Technical Analyses on the Materials from 2011-2017 Fieldwork at LA 20,000 La Cienega, New Mexico

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Chapter 1
Introduction

By Heather B. Trigg

LA 20,000 is a 17th-century site associated with Spanish colonizers. It is the largest, most complex of the few 17th-century Spanish ranches in New Mexico that have thus far been excavated. Located 12 miles southwest of Santa Fe (Figure 1.1), the site is owned by the non-profit living history museum El Rancho de las Golondrinas although structures associated with the ranch are also located on adjacent property to the north and to the south of the core of the site. Dendrochronology and material culture suggest the ranch was established by 1629 and destroyed in 1680 during the Pueblo Revolt.

Located at the base of a south facing hill, the site overlooks a downcut ephemeral stream coming from spring a few hundred meters east of the site. During the 17th century, the environment was wetter than today, so the stream would have been perennial providing water for crops and household purposes. Currently, there is little on the surface to indicate a site of this complexity and importance. Footings for the corral are visible, especially where erosional channels arroyo downcutting at the eastern third of the site have exposed the edge of the corral, but there is no standing architecture. Archaeological investigations by Snow and Stoller in the 1980s and 1990s revealed that the ranch's architecture comprises a large domestic structure, barn, corral and possibly a *torreon* (Figure 1.2). The known architectural remains cover roughly 1.5 acres, but the 17th -century ranch would have also had agricultural fields for crops, land for gardens and possibly orchards, and land for grazing livestock. Acequia systems no doubt supported the agricultural activities although no evidence of them has been found. The size and complexity of the structures, especially the barn, suggests that the occupants were an extended family of wealthy Spanish colonists who were supported by servants and Pueblo laborers. During the 50 year occupation of this site, colonists constructed the ranch's structures, and the family produced livestock, grew crops, produced textiles, and raised families. These and other quotidian activities, such as cooking, engaged Indigenous peoples, and the Spanish family probably relied on them for a significant portion of the needed labor. This report details several analyses performed on LA 20,000 materials that help investigate the activities that supported the farm and the relationships colonists developed with the Pueblos.

LA 20,000 was first identified in 1980 when a backhoe operator trenched through the midden revealing ceramics, animal bones, and charred plant parts. The landowner contacted the Museum of New Mexico, and under the direction of Reggie Wiseman, museum staff and volunteers profiled the trench walls and collected material culture and animal bones. The site was visited in 1982 to map surface features and conduct limited test excavations. In 1987, David Snow and Dr. Marianne Stoller began a series of field schools through Colorado College. These excavations delimited the structures, collected material culture, animal bones, and botanical samples. Eight field seasons were undertaken from 1987 through 1994 (Snow 1994). With these excavations, Snow and Stoller were able to define and date the site's structures (Figure 1.2).

In 1995, Trigg conducted a limited excavation of the midden, primarily to collect additional samples for paleoethnobotanical analysis. In 2012 and then again 2015 through 2017, Trigg returned to the site with funding from the National Science Foundation to undertake a geophysical survey and conduct targeted excavations to complement the earlier work (Figure 1.3). See Trigg et al. (2019) for a more detailed history of the excavations.

[redacted]

Figure 1.1. Location of LA 20,000.

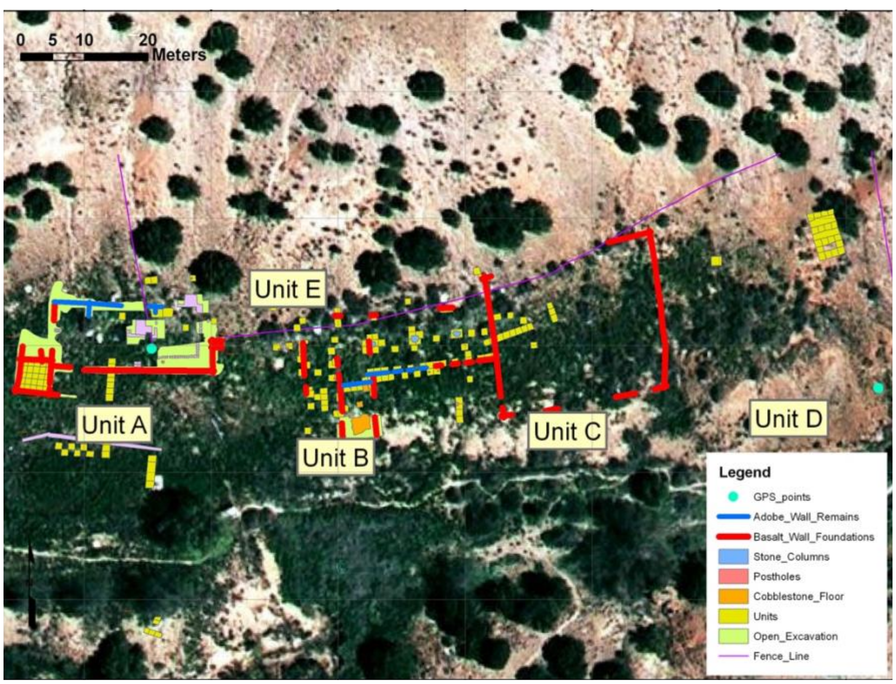


Figure 1.2. Units and architecture identified by Snow and Stoller.

Snow and Stoller largely defined the outline and extent of the structures at the site, although excavations in 2016 expanded the southernmost extent of the house. They identified a large house, now known to be at least 15 x 20 m in size, a barn that was nearly as large as the house, a corral (now known to be a series of corrals), and a possible *torreon* (Figure 1.4). Snow and Stoller identified the house as Unit A and a portion of Unit E, the barn as Unit B and a portion of Unit E, and the corral as Unit C. Unit D is the eastern edge of the site where there are several rock alignments. The possible *torreon* is located south of the house and can be identified on the map as a series of five excavation units. Excavations between the structures identified several midden deposits, the most extensive of which is located to the south of the house. Excavations by Trigg's team expanded the known size of the house, added a small corral to the eastern edge of the small corral, and added to our understanding of the western portion of the barn.

Based on the material culture and dendrochronological samples recovered during excavations, the farm was established by 1629 and was probably deserted in 1680 as a result of the Pueblo Revolt. Portions of the site were burned, probably during the Pueblo Revolt, as evidenced by layers of charred material that cover the area inside and around the barn. Curiously, the portions of the house do not seem to have been burned.

Both sets of excavations added to our understanding of the extent of the structures and collected material culture including a large Pueblo ceramic assemblage, a modest lithic assemblage, and small amounts of metal and glass. They also collected faunal remains, botanical remains, and samples of the architectural materials.

