-24	64-B4-4 (88)	1	Distal	Ventral: Step + Hinge, Clustered	Ventral: Crushed, Clustered	Unimarginal	85	Straight	Transverse
FST-25	AY2A-22	2	Left Lateral	Dorsal: Hinge + Feather, Clustered	Dorsal+Ventral: Hinge + Step + Snap + Light Crushing; Ventral Cluster + Dorsal Continuous	Bimarginal	40	Convex	None
			Right Lateral	Ventral: Feather, Continuous	Ventral: Crushed, Clustered	Unimarginal	25	Straight	None
FST-26	B85-266	1	Left Lateral	Dorsal+Ventral: Step + Hinge, Dorsal Cluster + Ventral Continuous	Dorsal+Ventral: Crushed, Continuous	Bimarginal	85	Straight	None
FST-27	162	2	Left Lateral	Absent	Dorsal: Crushed, Continuous	Unimarginal	90	Straight	Transverse
			Distal	Absent	Dorsal: Crushed, Clustered	Unimarginal	79	Pointed	None
FST-28	168	3	Left Lateral	Dorsal: Step + Hinge, Continuous	Dorsal: Crushed + Hinge + Step, Continuous	Unimarginal	85	Concave	None
			Distal	Absent	Dorsal: Crushed + Hinge + Step, Continuous	Unimarginal	90	Convex	None
			Right Lateral	Absent	Dorsal: Crushed + Hinge + Step, Continuous	Unimarginal	90	Straight	None
FST-29	379	1	Margin	Absent	Dorsal: Crushed, Clustered	Unimarginal	50	Pointed	None

Tool	FS #	# Tool Edges	Fracture Location	[1]Macro Fracture Type	[1]Micro Fracture Type	[1]Edge Alteration	[2]Edge Angle^0	Edge Shape	[1]Striations
FST-30	1J-47	2	Left Lateral	Absent	Dorsal+Ventral: Snap + Feather + Hinge + Crushed, Dorsal Clustered + Ventral Continuous	Bimarginal	35	Concave	None
			Right Lateral	Absent	Dorsal+Ventral: Snap + Feather + Hinge + Crushed, Dorsal Continuous + Ventral Clustered	Bimarginal	30-70	Irregular	None
FST-32	2-4	1	Distal	Absent	Dorsal: Crushed + Step, Continuous	Unimarginal	48	Straight	Transverse
Uniface-1	1K-130	3	Left Lateral	Absent	Dorsal: Hinge + Step + Crushed, Clustered + Continuous	Unimarginal	60	Concave	Transverse
			Distal	Absent	Dorsal: Hinge + Feather, Continuous	Unimarginal	50	Convex	Transverse
			Right Lateral	Absent	Ventral: Step + Hinge + Crushed	Unimarginal	100	Straight	None

[1] Refer to Appendix A for definitions.

[2] Correlations exist between a flaked stone tool's edge angle and its functional efficiency (Broadbent and Knutsson 1975; Cantwell 1979; Grace 2012; Wilmsen 1968). In general, acute edge angles (<45 degrees) are more efficient at cutting actions, while less acute edge angles (>45 degrees) are more efficient at scraping actions. To allow for a continuum of cutting and scraping activities this analysis viewed edge angles of <30 degrees as more likely to be cutting edges, edge angles between 30 and 60 degrees as either cutting or scraping edges, and edge angles >60 degrees likely associated with scraping activities.

APPENDIX D: EXPEDIENT TOOL USE INTERPRETATIONS

Tool	Altered Edge Count	Material	Tool Typology	Suggested Motion	Suggested Function	[1]Worked Material Hardness	[2]Possible Worked Material
FST-1	2	Quartz	Utilized Flake	Rotational	Boring	Medium	Wood or Dry Hide
				Unidirectional	Whittling		
FST-2	1	Quartzite	Modified Flake	Bidirectional	Cutting	Soft to Medium	Siliceous plants/grasses possibly on a wooden surface
FST-3	2	CCS	Modified Bipolar Flake	Unidirectional	Incising	Medium to Hard	Wood or Bone
				Unidirectional	Scraping		
FST-4	2	Chalcedony	Modified Bipolar Flake	Unidirectional	Incising	Medium to Hard	Wood or Bone
				Unidirectional	Scraping		
FST-5	1	CCS	Modified Angular Shatter	Unidirectional	Incising	Soft to Medium	Soft or green wood (e.g., alder, ash and pine); Leather
FST-6	2	CCS	Modified Flake	No evidence	None	Medium to Hard	Wood, dry hide, soft stone, or bone
				Rotational	Boring		
FST-7	1	Chert	Utilized Angular Shatter	Striking	Undetermined	Unknown	Unknown
FST-8	3	Quartz	Utilized Flake	Unidirectional	Scraping	Medium	Wood
				Unidirectional	Cutting + Whittling		
				Unidirectional	Cutting + Whittling		
FST-9	2	Chalcedony	Modified Flake	No evidence	Unknown	Unknown	Unknown
				No Evidence	Unknown		
FST-10	2	Chalcedony	Hafted End Scraper	Unidirectional	Scraping	Hard	Bone
				No Evidence	None		
FST-11	4	Chert	Modified Flake	No evidence	Tool Blank	NA	NA
FST-12	1	Chert	Utilized Flake	Unidirectional	Whittling/ Shaving	Medium	Wood
FST-13	1	Chert	Utilized Angular Shatter	Unidirectional	Scraping	Medium	Wood
FST-14	1	Pedernal Chert	Utilized Flake	Bidirectional	Cutting	Soft to Medium	Meat on Bone

Tool	Altered Edge Count	Material	Tool Typology	Suggested Motion	Suggested Function	[1]Worked Material Hardness	[2]Possible Worked Material
FST-15	4	Obsidian	Modified Flake	Unidirectional	Incising	Soft to Medium	Leather
				No evidence	None		
				No evidence	None		
				No evidence	None		
FST-16	2	Obsidian	Modified Flake	Unidirectional	Scraping	Soft to Medium	Woody Plant or Soft Wood
				Unidirectional	Cutting		
FST-17	1	Obsidian	Modified Flake	Rotational	Piercing	Medium	Dry Hide/Leather
FST-18	1	Chert	Utilized Flake	Unidirectional	Scraping	Soft to Medium	soft or green wood (e.g., alder, ash and pine); Dry Hide
FST-19	1	Obsidian	Modified Flake	Unidirectional	Scraping	Medium	Wood
FST-20	1	Obsidian	Modified Angular Shatter	Unidirectional	Scraping	Soft to Medium	Woody Plant, Fish Skin, or Wood
FST-21	1	Obsidian	Modified Flake	Bidirectional	Cutting	Soft to Medium	Woody Plant or Hide
FST-22	3	Chalcedony	Utilized Bipolar Flake	Unidirectional	Scraping	Hard	Bone
				Unidirectional			
				Unidirectional			
FST-23	2	Pedernal Chert	Utilized Bipolar Flake	Unidirectional	Cutting	Soft to Medium	Woody Plant or Hide
				Unidirectional	Scraping		
FST-24	1	Obsidian	Utilized Angular Shatter	Unidirectional	Scraping	Medium to Hard	Wood or Bone
FST-25	2	Chalcedony	Modified Flake	Unidirectional	Cutting	Soft to Medium	Woody Plant
				Unidirectional	Cutting		
FST-26	1	Chert	Modified Bipolar Flake	Striking	Undetermined	Unknown	Unknown
FST-27	2	Chalcedony	Modified Bipolar Flake	Unidirectional	Scraping	Medium	Wood
				Unidirectional	Incising		
FST-28	3	Obsidian	Utilized Angular Shatter	Unidirectional	Scraping	Unknown	Unknown
				Unidirectional			
				Unidirectional			
FST-29	1	Obsidian	Modified Angular Shatter	Unidirectional	Incising	Soft to Medium	Leather

Tool	Altered Edge Count	Material	Tool Typology	Suggested Motion	Suggested Function	[1]Worked Material Hardness	[2]Possible Worked Material
FST-30	2	Chalcedony	Modified Flake	Unknown	Unknown	Unknown	Unknown
				Unknown	Unknown		
FST-32	1	Obsidian	Modified Flake	Unidirectional	Scraping	Medium	Wood
Uniface-1	2	Chalcedony	Uniface	Unidirectional	Scraping	Medium	Wood
				Unidirectional	Whittling/ Shaving		

[1]Hardness of worked materials based on their resistivity (Odell and Odell-Vereecken 1980):

Soft - meat, plants, woody plants, bark, fresh soft wood, fresh hide

Medium - other wood, fish, soaked antler, dry hide, soft stone, horn

Hard - dry antler, bone, shell, stone

[2]Possible Worked Material interpretations are speculative and given with very low confidence.

APPENDIX E: OBSIDIAN X-RAY FLUORESCENCE DATA[1]