The materials used in these analyses were excavated during the field seasons from 1980 through 2017. Some of the materials have been analyzed and published elsewhere. The majority of the macro-botanical materials have been analyzed (Trigg 1999). There are few small finds, only a very small amount of glass and metal, and these have been described in the final report (Trigg et al. 2019). The extensive ceramic collection from the 1980-1995 materials have been analyzed by Snow (2009). The ceramics from the 2015-2017 excavations have been preliminarily examined (Brinkman 2019) and a subset of glaze wares are being for a dissertation by Danielle Huerta. The rest await more detailed analysis.

Report Organization

In Chapter 2, Anya Gruber provides a palynological investigation of LA 20,000 focusing on animal husbandry and the environment around the site. Most of Gruber's samples come from the structures and deposits on the site, so they are able provide a synchronic description of the activities while the farm was occupied. Gruber also uses a stratigraphic sequence of samples from a text excavation at the edge of the site in an area that was likely a marsh in the 17th century. This work provides a complement to Edwards' (Edwards 2015; Edwards and Trigg 2016) palynological analysis of a core from the Leonora Curtin Wetlands which provides a diachronic picture of a larger area. Gruber's analysis uses samples taken during the 2015-2017 field seasons.

In Chapter 3, Ana Opishinski present an analysis of the faunal remains collected from all excavation field seasons. As is typical with legacy collections, the bones that were available from the earlier field seasons appears to be a subset of those collected. Although there is a species list from an earlier analysis of fauna from the 1980-1995 excavations in manuscript form, Opishinski reports on the specimens she was able to examine. She combines this data with an analysis of the materials from 2015-2017.

In Chapter 4, Clint Lindsay gives an exhaustive analysis of the chipped stone materials from the site. Lindsay examined all material excavated from 1980 onwards. He conducted a morphometric analysis of the formal tools, the informal tools, and the lithic debitage, and

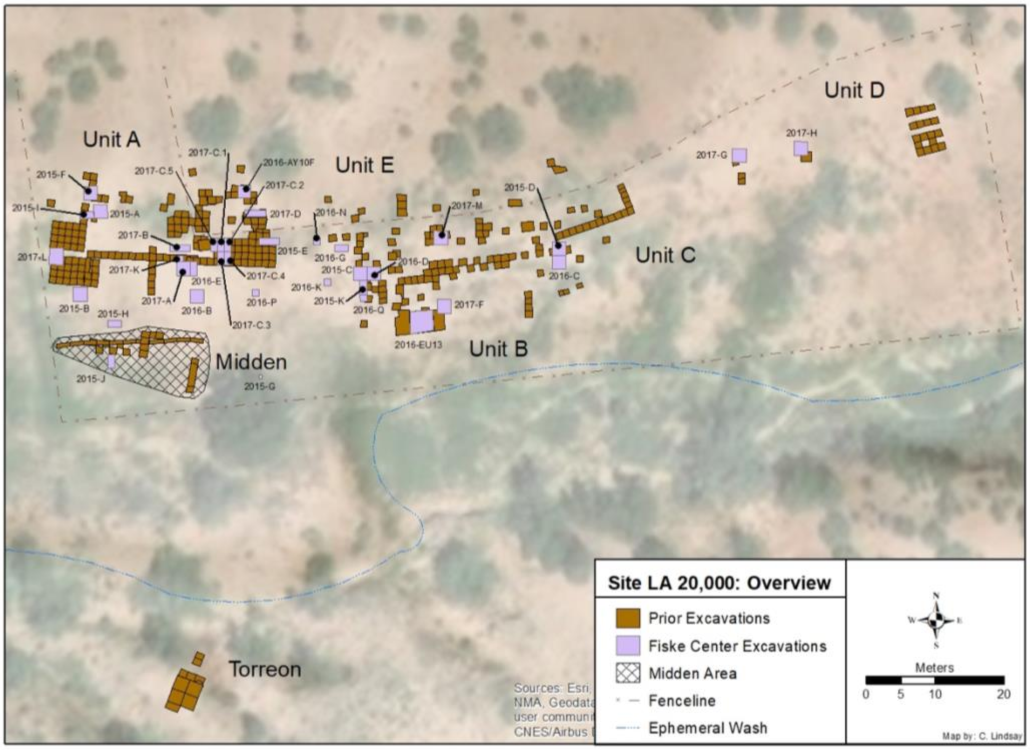


Figure 1.3. Updated map of LA 20,000. Showing the refinements to Snow and Stoller's maps and Fiske Center units excavated between 2012 and 2017.

Figure 1.4. Reconstruction of the walls at LA 20,000 based on Snow, Stoller, and Trigg's work.

a use wear analysis. He has also undertaken a sourcing analysis of the obsidian using pXRF. In this analysis, Lindsay compares the chemical signatures of the obsidian from LA 20,000 to the known signatures from sources in the Jemez mountains. A paper reporting this work was published in *Kiva* (Lindsay 2021).

In Chapter 5, Katherine Albert presents her analysis of the building materials, drawing together a variety of analyses on disparate sources of data, including adobe bricks, daub impressions, and photos and drawings of architectural elements from all years of field work. She offers a reconstruction of the structures' outlines and estimates the amount of materials needed for the construction of the perimeter walls and roofs. She also explores the sources of the raw materials, suggesting locations where critical materials could have been obtained. In her MA thesis (Albert 2021), she explores more fully the amount of labor needed to collect materials and construct the structures, and the implications this had for Indigenous people who likely did much of the work.

Conclusion

Each of these analyses draws on the author's Master's thesis in Historical Archaeology at the University of Massachusetts Boston (Albert 2021; Gruber 2018; Lindsay 2020; Opishinski 2019). The cultural implications of their analyses and their significance for understanding colonialism in the Southwest are presented in more depth in their theses. The descriptive reporting of their data and conclusions presented here provide an additional understanding of the ways these colonizers made a living in this new environment amd the ways they interacted with Indigenous peoples.

References Cited

Albert, Katherine A.
2021 Constructing Spaces, Deconstructing Meaning: An Examination of Architecture and Labor at a 17th-Century New Mexican Ranch. MA thesis (Historical Archaeology), University of Massachusetts Boston, Boston, MA.

Brinkman, Adam C.
2019 Comales and Colonialism: An Analysis of Cuisine and Ceramics on a 17th-Century New Mexican Estancia. MA thesis (Historical Archaeology) University of Massachusetts Boston.

Edwards, Kyle W.
2015 *Environmental Dimensions of Colonial Settlement: A Palynological Investigation of La Cienega, New Mexico.* Master's thesis, Department of Anthropology, University of Massachusetts, Boston.

Edwards, Kyle W., and Heather B. Trigg
2016 *Intersecting Landscapes: A Palynological Study of Pueblo, Spanish, and Anglo American Land Use in New Mexico*. Historical Archaeology 50(1):135–153.

Gruber, A.
2018 Palynological Investigations of Agropastoralism and Ecological Change at LA 20,000, New Mexico. Master's Thesis (Department of Anthropology) University of Massachusetts Boston.

Lindsay, Clint
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. MA thesis (Historical Archaeology) University of Massachusetts Boston.
2021 pXRF Analysis of Obsidian Artifacts from a Rural Spanish Household: Investigating Spanish-Pueblo Interactions in Seventeenth-Century New Mexico. *Kiva*:1-23.

Opishinski, Ana C.
2019 Eat This in Remembrance: The Zooarchaeology of Secular and Religious Sites in 17th-Century New Mexico. MA thesis (Historical Archaeology) University of Massachusetts Boston.

Snow, David H.
1994 Field Excavations at LA 20,000: 1980-1994. Manuscript on file at El Rancho de las Golondrinas, La Cienega, NM.
2009 Ceramics from LA 20,000: a 17th-century estancia near Santa Fe. *Pottery Southwest* 28(2):12-18.

Trigg, Heather
1999 *The Economy of Early Colonial New Mexico, A.D. 1598-1680: An Investigation of Social Structure and Human Agency Using Archaeological and Documentary Data.* Doctoral Dissertation (Anthropology) University of Michigan.

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

Chapter 2
Palynological Investigations of Excavations at LA 20,000, La Cienega, New Mexico

By Anya Gruber

Introduction

The introduction of Eurasian livestock with the Spanish colonization of North America has long been implicated in dramatic, often detrimental changes to vegetation and the landscape (Endfield and Ohara 1999; Melville 1990). However, the nature, timing, and especially the cause of environmental degradation has been debated. Fisher et al. (2003), for example, provide an alternative interpretation, suggesting that environmental decline in Central Mexico was evident prior to the arrival of the Spanish and was due to population levels and agricultural activities rather than grazing livestock. These studies relied on documentary or sedimentation data, but palynology has long been used to explore vegetation changes that occurred from anthropogenic and climatic causes (KJ Edwards et al. 2015).

Palynological inquiries have a rich history in the American Southwest with samples taken from archaeological strata/deposits/contexts or on material culture (Bryant and Holloway 1996; Hevly 1964) to understand synchronic activities. Taken onsite, pollen samples have been used to understand activity areas such as within dwellings or associated with burials (Bryant and Holloway 1996). Pollen washes of tools such as ground stone contributed to an understanding food and food processing methods (Bryant and Holloway 1996). With a sediment core from El Rancho de las Golondrinas, not far from LA 20,000, KW Edwards (2015) used palynology to suggest that environmental changes are evident in pre-colonial Puebloan areas due to the Pueblos' activities especially, the construction of water control features and agricultural practices. He further suggests that the introduction of Spanish style agriculture and livestock altered the environment to a limited extent in the early colonial period (AD 1598-1680), and only became noticeable in the palynological record when populations of Spanish colonists and their livestock increased in the mid to late 18th century. This understanding of these changes comes from off-site sediment and provides a diachronic view of local and regional vegetation changes.

The goals of the palynological analysis at LA 20,000 are two-fold. The first is to understand the environmental changes associated with the establishment of the 17th-century ranch at LA 20,000. These data are interpreted in dialogue with a pollen core from the nearby Leonora Curtin Wetland Preserve (located at El Rancho de Las Golondrinas) analyzed by KW Edwards (2015) (Figure 2.1). Due to the nature of pollen dispersal, it can be difficult to distinguish regional from local vegetation in the palynological record. The comparison of pollen from Golondrinas allows for a better understanding of the environment immediately surrounding LA 20,000 and how it changed through time. The second goal is to understand foodways, food production, and animal husbandry practices at the site.

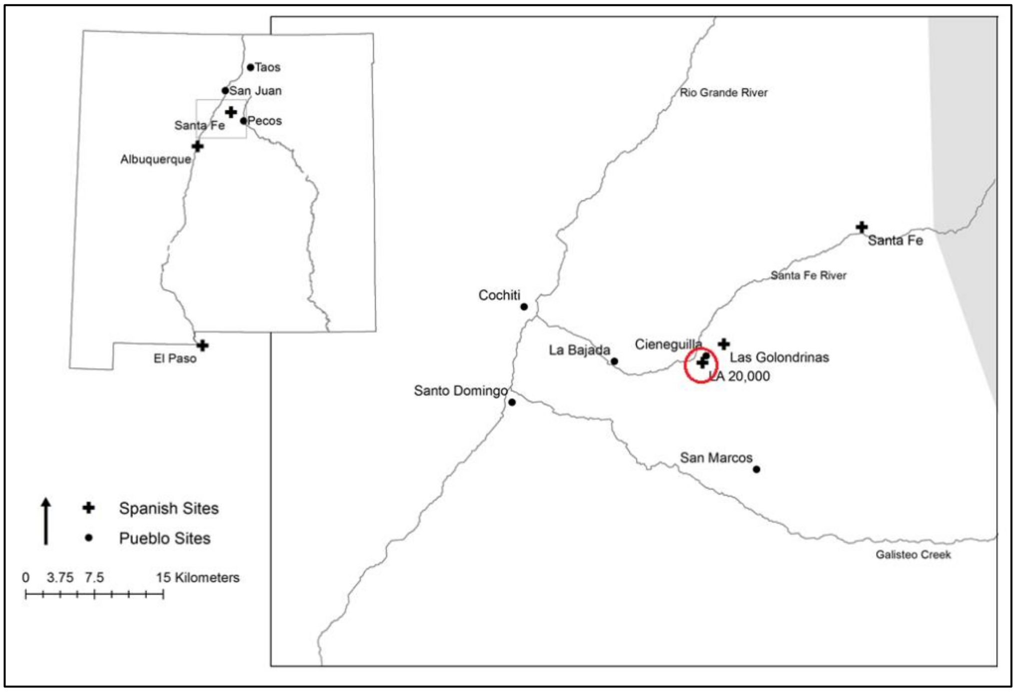


Figure 2.1. The location of LA 20,000 and El Rancho de las Golondrinas where the Leonora Curtin Wetland Preserve core was taken (from KW Edwards 2015).

Methods

This study analyzes pollen from two types of samples – a pollen column located south of the house and pinch or spot samples across the site (Figure 2.2). The pollen column was located at the southern boundary of the site, an area that was likely less impacted by the occupation due to its distance from the structures at LA 20,000 and the likelihood that the area was a marsh in the 17th century. The column provides a diachronic view of the vegetation around the site prior to, during, and after the site's 17th-century occupation. For the collection of these samples, a single 50 cm x 50 cm unit, identified as 2015-G was opened in 2015. An 80 cm profile was exposed, and samples were collected continuously every two centimeters over 60 cm of the profile.

To determine the ages of the strata in 2015-G, several samples were dated using AMS (Table 2.1); the dates of other samples were estimated using sedimentation rates between dated samples. Samples 9, 10, and 22 were sent to Beta Analytic Testing Laboratory for radiometric dating on organic compounds occurring in the soil. All calibrations were performed with INTCAL13.