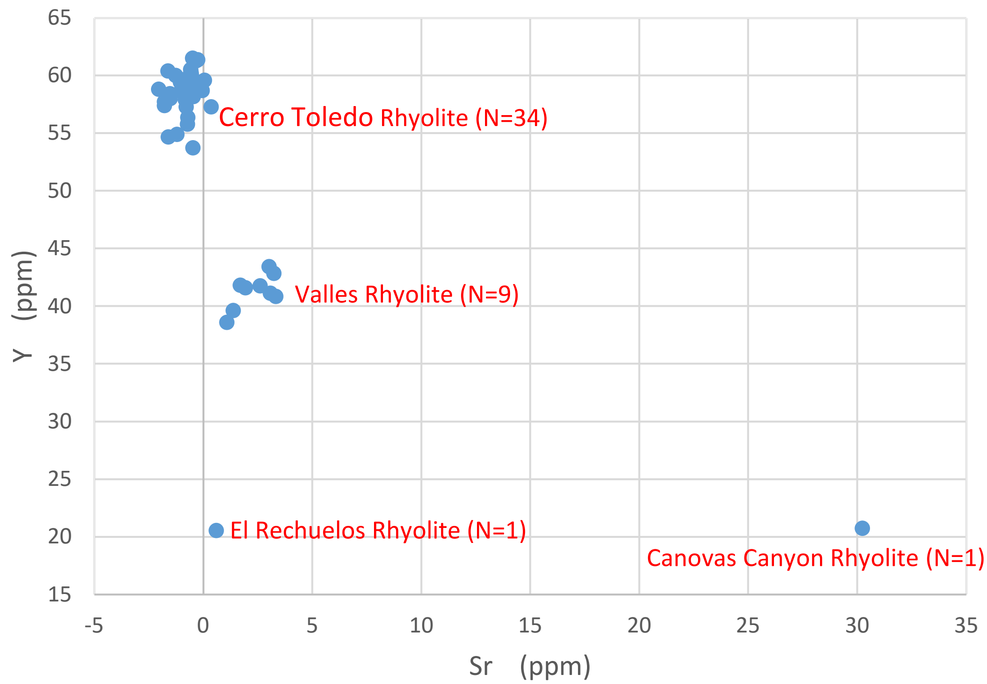
Field Spec#	Ti	Mn	Fe	Th	Rb	Sr	Y	Zr	Nb	Source	Artifact Type
0-15	246.9	487.2	7663.4	19.8	198.4	-0.5	61.5	174.7	88.5	Cerro Toledo Rhyolite	Modified Flake
1-18	117.2	503.0	7689.0	19.4	192.0	-1.3	60.0	170.3	89.2	Cerro Toledo Rhyolite	Modified Flake
1-35	234.4	500.2	7442.9	19.7	187.1	-0.4	59.7	170.9	88.9	Cerro Toledo Rhyolite	Flake Complete
119	230.8	532.4	7467.6	20.7	190.0	-0.6	60.2	169.5	89.6	Cerro Toledo Rhyolite	Biface Frag
155	28.2	489.3	7697.0	19.9	196.3	-0.8	57.9	168.9	89.6	Cerro Toledo Rhyolite	Flake frag
168	132.8	513.0	7194.6	19.4	186.8	-0.8	59.3	169.4	85.0	Cerro Toledo Rhyolite	Utilized Angular Shatter
171	320.3	480.8	7488.1	19.2	189.8	-1.0	59.6	172.0	89.5	Cerro Toledo Rhyolite	Core
171	191.8	474.9	7472.3	19.7	191.1	0.4	57.3	175.0	88.2	Cerro Toledo Rhyolite	Drill
180	-94.1	503.9	7601.1	17.7	179.4	-0.5	53.7	164.3	80.6	Cerro Toledo Rhyolite	Angular Shatter
1J-54	127.5	531.7	7868.6	22.6	199.4	0.1	59.6	181.7	92.2	Cerro Toledo Rhyolite	Core
1J-54	360.9	388.6	5150.2	17.8	111.6	30.2	20.8	103.2	46.3	Canovas Canyon Rhyolite	Flake Broken
1K-131	-158.8	442.4	7675.7	19.6	192.6	-1.6	54.7	170.4	82.6	Cerro Toledo Rhyolite	Flake Complete
1K-172	157.6	507.9	7480.3	19.5	192.1	-0.5	58.2	174.3	88.2	Cerro Toledo Rhyolite	Projectile Point
1M-149	62.2	381.3	7991.2	15.4	161.5	3.2	42.8	166.5	51.0	Valles Rhyolite	Flake frag
2-4	247.8	520.1	7686.4	19.7	191.2	-0.3	61.4	175.0	91.8	Cerro Toledo Rhyolite	Modified Flake
206	149.0	547.2	7639.9	20.6	195.1	-0.1	59.2	174.8	89.0	Cerro Toledo Rhyolite	Utilized Flake
219	38.4	500.0	7578.7	18.9	196.2	-1.8	57.4	171.1	87.0	Cerro Toledo Rhyolite	Flake frag
297	-9.0	492.8	7922.2	20.3	195.0	-0.3	61.3	171.9	90.6	Cerro Toledo Rhyolite	Modified Angular Shatter
30	181.0	391.4	7763.6	13.6	153.1	1.7	41.8	161.2	49.7	Valles Rhyolite	Biface
345	-91.3	497.1	7645.6	19.9	188.7	-1.0	59.4	171.5	90.0	Cerro Toledo Rhyolite	Angular Shatter
379	6.4	524.6	7600.5	19.5	188.5	-1.5	58.0	167.5	84.1	Cerro Toledo Rhyolite	Modified Angular Shatter
39	340.4	429.9	7666.0	16.9	153.6	3.3	40.9	166.5	51.1	Valles Rhyolite	Bipolar Core
4	69.4	525.8	7967.3	21.1	195.4	-0.6	60.5	178.4	89.9	Cerro Toledo Rhyolite	Projectile Point
42	357.7	424.9	7615.5	12.8	150.2	1.9	41.6	161.9	49.6	Valles Rhyolite	Biface
497	-38.5	550.5	9114.6	19.9	217.0	-1.6	58.3	177.4	86.3	Cerro Toledo Rhyolite	Flake Broken
50-1000A-1	3.9	489.9	7701.4	21.2	193.5	-0.5	58.5	175.5	88.1	Cerro Toledo Rhyolite	Flake Complete
50-1000A-2	-0.5	523.2	8592.7	21.1	207.1	-0.6	60.3	177.7	87.7	Cerro Toledo Rhyolite	Flake Complete
51-258	434.0	402.2	8040.4	17.6	154.2	3.1	41.1	168.2	52.3	Valles Rhyolite	Biface Frag
52-143	-115.4	505.5	8244.1	21.4	199.7	-2.0	58.8	172.3	90.5	Cerro Toledo Rhyolite	Flake frag
52-183	-31.6	374.9	8055.0	11.5	149.5	1.1	38.6	157.3	44.2	Valles Rhyolite	Biface

Field Spec#	Ti	Mn	Fe	Th	Rb	Sr	Y	Zr	Nb	Source	Artifact Type
64-5	29.4	445.8	7447.6	18.1	190.1	-0.7	55.8	169.1	84.7	Cerro Toledo Rhyolite	Angular Shatter
64-B4-4	387.7	400.4	7357.4	14.5	150.2	3.0	43.4	165.4	52.4	Valles Rhyolite	Utilized Angular Shatter
88	97.9	509.0	7862.7	19.2	193.8	-1.6	60.4	172.0	87.9	Cerro Toledo Rhyolite	Flake Complete
90-4a	-139.2	593.3	8590.1	22.5	207.3	-1.8	57.7	175.6	86.8	Cerro Toledo Rhyolite	Flake Broken
99-3a	312.7	497.5	7401.2	18.5	188.8	-0.6	60.2	174.5	89.4	Cerro Toledo Rhyolite	Angular Shatter
AY2A-16	141.7	505.9	7492.4	19.4	191.8	-0.7	56.4	171.4	89.5	Cerro Toledo Rhyolite	Flake Broken
B15-Unk	-273.6	428.9	4773.3	16.5	160.7	0.6	20.6	77.2	40.2	El Rechuelos Rhyolite	Flake Broken
B48-161	164.8	499.0	7309.6	21.1	187.8	0.0	58.7	171.0	86.7	Cerro Toledo Rhyolite	Flake Broken
B91-13-14-1	-44.0	553.9	7842.2	22.3	194.8	-1.5	58.4	171.3	85.4	Cerro Toledo Rhyolite	Angular Shatter
B91-13-14-2	-268.4	596.8	9320.7	17.5	200.8	-1.2	54.9	161.6	79.7	Cerro Toledo Rhyolite	Flake frag
B91-7-4	-48.0	397.9	8668.3	15.3	161.9	1.4	39.6	161.6	47.4	Valles Rhyolite	Flake frag
F-0-1990	220.3	503.7	7218.7	19.8	184.8	-0.8	57.3	167.3	87.6	Cerro Toledo Rhyolite	Bipolar Core
F-64-1990	350.8	511.0	7609.0	21.1	191.5	-0.7	59.0	176.7	87.7	Cerro Toledo Rhyolite	Modified Flake
T-0	321.7	370.4	7470.4	15.6	148.3	2.6	41.8	167.8	50.6	Valles Rhyolite	Flake frag
TP-3	84.4	500.7	7310.6	18.9	189.0	-1.0	58.7	163.6	89.1	Cerro Toledo Rhyolite	Modified Flake

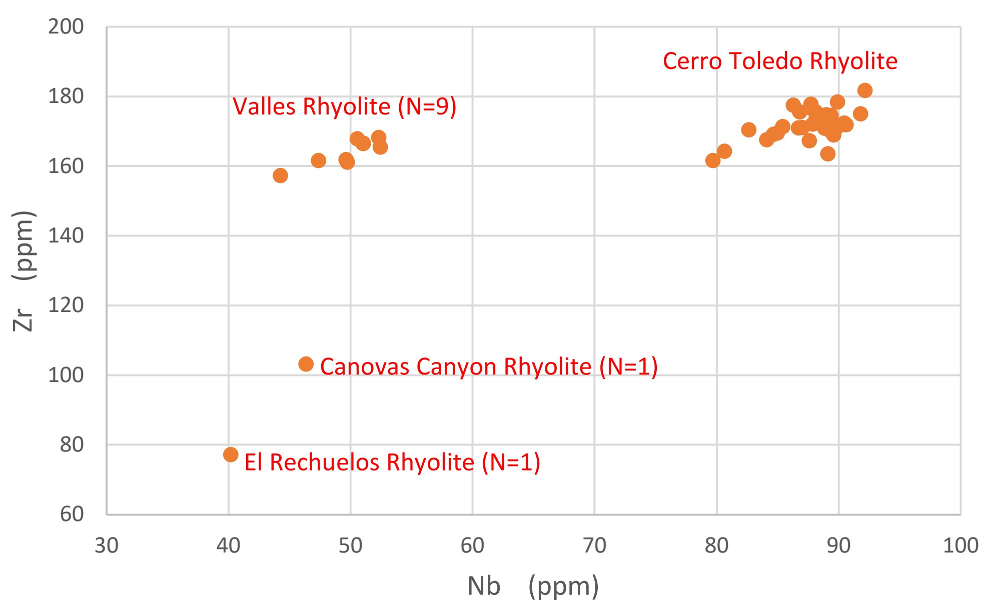
[1]All geochemical data reported in parts per million (ppm). Nondestructive X-ray fluorescence (XRF) was conducted on a Bruker AXS Tracer III-V portable instrument to source obsidian artifacts recovered from LA 20,000. This instrument uses an X-ray tube with a rhodium target and was operated at 40 kV, with a 180-second count time and a secondary target consisting of 6 mm copper (Cu), 1 mm titanium, and 12 mm aluminum (Al). The calibration samples included a suite of 40 well-known obsidian sources with data from previous MURR XRF and neutron activation analysis (NAA) measurements. The trace elements titanium (Ti), manganese (Mn), iron (Fe), thorium (Th), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb) were measured and converted to concentration estimates that were then converted in table form in parts per million (ppm). The proportions of Fe, Rb, Sr, Y, Zr, and Nb are commonly used to discriminate individual obsidian source groups using bivariate plots to separate the sources visually. The most precise discrimination among obsidian geochemical sources was achieved through biplots of Sr to Y and Nb to Zr (see below).