Sample 9 dated to 240 $\pm$ 30 BP (Beta – 437861; organic sediment; $\delta 13C$ = -18.6 o/oo). Calibration at 2σ yielded three possible date ranges: cal AD 1640 to 1670 and cal AD 1780 to 1800 and cal AD 1940 to Post 1950.

Sample 10 dated to 170 $\pm$ 30 BP (Beta - 480130; organic sediment; $\delta 13C$ = -17.6 o/oo). Calibration at 2σ yielded four possible date ranges: cal 1732 to 1782 AD, cal 1928 to Post 1950 AD, cal 1668 to 1685 AD, and cal 1797 to 1808 AD.

Sample 22 dated to 1230± 30 BP (Beta-437862; organic sediment; δ13C = -15.5 o/oo). Calibration at 2σ yielded three possible date ranges: cal AD 720 to 740, cal AD 765 to 775, and cal AD 790 to 800.

Sample 9 presented 2 equally probable date ranges (AD 1640 to 1670 and AD 1780 to 1800). Sample 10 was dated to refine the wide range of dates for Sample 9. Since Sample 10 was stratigraphically below Sample 9, we assumed that the earliest date of Sample 10 must older than the earliest date of Sample 9. The earliest date of Sample 10 is 1668 suggesting that the earliest date of Sample 9 should be the latter of its two dates – 1780-1800. Taking the midpoint of that date range, we used the date 1790 for calculating the extrapolated dates for the other layers. Sample 22 had three date ranges spanning AD 720-800. We chose the midpoint, which happened to be the intercept with the calibration curve at AD 770.

Estimated dates for individual samples were extrapolated between AMS dated samples (Table 2.1) using sedimentation rates that were calculated from the radiocarbon dates of Samples 9 and 22 (Mudie and Byrne 1980). The difference between the years 770 A.D. and 1790 A.D. (1,020 years) was divided by the difference in depth between the two samples (26 cm) yielding a sedimentation rate of 39 years/cm. Using this rate, the dates of the remaining samples were extrapolated. Based on the calculated and AMS dates (Table 2.1), five 2015-G samples were selected for pollen analysis. These were chosen to capture the pollen profile of the target 17th-century time period, as well as approximately one hundred years before and one hundred years after. Samples 12 and 13 are at the target 17th century. The dates of these two samples span approximately 180 years, with the occupation of LA 20,000 falling approximately in the middle of the sample range. Samples 14 and 16 provide information about the vegetation prior to the occupation of the site, and Samples 9 and 10 provide information about the vegetation after the site was abandoned.

Table 2.1
Provenience Data for Analyzed 2015-G Pollen Column Samples

Field Sample	Pollen Sample #	Context #	Depth Below Surface (cm)	Date*
292	9	224	16-18	AD 1790
293	10	225	18-20	AD 1712
295	12	227	22-24	*AD 1673*
296	13	228	24-26	*AD 1634*
297	14	229	26-28	*AD 1595*
299	16	231	30-32	*AD 1517*

*Italicized dates are extrapolated from radiometric dating results.

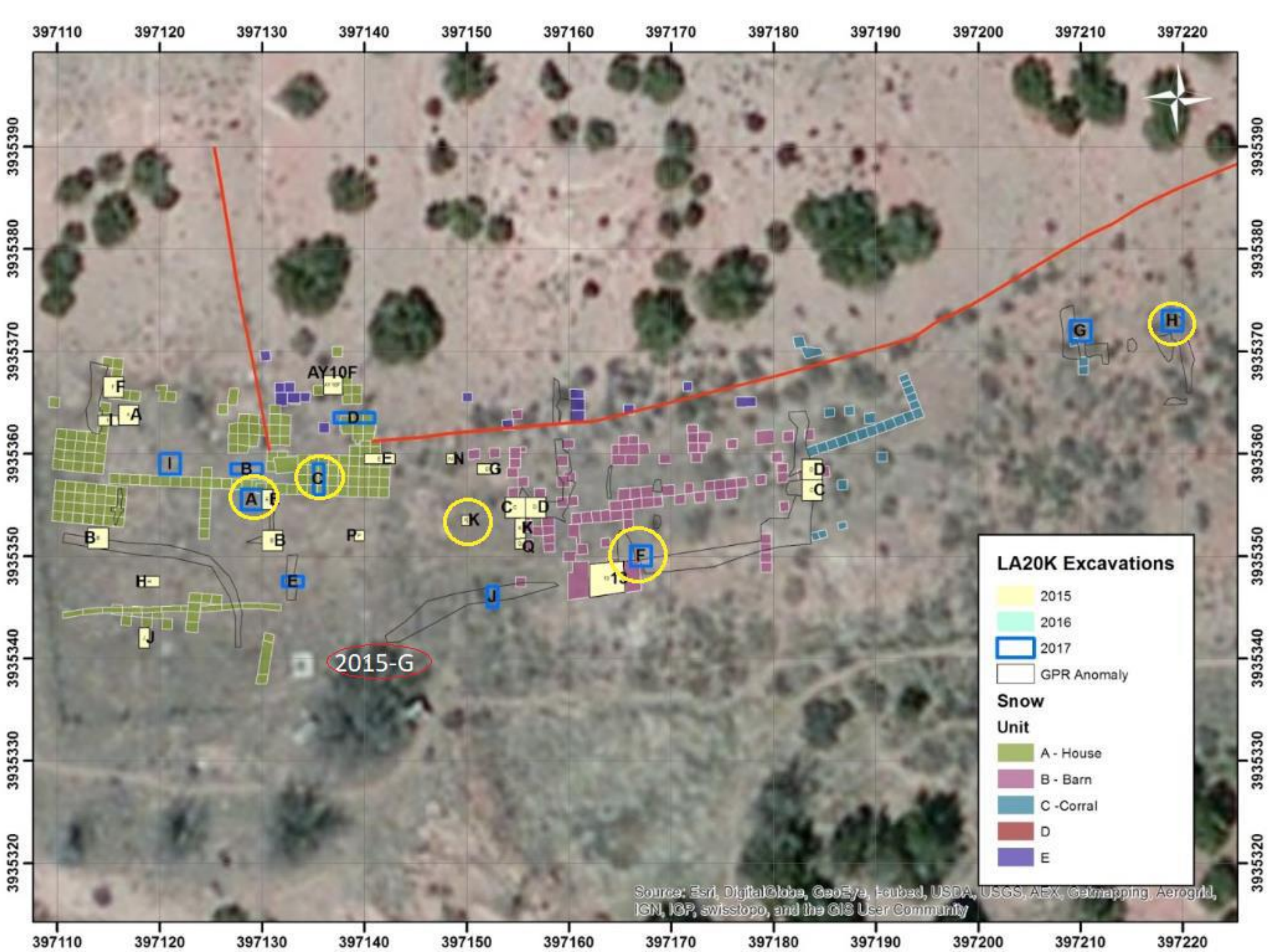


Figure 2.2. Location of pollen samples from LA 20,000. The letters denote the excavation unit (EU), and the EU color identifies the field season that the unit was first delimited.

A series of spot or pinch samples were taken from archaeological deposits associated with the 17th-century occupation of the site. These spot samples were collected in 2017 from excavation units opened during the 2016 and 2017 field seasons (Figure 2.2). The archaeological contexts included structure floors, manure layers in the barn and corral, and extramural areas between the house and barn.

Eight of the pinch samples were selected for pollen extraction (Table 2.2). Sample 420 was collected from a stratum believed to be the floor of the house in EU 2017-A. Sample 454 was from EU 2017-C.2, also from a floor stratum in the house area. Samples 321 and 323 were from 2016-K, above and between two burn layers exterior to but likely associated with the barn. Samples 439 and 442 came from 2017-F, inside the barn. Sample 439 is associated with a manure layer, and 442 from a floor surface. Samples 450 and 451 were taken from EU 2017-H, in the corral area. Thick layers of alternating reddish and greenish sediment in the strata of this unit were interpreted as manure layers in various states of decomposition.

Table 2.2
Provenience Data for On-site Pollen Samples from LA 20,000

Field Sample	Excavation Unit	Level	Context	Associated Structure	Depth Below Surface (cm)
321	2016-K	4	Above burn layer	Exterior to Barn	68
323	2016-K	6	Between first and second burn layers	Exterior to Barn	84
420	2017-A	3	Floor sample	House	78
439	2017-F	1	Manure layer	Barn	30
442	2017-F	3	Manure layer	Barn	55
454	2017-C.2	4	Floor surface	House	80
450	2017-H	4	Red and green lamination (manure layers)	Corral	52
451	2017-H	5	Red and green lamination (manure layers)	Corral	55

Pollen Extraction

During the Fall of 2017, sediment samples were analyzed in Dr. Heather Trigg's Paleoethnobotany Laboratory at the Andrew Fiske Memorial Center for Archaeological Research at the University of Massachusetts Boston. In order to extract the pollen from the sediment in the samples, it was treated with a series of chemical rinses. The extraction was completed using standard palynological practices and is described below.

First, each sample was dried and approximately 20 g of sediment was placed in beakers. To each sample, 50 mL of hydrochloric acid (HCl) was added. Two Lycopodium tablets (18583 spores/tablet) were added to each sample. After two hours, the HCl was poured off. To rinse to neutral pH, deionized water was added and then the sediment was centrifuged at 2,000 RPM for seven minutes repeatedly until the sediment reached neutral pH. Then, 50 mL of hydrofluoric acid (HF) was added to dissolve the silicates in the sediment. After soaking in HF overnight, the samples were centrifuged and rinsed to neutral. Glacial acetic acid was added to draw out any remaining water in the samples. In the final step, 9 mL of acetic anhydride ($(CH_3CO)_2O$) and 1 mL of sulfuric acid (H_2SO_4) were added to the sediment. The samples were warmed in a hot water bath for five minutes. This process breaks down organic compounds in the sediment and makes the pollen easier to identify by staining the grains (Traverse 2008:62). The residues were placed into vials with deionized water, glycerin, and isopropyl alcohol, which preserves the sediment by inhibiting bacteria growth. To identify the pollen, a glass pipette was used to place a few drops of the residue onto a small amount of glycerin on a microscope slide, and cover slip was placed on top. The slides were then observed under 400x magnification using a compound microscope. At least 300 pollen grains were counted for each sample (Table 2.3).

Table 2.3
Pollen Densities in Grains/G

Sample	Pollen Observed	Lycopodium Observed	Lycopodium Added	Sample Weight (g)	Pollen Density (grains/g)
9	421.5	71	37,166	25.93	8,509.08
10	346	30	37,166	26.73	16,036.21
12	379.5	63	37,166	29.61	7,560.10
13	485.5	124	37,166	23.03	6,318.58
14	347	74	37,166	28.11	6,199.87
16	378.5	147	37,166	25.73	3,719.24
321	313.5	41	37,166	21.54	13,193.31
323	326.5	159	37,166	20.43	3,735.62
420	301.5	76	37,166	20.42	7,220.44
439	318.5	53	37,166	20.92	10, 676. 22
442	335	32	37,166	23.93	16,259.20
450	326	44	37,166	25.41	10,836.93
451	315	76	37,166	26.14	5,893.00
454	309	84	37,166	23.40	5,842.64

Pollen keys, such as Ronald Kapp's (1969) detailed field guide, online resources such as Paldat.com, and the extensive reference collection at the Fiske Center for Archaeological Research at University of Massachusetts Boston were used to identify the pollen.

Pollen Density

According to Hall (1981), pollen recovered archaeologically almost always experiences some degree of deterioration. He also found that pollen grains with certain structures are more likely to deteriorate severely. The pines and members of the cypress family (Cupressaceae), which includes juniper, are two of the most common taxa recovered in the samples for this study, and are especially susceptible to deterioration (Hall 1981:198). According to Hall (1981), adequate preservation is indicated by a density of at least 1,000 grains per gram.

The density of the pollen in each sample in grains/gram was obtained using following equation:

$$\frac{O_L}{K_L} = \frac{O_P}{x}$$

Where O_L=observed number of Lycopodium tracer spores during pollen identification; K_L= known number of Lycopodium spores added to the sample; and O_P= observed number of pollen grains. Two Lycopodium tablets were dissolved in each, corresponding to 37,166 spores (at 18,583 spores in each tablet). This equation provides the approximate number of total pollen grains in the sample, based on the proportion between the number of observed tracer spores, observed pollen, and known quantity of spores. The result of this equation is then divided by the weight in grams of the sample, which results in the pollen density in grains/gram. All the samples analyzed in this project had a density above Hall's threshold (Table 2.3).

Pollen Dispersal Processes

Pollen in the archaeological record can relate to vegetation on a broad or a highly localized scale, in some cases simultaneously (Ford 1979:309). Pollen enters the archaeological record when it falls from a plant, a process called pollen rain, and becomes incorporated into sediments (Bryant and Hall 1993:278). Plants employ a variety of pollen dispersal methods, which influences how far pollen travels from the plant and often how much pollen is released. There are four main mechanisms of pollination: wind, water, animal, and self-pollination (Pearsall 2015:190). Generally, plants which disperse pollen on the wind produce a relatively large number of pollen grains, upwards of 10,000 per anther, and release it indiscriminately in a wide-reaching pollen rain (Pearsall 2015:190). Ponderosa pine (*P. ponderosa*), pinyon pine (*P. edulis*), and firs (*Abies*) disperse pollen in this way. Wind-dispersed pollen tends to comprise a high percentage of the pollen assemblage because trees produce a large amount of pollen.