Note: Dr. Bruce Kaiser (Chief Scientist, Bruker) calibrated the obsidian reference set readings taken on the Bruker AXS Tracer III-V portable instrument used in this analysis. He also verified my analysis and calculation conversions for the analyzed samples.

Bivariate plot of strontium (Sr) and yttrium (Y) parts-per-million (ppm) values for the four geochemical groups assigned to LA 20,000 obsidian sourcing samples.



Bivariate plot of niobium (Nb) and zirconium (Zr) parts-per-million (ppm) values for the four geochemical groups assigned to LA 20,000 obsidian sourcing samples.



APPENDIX F: SUPPLEMENTARY SPATIAL ANALYSIS

ArcGIS 10 was used to analyze the distribution of flaked stone artifacts at LA 20,000 in order to identify any location(s) of lithic related activities carried out at the site by the people who lived there. An artifact distribution map showing total flaked stone artifacts per excavation unit area from all analytical units of the main site area (Chapter 6, Figure 14) suggests that the site as a whole does not display any high-density concentrations of flaked stone artifacts indicating it unlikely that any large-scale knapping events took place on-site. A nearest neighbor raster map displaying flaked stone artifact density interpolation shows the lithic density distribution even more clearly (Figure F1). To further investigate potential in situ period flaked stone activity areas, additional spatial analyses were conducted (e.g., normalized artifact distributions, spatial autocorrelation, and cluster analyses). Maps depicting spatial autocorrelations and cluster analyses of flaked stone artifacts normalized by ceramics were also produced.

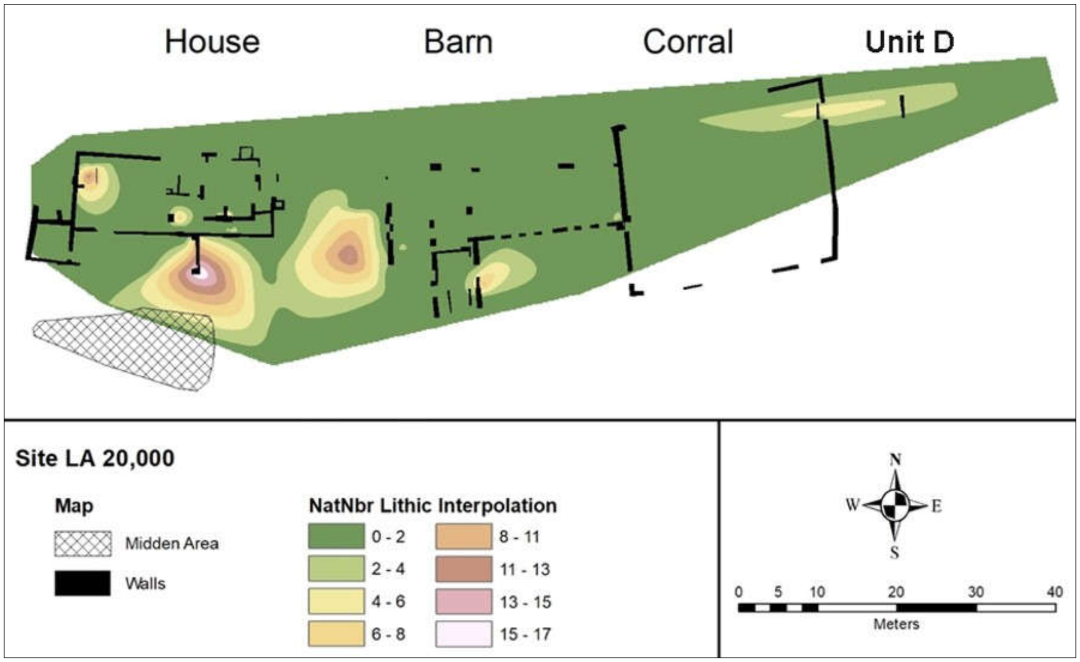


Figure F1. Flaked Stone Artifact Density Interpolation.

To see how the flaked stone artifact distribution compared to the overall artifact distribution pattern of the site flaked stone artifacts were normalized by ceramics (the most ubiquitous artifacts on site) and mapped (Figure F2). Normalizing flaked stone artifacts by ceramics on an excavation unit by excavation unit basis should help in understanding how flaked stone artifacts are patterned across the site, as well as how that pattern compares to another kind of material in the assemblage. This information has the potential to help distinguish spaces or activities within the site area. By comparing these type of artifacts and their spatial patterning, it may be possible to distinguish which areas of the site likely contain randomly generated deposits (e.g., artifacts scattered arbitrarily over the site as a result of post-occupation disturbance/site formation processes) versus those which do not (e.g., non-random clusters that might indicate in situ period activity areas).

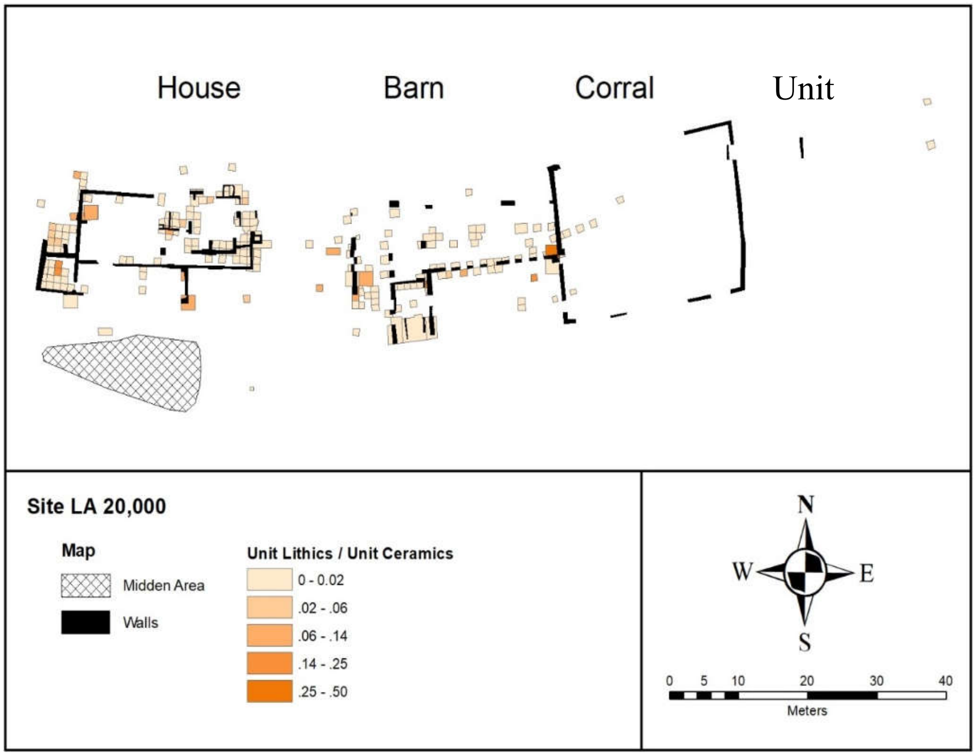


Figure F2. Flaked Stone Artifacts Normalized by Ceramics.

A visual comparison of Figure 14 (Chapter 6) and F2 seems to indicate that the spatial patterning of the two maps match up fairly well suggesting that higher density flaked stone artifact areas may be non-random clusters signifying in situ period activity areas. To statistically test the relationship and deviations from the expected relationship of flaked stone artifacts and ceramics an Ordinary Least Squares (OLS) Regression Analysis was conducted. OLS is used to determine how much the actual counts of flaked stone artifacts and ceramics in each unit deviates from expected values and presents the results in the form of a new shapefile and output report.

Based on the distribution of the standardized residuals of the newly generated shapefile, spatial patterning to the residuals appears to exist (i.e., excavation units with unexpectedly high or low amounts of flaked stone artifacts relative to ceramics appear to cluster together). The OLS output report revealed a probability-value < .01 associated with the regression analysis indicating statistical significance, but a R^2 value of 0.086 which indicates that ceramic distribution was not explanatory of the flaked stone artifact distribution. As an assumed measure of general background deposition ceramic distribution does not explain the flaked stone artifact distribution at the site; it accounts for less than 9% of the explanation. Flaked stone artifacts and ceramics do not, on average, covary across the site. This suggests that the site formation process driving the distribution of ceramics (possibly the result of in situ breakage, clean up, and redistribution into common areas of secondary refuse scattering) is not the same as that generating the depositional pattern of flaked stone artifacts. Flaked stone artifacts and ceramics are not being deposited on the site at the same time or through the same process (e.g., secondary refuse acquisition and redeposition from other site locations).

An OLS Standard Residual Scatterplot of flaked stone artifacts and ceramics (Figure F3) reveals that the divergence between the variables (the standard residual) and the expected value diverge in two directions on either side of the regression line heteroscedasticity. A regression line running roughly through the middle of the points north of the regression line and another regression line running through the points south of the regression line, taken together, do a better job of capturing the distribution of the variables than does the single OLS regression line. This likely indicates that something(s) unrelated to ceramic distribution is responsible for the flaked stone distribution at the site and helps explain the low R^2 value.

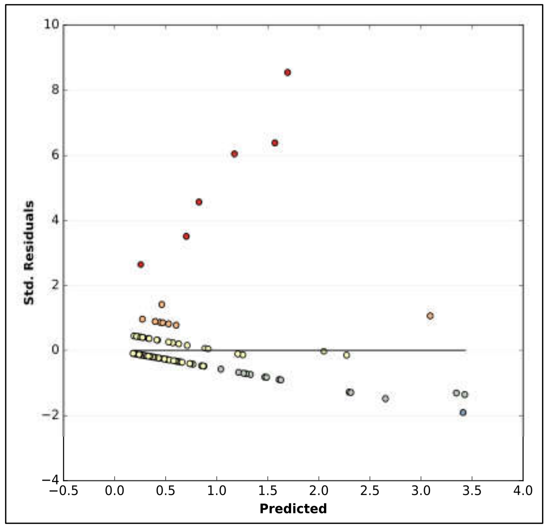


Figure F3. OLS Standard Residual Scatterplot of Flaked Stone Artifacts and Ceramics.

To statistically test the observed spatial patterning to the residuals of the flaked stone artifacts and ceramics across the site, a global spatial autocorrelation test - the Global Moran's I - was performed. This test evaluates whether an observed pattern is clustered, dispersed, or random and generates a z-score and p-value to gage significance (high or low z-scores indicate statistically significant clustering or dispersion, respectively). Global Moran's I revealed a z-score of 1.13 and a p-value of 0.257 indicating that there is not significant clustering of the data on a site-wide scale.