Zoophilous taxa, whose pollen is transported by animals especially insects, tend to create far fewer pollen grains because they use sticky oils or spines to attach to a passing pollinator like bats, bees or birds (Bryant 1974:412). It is much more difficult to find zoophilous pollen in the archaeological record because it does not disperse as widely as wind-pollinated species and many fewer grains are typically produced (Pearsall 2015:190). Many important food plants such as apples, peaches, pumpkins and squashes are pollinated by insects (Calderone 2012:1).

Other important taxa, including cereals like wheat and barley, are self-pollinated, producing less pollen overall, and they are therefore proportionally less represented in the data (Klein et al. 2007:303). Observing European cereal pollen in archaeological samples is notable because little released into the environment, so finding it is strong evidence of its nearby presence. Macrobotanical remains from sites in and around Santa Fe and documents show that domesticated cereal grains were some of the most important species in the early Spanish colonial period (Trigg 1995), though often the most difficult to recover palynologically (Dean and Toll 1995). Wheat pollen generally falls within 8 meters of the parent plant (Waines and Hegde 2003). The exact dispersal area depends heavily on ambient environmental conditions including temperature, wind conditions, and rainfall (Loureiro et al. 2007:25; Wilcock and Neiland 2002:262). As a self-pollinator, wheat's pollen remains inside the closed flower head, so the pollen is not released into the ambient environment until it is disturbed in some way, for example, threshing and processing for consumption. Thus, large quantities of wheat pollen are interpretively significant because it indicates very specific human activities (Kelso and Beaudry 1990:69).

Since different taxa have varying pollen production and dispersal habits, the relationship between parent vegetation and palynological representation may be difficult to determine. Arboreal, shrub, and certain herbaceous taxa including pine, fir, sagebrush, and ragweed, are better for understanding large-scale ecological changes because of their wide dispersal area. On the other hand, other herbaceous taxa and domesticate pollen is more suited for detecting patterns in local land use. The depositional patterns of pollen grains are important to consider in order to understand not only how pollen entered the archaeological record, but also in identifying whether pollen was dispersed according to natural processes or due to anthropogenic activities (Bohrer 1981).

Results

In all, 35 taxa were identified, including 13 different arboreal taxa, 3 shrubs, 15 herbs, and 4 domesticates (Tables 2.4, 2.5, and 2.6).

Characteristics such as pollen size, surface sculpturing, aperture appearance, and exine thickness are all used in pollen identification. It can be difficult to distinguish the pollen of related species because they often are morphologically similar. Therefore, pollen is frequently identified to genus or family rather than species (Pearsall 2015:225). Pines, including pinyon (*Pinus edulis***)** and ponderosa (*Pinus ponderosa*), appeared frequently in these samples. Although they look similar, it is possible to distinguish them based on their size, structure, and ornamentation. Pinyon pine, at approximately 60 μm long, is smaller than ponderosa pine, which averages 100 μm long (Hansen and Cushing 1973:1187–1190). The distinction between these two species of pine is important in understanding the subtleties of regional environmental change at LA 20,000 because these two species have prefer different environmental zones. Pinyon pine prefers lower elevations and tolerates a more arid climate. Ponderosa grows best in wetter conditions at higher elevations. In cases where the two species were too difficult to distinguish, they were grouped together as undifferentiated Pinus. Pine pollen is especially fragile and susceptible to crumpling because of its size (Hall 1981). Bladders of pine pollen grains were frequently separated from the bodies, which complicated accurate counting. Isolated bladders were tallied, and every two bladders were ultimately counted as one complete grain and added to the undif Pinus count.

Cheno-ams, the category including species in the family Chenopodiaceae and the genus *Amaranthus* in the Amaranthaceae family, appeared frequently in this dataset. These taxa are combined because they are closely related and morphologically similar (Hevly et al. 1965:128). Some notable species included in this broad category are goosefoot (*Chenopodium album*), saltbush (*Atriplex canescens*), and amaranth (*Amaranthus* sp.) (Tsukada 1967:157). Several of these species, including goosefoot and amaranth, were important sources of food in the ancestral Puebloan diet (Trigg 2005:45). Cheno-ams are particularly important to the interpretation of palynological data because they thrive in disturbed soils, especially agricultural fields and around human settlements. Saltbush, though considered a Cheno-am, is distinguishable from other Cheno-ams based on pore frequency. Many Chenopodiaceae pollen have 75 or more pores whereas saltbush has 40-45 pores (Kapp 1969). Therefore, saltbush is counted separately from the rest of the Cheno-ams. Saltbush was one of three types of shrub identified.

Two categories of Asteraceae pollen, high- and low-spine, refer to the grain's surface sculpturing. The high-spine Asteraceae, including sunflower (*Helianthus annuus*), have at least 2.0 μm -long spines. High-spine Asteraceae are generally insect pollinated and their pollen does not travel far from the parent plant. The low-spine Asteraceae had spines are less than 2.0 microns long (Hevly et al. 1965:128). This category includes ragweed (*Ambrosia* sp.) and the taxa are generally wind pollinated. They generate abundant pollen, which is widely dispersed. Ragweed is an important species in the study of colonial ecologies, as it is closely associated with the clearance of woodlands and the establishments of large tracts of farmland, particularly in the Northeast United States, where the so-called "Ambrosia rise" is highly characteristic of the 17th century (Cronon 2003:143). Like Cheno-ams, ragweed grows profusely in disturbed soils (Fuller et al. 1998:80).

Table 2.4
Identified Taxa

Taxon	Common name	Group
Pseudotsuga sp.	Douglas fir	Arboreal
Pinus ponderosa	Ponderosa pine	Arboreal
Pinus edulis	Pinyon pine	Arboreal
Abies sp.	Fir	Arboreal
Pinus sp.	Pine	Arboreal
Larix sp.	Larch/ tamarack	Arboreal
Pinaceae	Pine family	Arboreal
Juniperus sp.	Juniper	Arboreal
Cupressaceae	Cypress family	Arboreal
TCT	Juniper, Aspen category	Arboreal
Populus sp.	Cottonwood/ aspen	Arboreal
Salix sp.	Willow	Arboreal
Rosaceae	Rose/ peach family	Arboreal
Artemisia sp.	Sagebrush	Shrub
Atriplex sp.	Saltbush	Shrub
Ephedra sp.	Ephedra	Shrub
Chenopodium-Amaranthaceae	Goosefoot / amaranth family	Herb
Plantago sp.	Plantain	Herb
Portulaceae	Purslane family	Herb
Crassulucaceae	Stonecrop family	Herb
Sphaeralcea sp.	False mallow	Herb
Solidago sp.	Goldenrod	Herb
Ambrosia sp.	Ragweed	Herb
Asteraceae	Daisy family	Herb
Onagraceae	Evening primrose family	Herb
Typha sp.	Cattail	Herb
Opuntia sp.	Prickly pear cactus	Herb
Ranunculaceae	Buttercup family	Herb
Poaceae	Grass family	Herb
Cucurbita sp.	Squash	Domesticate
Zea mays	Maize/ corn	Domesticate
Cerealia	Wheat, Barley	Domesticate

Sagebrush (*Artemisia tridentata*) and ephedra (*Ephedra* sp.) are the other “shrub” species identified. Sagebrush is an important plant in the savanna ecozones of New Mexico and tends to prefer areas with deep soil and little tree cover (Dick-Peddie 1990:91). Ephedra thrives in desert conditions and rapidly adapts to changing climatic conditions (Carlquist 1989:442), often growing on well-drained slopes alongside grasses and cacti (Brand 1936:41).