Because Global Moran's I analysis only reveals if there is or is not significant clustering of the data on a site-wide scale, but not specifically where any clustering occurs, two other tests of spatial autocorrelation were performed. To determine the location(s) of any statistically significant clusters of high flaked stone artifact counts Cluster-Outlier Analysis (Anselin Local Moran's I) and Hot-Spot Analysis (Getis-Ord Gi) were utilized to identify where high and low values (or anomalously high or low values relative to their immediate surroundings) of the residuals from the regression analysis of the flaked stone and ceramics were located on the site at a more localized scale. (Note: when calculating local mean Anselin Local Moran's I does not include the observation point as the local mean is calculated, only the neighboring values; Getis-Ord Gi includes the observation along with its neighbors as the local mean is calculated). Since Anselin Local Moran's I and Getis-Ord Gi statistics are derived based on a local neighborhood of values, the technique chosen to define each area of the local neighborhood impacts the outcome of the tests (distance and neighboring values matter).

To conceptualize spatial relationships, Inverse_Distance was selected to represent how neighboring values contribute to the local mean. This results in closer observations being more heavily weighted than distant observations. The Distance Method utilized was Euclidean, or "as the crow flies." Considering the relatively low number of flaked stone artifacts and the broad expanse of the site, how flaked stone artifacts are differentially distributed between specific Analytical Unit areas (e.g., the House, Barn, and Corral) and how flaked stone artifacts are differently distributed within a specific activity area (e.g., the house, barn, corral) was investigated to understand where lithic activities did and did not take place and the type(s) of lithic activities that occurred at these locations. The results of Cluster-Outlier and Hot-Spot analyses indicate that clustered distributions of the residuals do occur on a more localized scale, especially relative to the House area, as well as the area located between the House area and Barn area (F4 and F5, respectively).

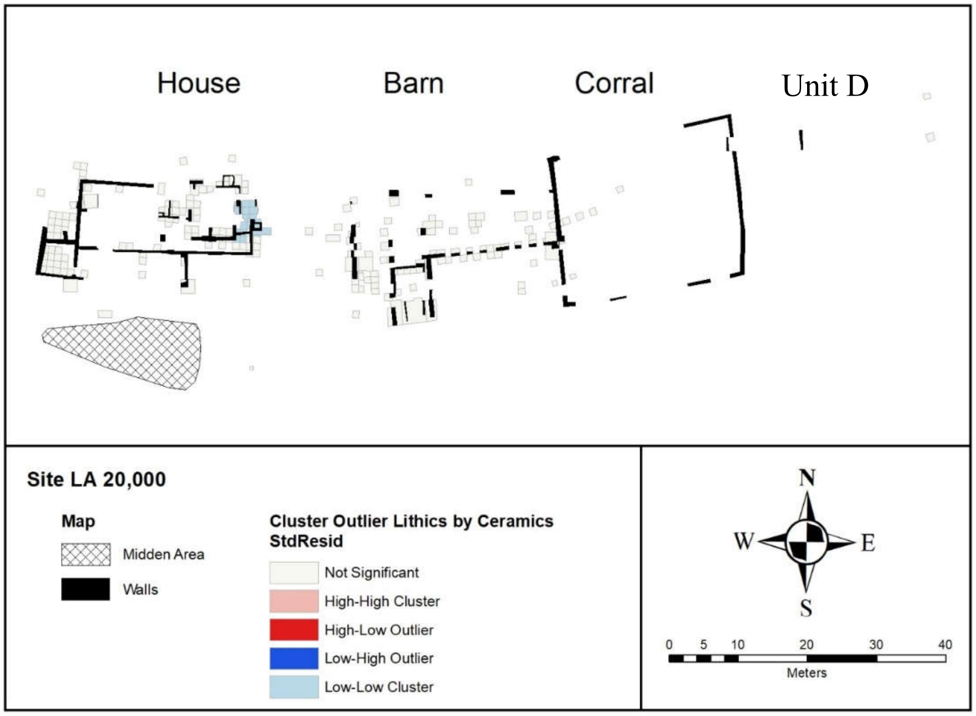


Figure F4. Results of StdResid Cluster-Outlier Analysis.

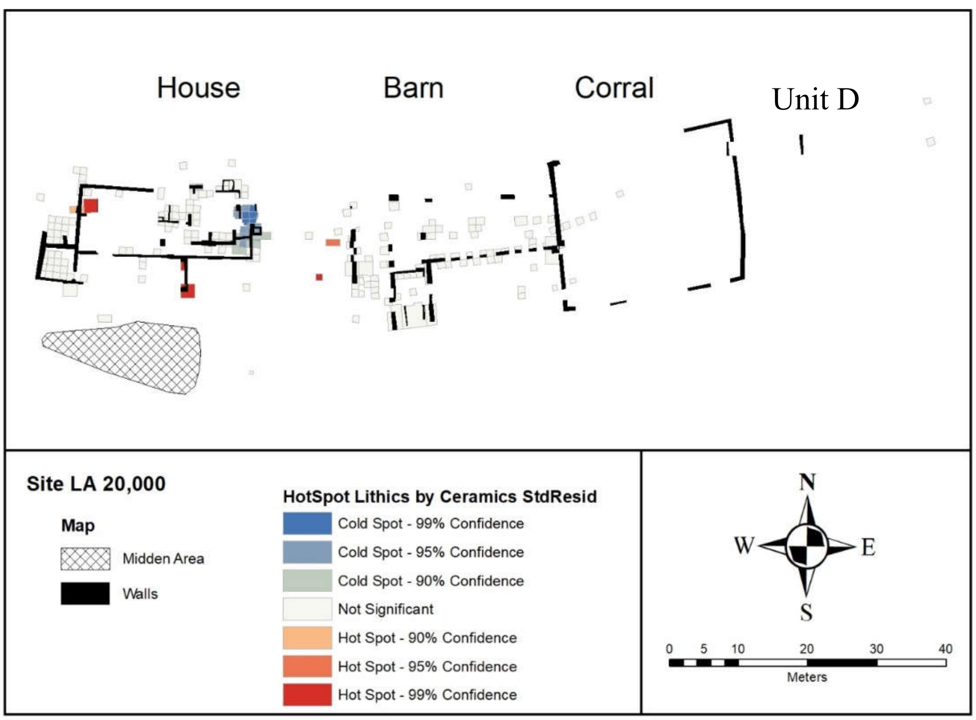


Figure F5. Results of StdResid Hot-Spot Analysis.

Attempting to improve the overall explanatory power (R^2) of the regression analysis, additional explanatory variables (e.g., by "Excavator" – excavations associated with Snow and Stoller vs. those associated with Trigg) were analyzed in hopes of identifying other underlying factors that may be affecting the flaked stone artifact distributions not controlled for by ceramics. Subsequent OLS analyses for flaked stone artifacts by "Excavator" ($p < .01$, $R^2 = .37$), as well as ceramics by "Excavator" ($p < .01$, $R^2 = .03$), indicate that the recovery of flaked stone artifacts was affected by "Excavator", but ceramics were not. This suggests that who was conducting archaeological investigations/excavations had a major impact on the recovery of flaked stone artifacts.

Looking at the distribution patterns of flake stone artifacts in Figure 14 (Chapter 6) and Figure F5 reveals that later excavations associated with Trigg are where clustered distributions occur. Later excavations tended to recover higher densities of flaked stone artifacts than earlier excavations. "Excavator" is much more explanatory (37%) than the relationship between flaked stone artifacts and the assumed measure of general background deposition, ceramics (9%). There are several possible reasons for this apparent excavator "bias" toward flaked stone artifacts. These may relate to archaeological assumptions, excavation methods, collection methods, and even excavator experience. For example, when flaked stone artifacts have been found at Spanish colonial sites in New Mexico, they have generally been attributed to either contamination from earlier occupations or to reoccupation of the site by historical Native Americans (Moore 1992:239). Such an assumption may have affected how/if flaked stone artifacts were collected during early excavations conducted at LA 20,000, resulting in the reduced collection (either implicitly or explicitly) of flaked stone artifacts as compared to later excavations. Related to this, as a historical site, early excavators simply may not have been consciously looking for flaked stone artifacts; assuming, incorrectly, that such artifacts would not and should not be found at a historical site.

Concerning excavation methods, early excavations at the site tended to focus on architectural elements ("chasing walls"), while later excavations were not only focused on ground-truthing earlier architectural excavation results, but also understanding the use of and relationship between "inside" and "outside" spaces. As a result, early excavations, in general, tended to be shallower and consist of greater amounts of architectural elements (e.g., stone and/or adobe walls), while later excavations tended to be deeper and consist of less architectural elements; excavations being located within or outside of the walled spaces (Snow 1994; Trigg 2017). This difference in excavation methods could have resulted in the differential collection of flaked stone artifacts since later excavations tended to be more concerned with use-space while earlier excavations tended to focus on architectural space.

Also, post-depositional processes such as bioturbation (e.g., root action and animal burrowing), expansion and contraction of clays (e.g., desiccation cracks), aeolian deposition and deflation, sheet-wash, cryoturbation (i.e., freeze-thaw), and even trampling (human and animal) can cause flaked stone artifacts to become sorted by size with smaller artifacts often buried or moved downwards, but larger ones remaining near the surface or being uplifted through such post-depositional processes (Rapp and Hill 1998:81-85). As a result, later deeper excavations would likely result in the recovery of more and smaller artifacts, while earlier shallower excavations would result in the recovery of mostly larger artifacts.

In terms of collection methods, flaked stone artifacts were recovered from similar surface and excavation contexts located across the site (i.e., household, barn, and midden) during both earlier and later archaeological investigations. However, early excavations used 1/4-inch mesh screen exclusively, while later excavations utilized both 1/8-inch and 1/4-inch mesh screen, as well as conducted flotation/heavy fraction recovery (Snow 1994; Trigg 2017). This means that artifacts smaller than 6 mm were much less likely to be recovered during earlier excavations as compared to later excavations. (Note: Debitage attribute analysis indicates that this did not likely impact conclusions or interpretations reached concerning flaked stone reduction, production, and use at the site. Small debitage is produced during all stages of reduction/production and, as a stand-alone metric, is not reflective of any one form or stage of reduction (Andrefsky 2004:127)).