Mallows (*Sphaeralcea* sp.) are bushy, drought-tolerant perennial flowering plants common in the Southwest. Mallows are particularly important in the arid regions because they are restorative plants that replenish nutritionally deficient desert landscapes (Shryrock et al. 2015:1304). These were common in the 2015-G pollen profile.

Cattail (*Typha* sp.) is a common marsh plant, more frequent in Edwards' samples than in the LA 20,000 samples. Cattails are distinctive with tall, slender leaves, often growing as clumps in standing water.

Table 2.5
Column Sample Pollen Counts

Taxon	Sample 9	10	12	13	14	16
Pseudotsuga	1	1	0	2	0	1
P. ponderosa	78	53	29	42	16	32
P. edulis	103	105	55	61	18	45
Pinus undif.	198.5	170	114.5	195.5	81	140.5
Abies	19	6	8	7	3	6
Juniperus	21	18	22	52	47	45
Cupressaceae	13	5	2	0	4	7
Populus	21	19	42	68	49	47
Salix	7	4	8	7	6	5
Ephedra	1	1	1	2	1	3
Artemisia tridentata	0	0	2	3	0	0
Atriplex	11	10	22	16	12	24
Ambrosia	10	5	12	5	11	1
Cheno-Am	106	105	123	258	119	96
Sphaeralcea	4	0	11	18	3	0
High-spine Asteraceae	0	0	0	1	0	0
Low-spine Asteraceae	8	2	13	20	8	5
Typha	0	0	0	0	0	1
Ranunculaceae	1	0	0	9	0	0
Wild grass	0	0	1	0	3	3

Distinguishing between wild grasses and domesticated cereal grains was a crucial aspect of this study. Poaceae pollen is monoporate, meaning it has a single pore, and typically psilate, meaning it has a smooth surface without sculpturing. Grain size is an important characteristic when identifying grasses. The grains of wild grasses are small, approximately 20-30 μm, whereas the pollen from domesticated taxa are significantly larger. Wheat pollen is generally about 50 μm in diameter, while barley averages 32-45 μm. Maize pollen grains are even larger, measuring about 100-110 μm. The size of the annulus–the thickened ridge around the pore–is diagnostic. Wild grains have smaller annuli, approximately 5 μm, while domesticated grains are larger, about 7-10 μm. The annulus wall is also slightly thicker on domesticated pollen grains

(Tweddle et al. 2005). Wheat and barley pollen are morphologically very similar. In many instances, the grains were too degraded to be able to differentiate them confidently, but the better-preserved grains demonstrated this size differential more readily. However, since I could not routinely differentiate between wheat and barley, all European cereals are categorized together as “Old World cereals. ”

Table 2.6
Pinch Sample Pollen Counts

	Sample							
Taxon	321	323	439	420	442	450	451	454
Pseudotsuga	0	0	1	0	1	0	0	0
P. ponderosa	14	30	32	38	12	23	22	40
P. edulis	13	30	23	70	18	41	29	55
Pinus undif.	32.5	65	67.5	112	35.5	66.5	53	102
Abies	5	7	7	6	5	7	3	7
Juniperus	23	23	15	20	17	31	9	13
Cupressaceae	0	1	1	0	1	0	1	0
Populus	19	25	16	22	16	21	13	14
Salix	14	16	19	3	15	21	3	5
Ephedra	4	0	2	2	1	2	3	1
Artemisia	3	0	6	0	0	4	11	4
Atriplex	24	11	10	10	17	22	11	12
Ambrosia	10	6	14	7	5	1	1	15
Cheno-Am	53	61	92	69	175	67	35	89
Sphaeralcea	22	15	9	22	1	13	10	8
High-spine Asteraceae	9	20	0	3	2	3	4	3
Low-spine Asteraceae	36	13	20	7	18	13	16	13
Onagraceae	1	2	1	0	1	1	1	0
Ranunculaceae	6	3	1	1	0	0	0	0
Wild grass	33	32	28	20	24	52	140	16
Zea mays	11	14	2	0	0	5	1	1
Cerealia	1	3	3	1	3	0	0	0
Cucurbita	2	1	0	0	0	0	0	0

The pollen counts were entered into Tilia, a computer program which calculates the sums of each taxon and percentages within each sample (Table 2.5, 2.6). The column data were then converted into a pollen diagram to graphically represent comparative fluctuations in pollen levels through time. The taxa appear at the top of the graph along the x axis, while the y axis shows the depth of the samples in centimeters below surface and radiometric date. The pollen diagram generated from the column data (Figure 2.3) shows a series of fluctuating taxa. The samples range in date between AD 1517 and 1751 a time scale of approximately 250 years, which encompasses the occupation of LA 20,000. The pollen profile immediately before and after the occupation of LA 20,000 is important in order to understand how the occupation of this area impacted the environment within the longer-term trajectory of the local ecology.