Excavator experience can also influence “bias” toward the recognition and collection of artifacts. For example, lithics that are facially flaked and have distinct forms (e.g., projectile points) are more easily recognized than smaller amorphous debitage. Familiarity with local and regional lithic materials can also affect the recognition of flaked stone artifacts. Obsidian is easily recognized due to its unique characteristics, while limestone or basalt may not be so easily identified as debitage. Finally, inexperienced excavators who are focusing on recovering historical artifacts (e.g., ceramics) may have a propensity to overlook lithic artifacts. With this idea of excavator experience in mind, it may be relevant that early site excavations were carried out by undergraduate students who may or may not have been focusing on archaeology as a career, while later excavations were conducted by archaeological graduate students who likely had classes in method and theory, as well as previous excavation experience.

By conducting these spatial analyses (artifact distributions, autocorrelations, and cluster analysis), it was hoped that areas of the site likely to contain non-random clusters that might indicate in situ period activity areas would be identified. Unfortunately, due in part to at least some excavator bias and other as yet unidentified explanatory variables, more excavation appears to be needed in areas showing flaked stone artifact clustering to better understand what is going on in and around those areas before such locations can be confidently identified as discrete areas of activity.

Appendix F: Tables

Table F1. Flaked Stone Tools by Analytical Unit.

AU	Biface	Core	Expedient Tool	Projectile Point	Strike-A-Light Flint	Gunflints	Drill	Indeterminate
House	*BF-5 *BF-6 +BF-7	Core-1 Core-4 Core-6 *Core-7	FST-1 FST-4 FST-6 FST-7 FST-8 +FST-14 *FST-15 *FST-17 FST-18 *FST-19 +FST-23 *FST-24 FST-25 *FST-29 *FST-32	+PP-2	SALF-1 +SALF-5 SALF-6	-	-	FST-31
Barn	*BF-1	Core-3	FST-2 FST-3 FST-5 FST-26	-	-	-	-	-
Corral	-	-	*FST-20	-	-	-	-	-
Unit D	-	Core-5 Core-11	FST-27 *FST-28	-	SALF-8	-	-	-
Midden	BF-2 *BF-3 *BF-4	*Core-2 Core-8 *Core-9 *Core-10	FST-9 FST-10 FST-11 FST-12 FST-13 *FST-16 *FST-21 FST-22 FST-30 Uniface-1	*PP-1 *PP-3 #PP-4	SALF-2 +SALF-3 SALF-4 SALF-7	Gunflint-1 Gunflint-2 Gunflint-3 Gunflint-4 Gunflint-5 Gunflint-6 +Gunflint-7 Gunflint-8 Gunflint-9	*Drill-1	-

* = Obsidian
+ = Pedernal chert
# = Nonlocal chert

REFERENCES

Ahler, Stanley A.
1989 Mass Analysis of Flaking Debris: Studying the Forest Rather than the Trees. In *Alternative Approaches to Lithic Analysis*, edited by D. Henry and G. Odell, pp. 85-118. Archeological Papers of the American Anthropological Association No. 1.

Akins, Nancy J.
2001 *Valencia: A Spanish Colonial and Mexican Period Site Along NM 47 in Valencia County, New Mexico., Archaeology Notes 267*. Office of Archaeological Studies, Museum of New Mexico. Santa Fe.

Amick, Daniel S.
2007 Investigating the Behavioral Causes and Archaeological Effects of Lithic Recycling. In *Tools versus Cores: Alternative Approaches to Stone Tool Analysis*, edited by Shannon P. McPherron, pp. 223–252. Cambridge Scholars Publishing, Newcastle.

Amick, Daniel S. and Raymond P. Mauldin
1997 Effects of Raw Material on Flake Breakage Patterns. *Lithic Technology* 22(1):18- 32.

Andrefsky, William A. ed.
1994 Raw-Material Availability and the Organization of Technology. *American Antiquity* 59:21-34.
2001 Emerging directions in debitage analysis. In *Lithic Debitage: Context, Form, Meaning*, edited by William Andrefsky, Jr., pp. 2–14. University of Utah Press, Salt Lake City.
2004 *Lithics: Macroscopic Approaches to Analysis*. Cambridge University Press, Cambridge.
2008 Projectile Point Provisioning Strategies and Human Land Use. In *Lithic Technology: Measures of Production, Use, and Curation*, edited by William Andrefsky, Jr., pp. 195-215. Cambridge University Press, Cambridge.
2009 The Analysis of Stone Tool Procurement, Production and Maintenance. *Journal of Archaeological Research* 17:65-103.

Arakawa, Fumiyasu
2013 Gendered Analysis of Lithics from the Central Mesa Verde Region. *Kiva* 78(3):279-312.

Bakker, Keith
1999 New Mexican Spanish Colonial Furniture. In *El Camino Real de Tierra Adentro*, Vol. 2, comp. Gabrielle G. Palmer and Stephen L. Fosberg, pp. 117-132. Bureau of Land Management, New Mexico State Office, Santa Fe.

Bamforth, Douglas B.
1986 Technological Efficiency and Tool Curation. *American Antiquity* 51(1):38-50.

Barrett, Elinore M.
2012 *The Spanish Colonial Settlement Landscapes of New Mexico, 1598-1680*. University of New Mexico Press, Albuquerque.

Baugh, Timothy G. and Fred W. Nelson, Jr.
1987 New Mexico Obsidian Sources and Exchange on the Southern Plains. *Journal of Field Archaeology* 14:313-329

Broadbent, Noel D. and Kjel Knutsson
1975 An Experimental Analysis of Quartz Scrapers. Results and Applications. *Fornvännen* 70:113–128.

Brown, Gary M. and Patricia M. Hancock
1992 The Dinetah Phase in the La Plata Valley. In *Cultural Diversity and Adaptation: The Archaic, Anasazi, and Navajo occupation of the Upper San Juan Basin*, edited by L.S. Reed and P.F. Reed, pp. 69-90. Cultural Resources Series No. 9. Bureau of Land Management and New Mexico State Land office, Santa Fe.

Brown, Tracy L.
2013 *Pueblo Indians and Spanish Colonial Authority in Eighteenth-Century New Mexico.* University of Arizona Press, Tucson.

Bussey, Stanley D., and Kenneth Honea
1971 LA 34: The Cochiti Springs Site. In *Excavations at Cochiti Dam, New Mexico, 1964-1966 Seasons, Volume 1: LA 272, LA 9154, LA 34*, edited by D. Snow. Laboratory of Anthropology Notes No. 79. Museum of New Mexico, Santa Fe.

Callahan, Erret
1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition: A Manuel for Flintknappers and Lithic Analysts. *Archaeology of North America* 7:1-180.

Cantwell, Anne-Marie
1979 The Functional Analysis of Scrapers: Problems, New Techniques and Cautions. *Lithic Technology* 8(1):5-9.

Cassell, Mark S.
2003 *Flint and Foxes*: *Chert Scrapers* and the Fur Industry in Late-Nineteenth- and Early Twentieth-Century North Alaska. In *Stone Tool Traditions in the Contact Era*, edited by Charles R. Cobb, pp. 151-164. University of Alabama Press, Tuscaloosa.

Chapman, Richard C., Jan V. Biella, Jeanne A. Schutt, James G. Enloe, Patricia J. Marciando, A. H. Warren, and John R. Stein
1977 Description of Twenty-Seven Sites in the Permanent Pool of Cochiti Reservoir. In *Archeological Investigations in Cochiti Reservoir, New Mexico* (Vol. 2), edited by R. Chapman and J. Biella, pp. 119-359. Office of Contract Archeology, University of New Mexico, Albuquerque.

Church, Tim
2000 Distribution and Sources of Obsidian in Rio Grande Gravels of New Mexico. *Geoarchaeology* 15(7):649–678.

Cobb, Charles R., ed.
2003 *Stone Tool Traditions in the Contact Era*. University of Alabama Press, Tuscaloosa.

Collins, Michael B.
1993 Comprehensive Lithic Studies: Context, Technology, Style, Attrition, Breakage, Use-Wear and Organic Residues. *Lithic Technology* 18(1/2):87-94.

Compton, Anne M.
2017 Lithic Technology at Pueblo San Marcos. In *The Archaeology and History of Pueblo San Marcos Change and Stability*, edited by Ann F. Ramenofsky and Kari L. Schleher, pp. 129-154. University of New Mexico Press, Albuquerque.

Cotterell, Brian and Johan Kamminga
1987 The Formation of Flakes. *American Antiquity* 52(4):675-708.
1992 *Mechanics of Pre-Industrial Technology: An Introduction to the Mechanics of Ancient and Traditional Material Culture*. Cambridge University Press, Cambridge.

Crown, L. Patricia, ed.
2000 *Women and Men in the Prehispanic Southwest: Labor, Power, and Prestige*. School for Advanced Research Press, Santa Fe.

Curtis, F.S. Jr.
1927 Spanish Arms and Armor in the Southwest. *New Mexico Historical Review* 2(2):107-133.

Deagan, Kathleen
1996 Colonial transformation: Euro-American cultural genesis in the early Spanish-American colonies. *Journal of Anthropological Research* 52(2):135-160.
2003 Colonial Origins and Colonial Transformations in Spanish America. *Historical Archaeology* 37(4):3-13.

Dibble, Harold L.
1997 Platform Variability and Flake Morphology: A Comparison of Experimental and Archaeological Data and Implications for Interpreting Prehistoric Lithic Technological Studies. *Lithic Technology* 22:150-170.

Dobres, Marcia-Anne and Christopher Hoffman
1994 Social Agency and the Dynamics of Prehistoric Technology. *Journal of Archaeological Method and Theory* 1(3):211-258.

Dockall, John E.
1997 Wear Traces and Projectile Impact: A Review of the Experimental and Archaeological Evidence. *Journal of Field Archaeology* 24:321-331.

Durst, Jeffrey J.
2009 Sourcing Gunflints to Their Country of Manufacture. *Historical Archaeology* 43(2):18-29.

Eiselt, Bernice Sunday
2006 *The Emergence of Jicarilla Apache Enclave Economy During the 19^th^ Century in Northern New Mexico*. Ph.D. dissertation, University of Michigan.

Ferg, Alan
1982 *Historic Archaeology on the San Antonio de Las Huertas Grant, Sandoval County, New Mexico*. Woodward-Clyde Consultants, San Francisco.

Frison, George C.
1968 A Functional Analysis of Certain Chipped Stone Tools. *American Antiquity* 33:149-155.

Frison, George C. and Bruce A. Bradley
1980 *Folsom Tools and Technology at the Hanson Site, Wyoming.* University of New Mexico Press, Albuquerque.

Gero, Joan M.
1991 Genderlithics: Women's Roles in Stone Tool Production. In *Engendering Archaeology*, edited by Joan M. Gero and Margaret W. Conkey, pp. 163–193. Basil Blackwell, Oxford.

Glascock, Michael D., Raymond Kunselman, and Daniel Wolfman
1999 Intrasource Chemical Differentiation of Obsidian in the Jemez Mountains and Taos Plateau, New Mexico. *Journal of Archaeological Science* 26:861–868.

Goodyear, Albert
1979 *A Hypothesis for the Use of Cryptocrystalline Raw Materials among Paleo-Indian Groups of North America*. Research Manuscript Series, 156, Institute of Archeology and Anthropology, University of South Carolina, Columbia.
1993 Toolkit Entropy and Bipolar Reduction: A Study of Interassemblage Lithic Variability Among Paleo-Indian Sites in the Northeastern United States. *North American Archaeologist*, 14(1):1-23.

Grace, Roger
1990 The Limitations and Applications of Use Wear Analysis. Proceedings of the International Conference on Lithic Use-Wear Analysis. *AUN* 14:9-14.
2012 *Interpreting the Function of Stone Tools*. Ikarus Books.

Grace, Roger, K. Ataman, R. Fabregas, and C. M. B. Haggren
1988 A Multivariate Approach to the Functional Analysis of Stone Tools. In *Industries lithiques, vol. 2: Aspects me´thodologiques*, edited by Sylvie Beyries, pp. 217–30, BAR International Series 411 (ii). BAR, Oxford.

Gunnerson, James H.
1960 *An Introduction to Plains Apache Archaeology: The Dismal River Aspect. Anthropological Papers, Vol. 58*. Smithsonian Institution, Bureau of American Ethnology, Washington, D.C.
1969 Apache Archaeology in Northeastern New Mexico. *American Antiquity* 34(1):167-189.

Gutiérrez, Ramón A.
1991 *When Jesus Came, the Corn Mothers Went Away: Marriage, Sexuality, and Power in New Mexico, 1500-1846*. Stanford University Press, Stanford.

Hackett, Charles
1937 *Historical Documents Relating to New Mexico, Nueva Vizcaya, and Approaches Thereto, to 1773*. The Lord Baltimore Press, Baltimore.

Hale, Kenneth and David Harris
1979 Historical Linguistics and Archaeology. In *Handbook of North American Indians: Southwest*, edited by Alfonso Ortiz, pp. 170-177. Smithsonian Institution, Washington, DC.

Hardy, Bruce
2009 Understanding Stone Tool Function: Methods and Examples from the Aurignacian Levels at Hohle Fels. *Mitteilungen der Gesellschaft für Urgeschichte* 18:109–121.

Hardy, Bruce L., and Gary T. Garufi
1998 Identification of Woodworking on Stone Tools Through Residue and Use-wear Analysis: Experimental Results. *Journal of Archaeological Science* 25:177–84.

Harper, Cheryl and William Andrefsky, Jr.
2008 Exploring the Dart and Arrow Dilemma: Retouch Indices as Functional Determinants. In *Lithic Technology: Measures of Production, Use, and Curation*, edited by William Andrefsky, Jr., pp. 175-191. Cambridge University Press, Cambridge.

Hughes, Richard E.
1988 Archaeological Significance of Geochemical Contrasts among Southwestern New Mexico Obsidians. *Texas Journal of Science* 40(3):297–307.
2019 Geochemical Research Laboratory Letter Report 2002-20 to Ann Ramenofsky. In *Archaeological Studies at Comanche Springs and Metzler Ruin Valencia County, New Mexico: An Overview*, by Lucy C. Schuyler, Appendix B, pp. 62-72. Maxwell Museum of Anthropology, Technical Series No. 32. University of New Mexico, Albuquerque.

Jenks, Kelly L.
2017 Becoming Vecinos: Civic Identities in Late Colonial New Mexico. In *New Mexico and the Pimería Alta: The Colonial Period in the American Southwest*, edited by John G. Douglass and William M. Graves, pp. 213–238. University of Colorado Press, Boulder.

Jennings, Thomas A.
2011 Experimental production of bending and radial flake fractures and implications for lithic technologies. *Journal of Archaeological Science* 38(12):3644-3651.

Jeske, Robert J. and Rochelle Lurie
1993 Archaeological Visibility of Bipolar Technology: An Example from the Koster Site. *Midcontinental Journal of Archaeology* 18(2):131-160.

Johnson, Peggy S., Daniel J. Koning, and Stacy S. Timmons
2015 *A Hydrogeologic Investigation of Groundwater-Fed Springs and Wetlands at La Cienega, Santa Fe County, New Mexico*. New Mexico Bureau of Geology and Mineral Resources Aquifer Mapping Program, Open File Report 569.

Justice, Noel D.
2002 *Stone Age Spear and Arrow Points of the Southwestern United States*. Indiana University Press, Bloomington.

Kamminga, Johan
1982 *Over the Edge: Functional Analysis of Australian Stone Tools*. Occasional Papers in Anthropology 12. Anthropology Museum, University of Queensland, Australia.

Keeley, Lawrence H.
1980 *Experimental Determination of Stone Tool Uses: A Microwear Analysis*. University of Chicago Press, Chicago.

Keeley, Lawrence H. and Mark H. Newcomer
1977 Microwear Analysis of Experimental Flint Tools: A Test Case. *Journal of Archaeological Science* 4:29-62

Kelley, Edmund N.
1980 *The Contemporary Ecology of Arroyo Hondo*, *New Mexico*. *Arroyo Hondo Archaeological* Series, vol. 1. School of American Research Press, Santa Fe.

Kelly, Robert L.
1988 The Three Sides of a Biface. *American Antiquity* 53:717–34.
2013 *The Lifeways of Hunter-Gatherers: The Foraging Spectrum.* Cambridge University Press, New York.

Kemrer, Meade, and Sandra Kemrer
1979 A Comparative Study of Archaic, Anasazi, and Spanish Colonial Subsistence Activities in Cochiti Reservoir. In *Archeological Investigations in Cochiti Reservoir, New Mexico* (Vol. 4), edited by J. Biella, pp. 269-282. Office of Contract Archeology, University of New Mexico, Albuquerque.

Kenmotsu, Nancy
1990 Gunflints: A Study. *Society for Historical Archaeology* 24(2):92-124.

Kent, Barry C.
1983 More on Gunflints. *Historical Archaeology* 17(2):27-40.

Kessell, John L.
1987 *Kiva, Cross, & Crown: The Pecos Indians and New Mexico, 1540-1840*. Western National Parks Association, Tucson.
1997 Restoring Seventeenth-Century New Mexico, Then and Now. In Diversity and Social Identity in Colonial Spanish America: Native American, African, and Hispanic Communities during the Middle Period. Donna L. Ruhl, Kathleen Hoffman, editors. Thematic Issue. *Historical Archaeology* 31(1):46-54.

Kidder, Alfred V.
1932 *The Artifacts of Pecos*. Yale University Press, New Haven.

Kononenko, Nina
2011 Experimental and Archaeological Studies of Use-Wear and Residues on Obsidian Artefacts from Papua New Guinea. *Technical Reports of the Australian Museum, Online* 21:1–244.

Kooyman, Brian P.
2000 *Understanding Stone Tools and Archaeological Sites*. University of Calgary Press, Calgary.

Kuhn, Steven L.
1995 *Mousterian Lithic Technology: An Ecological Perspective*. Princeton University Press, Princeton.

Kuijt, Ian, William C. Prentiss, and David L. Pokotylo
1995 Bipolar Reduction: An Experimental Study of Debitage Variability. *Lithic Technology* 20:116-127.

Larson, Dorothy L., Kari L. Schleher, Ann F. Ramenofsky, Jonathan E. Van Hoose, and Jennifer Boyd Dyer
2017 Artifacts from San Marcos Pueblo. In *The Archaeology and History of Pueblo San Marcos Change and Stability*, edited by Ann F. Ramenofsky and Kari L. Schleher, pp. 89-105. University of New Mexico Press, Albuquerque.

Lerner, Harry J.
2007 Digital Image Analysis and Use-Wear Accrual as a Function of Raw Material: An Example from Northwestern New Mexico. *Lithic Technology* 32(1):51-67.

Lerner, Harry, Xiangdong Du, Andre Costopoulos, and Martin Ostaja-Starzewski
2007 Lithic Raw Material Physical Properties and Use-Wear Accrual. *Journal of Archaeological Science* 34:711–722.

Levine, Frances E.
1992 Hispanic Household Structure in Colonial New Mexico. In *Current Research on the Late Prehistory and Early History of New Mexico*, edited by B. Vierra, pp. 195-206. New Mexico Archaeological Council Special Publication No. 1, Albuquerque.
1999 What Is the Significance of a road? In In *El Camino Real de Tierra Adentro*, Vol. 2, comp. Gabrielle G. Palmer and Stephen L. Fosberg, pp. 1-14. Bureau of Land Management, New Mexico State Office, Santa Fe.

Levine, Frances E., John C. Acklen, Jack B. Bertram, Stephen C. Lent, and Gale McPherson
1985 *Archeological Excavations at LA16769*. Public Service Company of New Mexico Archeological Report No. 5, Albuquerque.

Liebmann, Matthew
2012 The Rest Is History: Devaluing the Recent Past in the Archaeology of the Pueblo Southwest. In *Decolonizing Indigenous Histories: Exploring Prehistoric/Colonial Transitions in Archaeology*, edited by Maxine Oland, Siobhan M. Hart, and Liam Frink, pp. 19-44. University of Arizona Press, Tucson.
2017 From Landscapes of Meaning to Landscapes of Signification in the American Southwest. *American Antiquity* 82(4):642-661.

Lightfoot, Kent, Antoinett Martinez, and Ann M. Schiff
1998 Daily Practice and Material Culture in Pluralistic Social Settings: An Archaeological Study of Culture Change and Persistence from Fort Ross, California. *American Antiquity* 63:199-222.

Loren, Diana DiPaolo
2007 Corporeal Concerns: Eighteenth-century casta paintings and colonial bodies in Spanish Texas. *Historical Archaeology* 41(1):23-36.

Low, Bruce D.
1997 *Bipolar Technology and Pebble Stone Artifacts: Experimentation in Stone Tool Manufacture*. MA Thesis, Department of Anthropology and Archaeology, University of Saskatchewan, Saskatoon.

Luedtke, Barbara E.
1992 *An Archaeologist's Guide to Chert and Flint. Archaeological Research Tools 7*. Institute of Archaeology, University of California, Los Angeles.

Mauldin, Raymond P. and Daniel S. Amick
1989 Investigating Patterning in Debitage from Experimental Bifacial Core Reduction. In *Experiments in Lithic Technology*, edited by D. S. Amick and R. P. Mauldin, pp. 67-88. BAR International Series 528. BAR, Oxford.

McAnany, Patricia A.
1988 The Effects of Lithic Procurement Strategies on Tool Curation and Recycling. *Lithic Technology* 17(1):3-11.

McDevitt, Kendal B. and Kendall B. McDevitt
1994 Results of Replicative Hide-Working Experiments: The Roles of Raw Material, Hide Condition and Use-Wear Patterns in the Determination of Rhyolite End Scraper Function. *Lithic Technology* 19(2):93-97.

McGuire, Randall H., John Whittaker, Michael McCarthy and Rebecca McSwain
1982 A Consideration of Observational Error in Lithic Use Wear Analysis. *Lithic Technology* 11(3):59-63.

Moore, James L.
1992 Spanish Colonial Stone Tool Use. In *Current Research on the Late Prehistory and Early History of New Mexico*, edited by B. Vierra, pp. 239-244. New Mexico Archaeological Council Special Publication 1, Albuquerque.
2001a Analysis of the Chipped Stone Assemblages. In *Prehistoric and Historic Occupation of Los Alamos and Guaje Canyons: Data Recovery at Three Sites Near the Pueblo of San Ildefonso, Archaeology Notes 244*, edited by J. Moore, pp. 77-128. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.
2001b Analysis of the Chipped Stone Assemblage. In *Valencia: A Spanish Colonial and Mexican Period Site Along NM 47 in Valencia County*, *New Mexico, Archaeology Notes 267*, edited by Nancy J. Akins, pp 61-85. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.
2004 Spanish Chipped Stone Artifacts. In *Adaptations on the Anasazi and Spanish Frontiers: Excavations at Five Sites near Abiquiú, Rio Arriba County, New Mexico, Archaeology Notes 187*, edited by James L. Moore, Jeffery L. Boyer, and Daisy F. Levine, pp. 179-198. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

Moore, James L., Jeffery L. Boyer, and Daisy F. Levine, eds.
2004 *Adaptations on the Anasazi and Spanish Frontiers Excavations at Five Sites near Abiquiú, Rio Arriba County, New Mexico, Archaeology Notes 187*. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

Morrow, Toby A.
1997 A Chip Off the Old Block: Alternative Approaches to Debitage Analysis. *Lithic Technology* 22:51-69.

Nassaney, Michael S. and Michael Volmar
2003 Lithic Artifacts in Seventeeth-Century Native New England. In *Stone Tool Traditions in the Contact Era*, edited by Charles R. Cobb, pp. 78-93. University of Alabama Press, Tuscaloosa.

Newman, Jay R.
1994 The Effects of Distance on Lithic Material Reduction Technology. *Journal of Field Archaeology* 21:491-501.

Odell, George H.
1980 Butchering with Stone Tools: Some Experimental Results. *Lithic Technology* 9(2):39-48.
1989 Experiments in Lithic Reduction. In *Experiments in Lithic Technology*, edited by Daniel S. Amick and Raymond P. Martin, pp. 163-98. BAR International Series 528. BAR, Oxford.

1996 Economizing Behavior and the Concept of "Curation". In *Stone Tools: Theoretical Insights into Human Prehistory*, edited by George H. Odell, pp. 51–80. Plenum Press, New York.
2000 Stone Tool Research at the end of the Millennium: Procurement and Technology. *Journal of Archaeological Research* 8(4):269-331.
2001 Stone Tool Research at the end of the Millennium: Classification, Function and Behavior. *Journal of Archaeological Research* 9(1):45-100.
2004 *Lithic Analysis*. Plenum Publishers, New York.

Odell, George H., and Frieda Odell-Vereecken
1980 Verifying the Reliability of Lithic Use-Wear Assessments by 'Blind Tests': The Low-Power Approach. *Journal of Field Archaeology* 7: 87–120.

Opishinski, Ana C.
2019 *Eat This in Remembrance: The Zooarchaeology of Secular and Religious Sites in Seventeenth-Century New Mexico*. Master's Thesis, Department of Anthropology, University of Massachusetts, Boston.

Ortiz, Alfonso, ed.
1979 *Handbook of North American Indians: Southwest*. Smithsonian Institution, Washington, DC.

Parry, William J., and Robert L. Kelly
1987 Expedient Core Technology and Sedentism. In *The Organization of Core Technology*, edited by Jay K. Johnson and Carrol A. Morrow, pp. 285-304. Westview Press, Boulder.

Patterson, Leland W.
1987 Amorphous Cores and Utilized Flakes: A Commentary. *Lithic Technology* 16(2/3):51-53.

Patterson, Leland W. and J.B. Sollberger
1976 The Myth of Bipolar Flaking Industries. *Newsletter of Lithic Technology.* 5(3):40-42.

Payne, Melissa
2012 Pueblo Potsherds to Silver Spoons: A Case Study in Historical Archaeology from New Mexico. *Historical Archaeology* 46(4):70-84.

Plew, Mark G. and James C. Woods
1985 Observation of Edge Damage and Technological Effects on Pressure-Flaked Stone Tools. In *Stone Tool Analysis: Essays in Honor of Don E. Crabtree*, edited by Mark G. Plew, James C. Woods, and Max Pavesic, pp. 221-227. University of New Mexico Press, Albuquerque.

Prentiss, William

1993 *Hunter-Gatherer Economics and the Formation of a Housepit Floor Lithic Assemblage*. Ph.D. dissertation, Department of Archaeology, Simon Fraser University, Burnaby, B.C.

1998 The Reliability and Validity of a Lithic Debitage Typology: Implications for Archaeological Interpretation. *American Antiquity* 63(4):635-650.

2001 Reliability and Validity of a Distinctive Assemblage Typology: Integrating Flake Size and Completeness. In *Lithic Debitage: Context, Form and Meaning*, edited by William Andrefsky Jr., pp. 147-172. University of Utah Press, Salt Lake City.

Preucel, Robert

2002 Writing the Pueblo Revolt. In *Archaeologies of the Pueblo Revolt: Identity, Meaning, and Renewal in the Pueblo World*, edited by Robert Preucel, pp. 3-29. University of New Mexico Press, Albuquerque.

2010 Becoming Navajo: Refugees, Pueblitos, and Identity in the Dinétah. In *Enduring Conquests: Rethinking the Archaeology of Resistance to Spanish Colonialism in the Americas,* edited by Matthew Liebmann and Melissa S. Murphy, pp. 223-242. School for Advanced Research Press, Santa Fe.

Railey, Jim A.

2010 Reduced Mobility or the Bow and Arrow? Another Look at "Expedient" Technologies and Sedentism. *American Antiquity* 75(2):259-286.

2011 Lithic Debitage. In *Data Recovery Excavation at Seven Sites Along Interstate 25 Sandoval County, New Mexico*, edited by Cherie Walth and Jim Railey, pp. 187-225. New Mexico Department of Transportation, Cultural Resource Technical Series 2011-1. SWCA Environmental Consultants, Albuquerque.

Ramenofsky, Ann F., C. David Vaughan, and Michael Spilde

2008 Seventeenth-Century Metal Production at San Marcos Pueblo. *Historical Archaeology* 42(4):105–131.

Ramenofsky, Ann F. and Kari L. Schleher, eds.

2017a *The Archaeology and History of Pueblo San Marcos Change and Stability.* University of New Mexico Press, Albuquerque.

Ramenofsky, Ann F. and Kari L. Schleher

2017b Introducing San Marcos: A Protohistoric Town in North-Central New Mexico. In *The Archaeology and History of Pueblo San Marcos Change and Stability,* edited by Ann F. Ramenofsky and Kari L. Schleher, pp. 1-8. University of New Mexico Press, Albuquerque.

Ramenofsky, Ann F., Kari L. Schleher, and Ariane O. Pinson
2017a Situating San Marcos: Space, Time, and Tradition. In *The Archaeology and History of Pueblo San Marcos Change and Stability*, edited by Ann F. Ramenofsky and Kari L. Schleher, pp. 9-22. University of New Mexico Press, Albuquerque.

Ramenofsky, Ann F., Anastasia Steffen, Jeffrey R. Ferguson, Philippe D. Letourneau, and Adam Okun
2017b Obsidian Sourcing, Technology, and Hydration Dating. In *The Archaeology and History of Pueblo San Marcos Change and Stability*, edited by Ann F. Ramenofsky and Kari L. Schleher, pp. 155-184. University of New Mexico Press, Albuquerque.

Rapp, George Jr. and Christopher L. Hill
1998 *Geoarchaeology: The Earth-Science Approach to Archaeological Interpretation*. Yale University Press, New Haven.

Rasic, Jeffery T.
2011 Functional Variability in the Late Pleistocene Archaeological Record of Eastern Beringia: A Model of Late Pleistocene Land Use and Technology of Northwest Alaska. In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by Ted Goebel and Ian Buvit, pp. 128-164. Texas A & M University Press, College Station.

Rinehart, Niels R.
2008 Moving Beyond the Reduction Stage in Debitage Analysis, with a Little Help from the Pot Sherd. *North American Archaeologist* 29(3-4):383-390.

Rothschild, Nan A.
2006 Colonialism, Material Culture, and Identity in the Rio Grande and Hudson River Valleys. *International Journal of Historical Archaeology* 10(1):73-108.

Sassaman, Kenneth E.
1992 Lithic Technology and the Hunter-Gatherer Sexual Division of Labor. *North American Archaeologist* 13(3):249-262.

Sawyer, David A., Ralph R. Shroba, Scott A. Minor, and Ren A. Thompson
2002 *Geologic Map of the Tetilla Peak Quadrangle, Santa Fe and Sandoval Counties, New Mexico*. U. S. Geological Survey Pamphlet to Accompany Miscellaneous Field Studies Map MF–2352, scale 1:24,000.

Scholes, Frances V.
1937 Troublous Times in New Mexico 1659-1670. *New Mexico Historical Review* 12:134-174, 380-452.

Schwendler, Rebecca H.
2008 Lithic Artifacts. *In Hokona: A Pueblo III-IV Settlement on NM 53 Near El Morro Cibola County, New Mexico)*, edited by Rebecca H. Schwendler, pp. 183-221. New Mexico Department of Transportation, Cultural Resource Technical Series 2007-2. SWCA Environmental Consultants, Albuquerque.

Sedig, Jacob W.
2014 An analysis of non-utilitarian stone point function in the US Southwest. *Journal of Anthropological Archaeology* 34:120-132.

Shackley, M. Steven
1995 Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantitative Analysis. *American Antiquity* 60 (3):531–551.
2002 *Archaeological Obsidian and Secondary Depositional Effects in The Jemez Mountains and The Sierra De Los Valles, Northern New Mexico*. Archaeological Research Facility, UC Berkeley. Retrieved from https://escholarship.org/uc/item/6tq782ss
2005 *Obsidian: Geology and Archaeology in the North American Southwest*. University of Arizona Press, Tucson.
2011 An Introduction to X-Ray Fluorescence Spectrometry for Archaeologists. In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeologv*. edited by M. Steven Shackley, pp. 7-44. Springer, New York.
2019 *Sources of Archaeological Obsidian in the Greater Southwest, The Northern New Mexico Region*. Geoarchaeological XRF Lab, Albuquerque. <http://www.swxrflab.net//nnewmex.htm>. Accessed 20 November 2019.

Shackley, M. Steven and James L. Moore
2018 More than Just Jemez Pueblo Obsidian: Comment on Liebmann's "… Landscapes of Signification in the American Southwest." *American Antiquity* 83(4):753-755.

Shea, John J.
1991 *The Behavioral Significance of Levantine Mousterian Industrial Variability.* Ph.D. dissertation, Harvard University, Cambridge, Massachusetts. (http://ezproxy.lib.umb.edu/login?url=https://search-proquest-com.ezproxy.lib.umb.edu/docview/303905174?accountid=28932).
1992 Lithic Microwear Analysis in Archeology. *Evolutionary Anthropology* 1(4):143–150.

Shott, Michael J.
1994 Size and Form in the Analysis of Flake Debris: Review and Recent Approaches. *Journal of Archaeological Method and Theory* 1:69–110.

Silliman, Stephen W.
2001 Theoretical Perspectives on Labor and Colonialism: Reconsidering the California Missions. *Journal of Anthropological Archaeology* 20:379-407.
2003 Using a Rock in a Hard Place: Native American Lithic Practices in Colonial California. In *Stone Tool Traditions in the Contact Era*, edited by Charles Cobb, pp. 127-150. University of Alabama Press, Tuscaloosa.
2004 *Lost Laborers in Colonial California*. University of Arizona Press, Tucson.
2005 Obsidian Studies and the Archaeology of 19th-Century California. *Journal of Field Archaeology* 30(1):75-94
2006 Struggling with Labor, Working with Identities. In *Historical Archaeology*, Martin Hall and Stephen W. Silliman, editors, pp. 147-166. Blackwell Publishing, Malden.
2010 Indigenous Traces in Colonial Spaces: Archaeologies of Ambiguity, Origin, and Practice. *Journal of Social Archaeology* 10(1):28-58.

Simmons, Marc
1979 History of Pueblo-Spanish Relations to 1821. In *Handbook of North American Indians: Southwest*, edited by Alphonso Ortiz, pp. 178-193. Smithsonian Institution, Washington, DC.

Smith, Gary A. and Bruce B. Huckell
2005 The Geological and Geoarchaeological Significance of Cerro Pedernal, Rio Arriba County, New Mexico. In *New Mexico Geological Society Fall Field Conference Guidebook 56: Geology of the Chama Basin*, edited by Spencer G. Lucas, Kate E. Zeigler, Virgil W. Leuth and Donald E. Owen, pp. 425–431. New Mexico Geological Society, Socorro.

Snow, David H.
1973 *Cochiti Dam Salvage Project: Archaeological Excavation of the Las Majadas Site, LA 591, Cochiti, New Mexico*. Laboratory of Anthropology Notes No. 75. Museum of New Mexico, Santa Fe.
1976 *Archaeological Investigations at Pueblo del Encierro, LA 70, Cochiti Dam Project, Cochiti, New Mexico, Final Report: 1964-1965 Field Seasons* (vol. 2). Laboratory of Anthropology Notes No. 78. Museum of New Mexico, Santa Fe.
1983 A Note on Encomienda Economics in Seventeenth-Century New Mexico. In *Hispanic Arts and Ethnohistory in the Southwest*, edited by Marta Weigle, pp. 347-357. Ancient City Press, Santa Fe.
1992 A Review of Spanish Colonial Archaeology in Northern New Mexico. In *Current Research on the Late Prehistory and Early History of New Mexico*, Bradley J. Vierra, editor, pp. 185-193. New Mexico Archaeological Council, Albuquerque.
1993 Purchased in Chihuahua Feasts. In *El Camino Real de Tierra Adentro*, Vol. 1, comp. Gabrielle Palmer, pp. 133-146. Bureau of Land Management, New Mexico State Office, Santa Fe.

1994 *Field Excavations at LA 20,000,1980-1994*. Manuscript on file at El Rancho de las Golondrinas, Santa Fe, New Mexico.
2009 Ceramics from LA 20,000: A 17th century Estancia Near Santa Fe. *Pottery Southwest* 28(2): 12-18.

Stahle, David W., and James E. Dunn
1982 An Analysis and Application of the Size Distribution of Waste Flakes from the Manufacture of Bifacial Stone Tools. *World Archaeology* 14: 84-96.

Steffen, Anastasia
2005 *The Dome Fire Obsidian Study: Investigating the Interaction of Heat, Hydration, and Glass Geochemistry*. Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque. (http://ezproxy.lib.umb.edu/login?url=https://search-proquest-com.ezproxy.lib.umb.edu/docview/305464971?accountid=28932).

Sullivan III, Alan P., and Kenneth C. Rozen
1985 Debitage Analysis and Archaeological Interpretation. *American Antiquity* 50:755–79.
Tainter, Joseph A. and Francis Levine

Thomas, Noah
2008. *Seventeenth-Century Technology on the Spanish Colonial Frontier: Transformations of Technology, Value, and Identity*. Ph.D. dissertation, University of Arizona, Tucson.

Toll, H. Wolcott
1978 Quartzite QUA Material in Archaeology: Qualities and Quandaries with Special Reference to Use-Wear. *Plains Anthropologist* 23(79):47-67.

Torres, John A.
2000 Changing Lithic Technology during the Basketmaker-Pueblo Transition. In *Foundations of Anasazi Culture: The Basketmaker-Pueblo Transition*, edited by Paul F. Reed, pp. 221–230. University of Utah Press, Salt Lake City.

Trigg, Heather
2003 The Ties that Bind: Regional Interactions in Early Colonial New Mexico, AD 1598-1680. *Historical Archaeology* 37:65-84.
2004 Food Choice and Social Identity in Early Colonial New Mexico. *Journal of the Southwest* 46(2):223-252.
2005 *From Household to Empire: Society and Economy in Early Colonial New Mexico*. University of Arizona Press, Tucson.
2017 *Cultural and Environmental Investigations of a 17th-Century Spanish New Mexican Household: 2017 Excavations at LA 20,000*. Excavation Report: 2016, Andrew Fiske Memorial Center for Archaeological Research, University of Massachusetts, Boston.

Trigg, Heather, Christina Spellman, and John Steinberg
2019 *Final Report on the 2011-2017 Fieldwork at LA 20,000*. Cultural Resource Management Study No. 85. Andrew Fiske Memorial Center for Archaeological Research, University of Massachusetts, Boston.

Trigg, Heather and Debra Gold
2005 Mestizaje and Migration: Modeling Population Dynamics in Seventeenth-Century New Mexico's Spanish Society. In *Engaged Anthropology: Research Essays on North American Archaeology, Ethnobotany, and Museology*, edited by M. Hegmon and B. Eiselt. University of Michigan Museum of Anthropology Paper 94.

Tringham, Ruth, Glenn Cooper, George Odell, Barbara Voytek, and Anne Whitman
1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. *Journal of Field Archaeology* 1(1/2):171-196.

Van Buren, Mary
2010 The Archaeological Study of Spanish Colonialism in the Americas. *Journal of Archaeological Research* 18(2):151-201.

Vaughan, C. David
2006 *Taking the Measure of New Mexico's Miners, Mining, and Metallurgy*. Ph.D. dissertation, University of New Mexico, Albuquerque.
2017 Metallurgy and Its Consequences in the New Mexico Colony. In *The Archaeology and History of Pueblo San Marcos Change and Stability,* edited by Ann F. Ramenofsky and Kari L. Schleher, pp. 185-204. University of New Mexico Press, Albuquerque.

Vaughan, Patrick
1985 *Use-Wear Analysis of Flaked Stone Tools*. University of Arizona Press, Tucson.

Vierra, Bradley J.
2005 Late Archaic Stone Tool Technology Across the Borderlands. In *The Late Archaic Across the Borderlands: From Foraging to Farming*, edited by Bradley J. Vierra, pp. 187-218. University of Texas Press, Austin.
2016 Coping with Changes: Stone Tool Production and Procurement in the Northern Rio Grande Valley during the Prehispanic and Historic Periods. In *History and Archaeology - Connecting the Dots: Papers in Honor of David Snow*, edited by Emily J. Brown, Carol J. Condie and Helen K. Crotty, pp. 263–268. Papers of the Archaeological Society of New Mexico, Albuquerque.

Voss, Barbara
2008 Gender, Race, and Labor in the Archaeology of the Spanish Colonial Americas. *Current Anthropology* 49:861-893.

Walsh, Michael R.
2000 Material Evidence for Social Boundaries on the Pajarito Plateau, New Mexico. *Kiva* 65(3):197-213.

Whittaker, John C.
1994 *Flintknapping: Making and Understanding Stone Tools*. University of Texas Press, Austin.

Whittaker, John C. and Eric J. Kaldahl
2001 Where the Waste Went: A Knappers' Dump at Grasshopper Pueblo. In *Lithic Debitage: Context, Form, Meaning*, edited by William Andrefsky Jr., pp.32-60. University of Utah Press, Salt Lake City.

Whittaker, John C., and Lee Fratt
1984 Continuity and Change in Stone Tools at Mission Tumacacori, Arizona. *Lithic Technology* 13(1):11-19.

Wilmsen, Edwin
1968 Functional Analysis of Flaked Artifacts. *American Antiquity* 22:156-61.

Wilson, Jennifer Keeling and William Andrefsky, Jr.
2008 Exploring Retouch on Bifaces: Unpacking Production, Resharpening and Hammer Type. In *Lithic Technology: Measures of Production, Use and Curation*, edited by William Andrefsky, Jr., pp. 86-105. Cambridge University Press, Cambridge.

Wiseman, Regge N.
1992 Early Spanish Occupation in Santa Fe: Excavations at the La Fonda Parking Lot Site (LA 54000). In *Current Research on the Late Prehistory and Early History of New Mexico*, edited by B. Vierra, pp. 207-214. New Mexico Archaeological Council Special Publication 1. Albuquerque.

Witthoft, John
1966 A History of Gunflints. *Pennsylvania Archaeologist* 36(1):12-49.