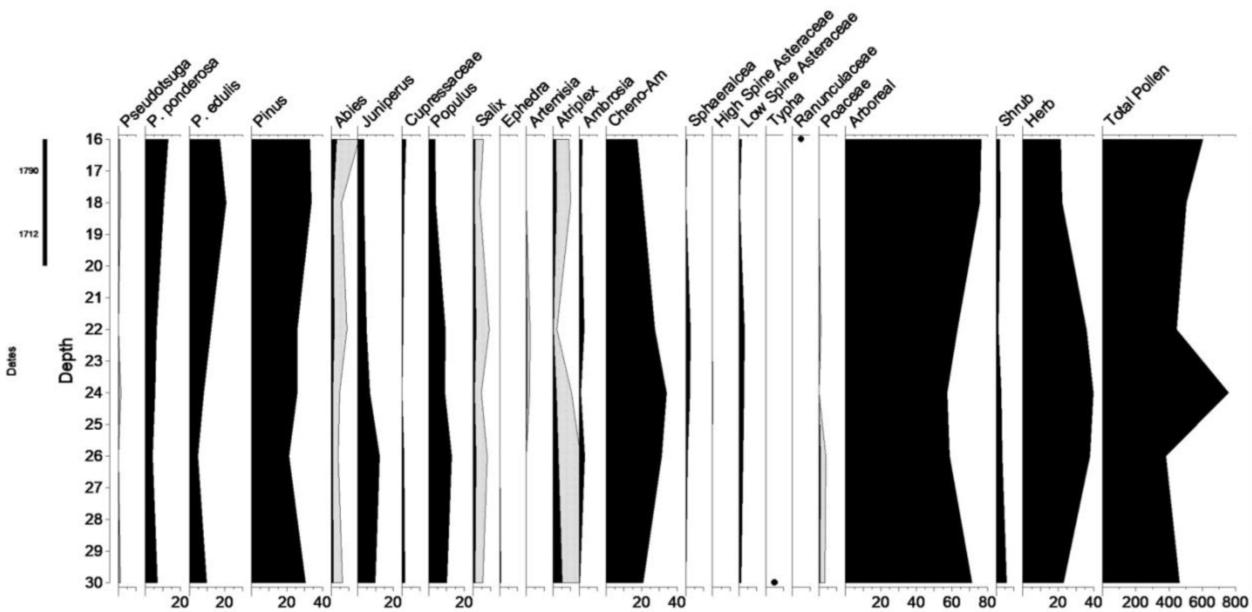


Figure 2.3. Diagram showing the pollen column profile.

The earliest dates in the pollen column refer to samples that were 26-32 cm deep (Samples 14 and 16) and reflect the time prior to the Spanish occupation of the site, from AD 1517-1595. During this period presence of arboreal pollen, most notably, pinyon and ponderosa pine decreased. Fir and willow, too, decrease over time, but less dramatically than pine. Juniper and cottonwood increase slightly. Shrubs, including ephedra and saltbush (decrease), and herbs, including ragweed and Cheno-ams, increase.

LA 20,000's occupation corresponds to sediments at 20-26 cm in depth (Samples 12 and 13). During this interval, the vegetation had changed in a number of ways. Pine, including ponderosa and pinyon, increase. Juniper decreases significantly, and riparian vegetation such as cottonwood and to a lesser extent willow, also decrease. These patterns indicate changes in the plant communities immediately around the collection area. The arboreal vegetation around the site was likely impacted by collection of wood for fuel. The increase in fir and ponderosa furthermore suggests an increase in long-distance dispersal of wind-pollinated arboreal pollen. Juniper and cottonwood both increase, but juniper less markedly so. Saltbush first decreases and increases slightly. The most notable change during this interval is the dramatic increase in Cheno-ams early in the occupation followed by a decline, probably reflecting the disturbance caused by the occupation of the site and the presence of livestock. Mallow (*Sphaeralcea*) increases during the occupation of the site and then declines after LA 20,000 was abandoned. Ranunculaceae, a marshy plant, occurs at the early end of this time period.

The samples at a depth of 16-20 cm correlate to the years AD 1712-1790. Ponderosa pine increases during the first half of this time period, and spikes again in the late 18th century. Pinyon pine increases, and then slightly decreases around the same time that ponderosa pine increases again. Fir remains steady until the latter half of the 18th century when it slightly increases. Juniper, willow, and cottonwood decline and then remain steady. Sagebrush decreases, and tapers off early in this period. Ephedra remains steady. Saltbush increases. Cheno-ams remain steady. No marshy plants, such as cattail, were recovered from this suite of data. One grain of maize was recovered from Sample 9, at a 16-18 cm depth, in preliminary analysis, but no grains after that were identified and maize was not included in the final counts. However, its presence does corroborate existing palynological evidence of agricultural maize production in the area (KW Edwards 2015:61), but dating well after the occupation of LA 20,000. Grasses of any sort were rare throughout the sequence.

The arboreal and shrub species observed in the on-site samples did not vary significantly from the column profile. However, the on-site samples included domesticated taxa including cereals, maize, and cucurbits. These taxa are significant because they indicate the presence of agro-pastoral activities at LA 20,000 during the 17th century. The presence of cereal pollen is also noteworthy because these species are rarely found in the archaeological record, and they were not recovered in the off-site column. The proximity of the off-site profile to the highly anthropogenic deposits of the barn and house reflect the poor dispersal of cereal pollen and the critical need for examining site deposits in addition to wetland cores. A greater variety of insect-pollinated species, including flowers in the evening primrose family, prickly pear cactus, and ephedra were found in these samples.

Wild grasses were observed with far more frequency in the on-site samples than in the column samples. Nonetheless, the majority of the observed pollen grains belonged to arboreal or ruderal plants. This is not unusual because these species produce great amounts of pollen which fall across a wide area, thus, are far more frequently identified than insect- or self-pollinated species (Kelso and Beaudry 1990:61).

By comparing archaeological pollen assemblages with known palynological signatures associated with agriculture and animal grazing, changes in vegetation can be correlated with what is already known about agro-pastoral practices at LA 20,000 based on architectural, faunal and macrobotanical evidence.

The presence of wheat in these samples is highly significant. Documentary evidence indicates that wheat was cultivated in early colonial New Mexico, in the forms of letters, inventory lists, and reports (Hammond and Rey 1953; Trigg 1999). It was clear from these documents that the difficulty of wheat cultivation did not dampen enthusiasm for the European crop. Indeed, by 1601, the first mill to process wheat had been built, and a number of productive wheat fields had been established (Trigg 1999:202-203). The presence of Old World cereal pollen is significant. Prior to this project, Edwards (2015) observed maize pollen in his core from the Leonora Curtin Wetland Preserve, but no Old World cereals. Trigg (1999) recovered wheat and barley seeds in flotation samples from midden deposits, and Jacobucci (Jacobucci and Trigg 2011) tentatively identified one cereal pollen grain in a poorly defined context at LA 20,000. Therefore, this project provides the first securely identified Old World cereal pollen from LA 20,000. These findings were significant, especially when combined with the presence of the wheat kernels at LA 20,000.

Discussion

2015-G Pollen Column

One objective of this study is to understand the local environment around LA 20,000 as it reflects human activity at the site. Because pollen assemblages typically have local and regional pollen inputs, it can be difficult to disentangle local from regional signatures. Some palynologists have suggested that arboreal pollen reflects regional vegetation patterns, whereas herbaceous pollen is indicative of local vegetation (Kelso and Beaudry 1990:61). However, in an environment as open as that of LA 20,000 and where changes in local tree cover could signal important activities, I sought a more refined way of identifying vegetation around the site. In order to accomplish this, I compared the 2015-G pollen column assemblage with previous palynological research undertaken at the Leonora Curtin Wetland Preserve, a 35-acre protected area managed by the Santa Fe Botanical Garden (Edwards 2015; Edwards and Trigg 2016). The Leonora Curtin Wetland Preserve is located approximately two miles away from LA 20,000 Differences in assemblages between the two closely located sites suggest local inputs. The immediate environment around LA 20,000 today is drier than the Leonora Curtin area, but a recent drop in the water table and other factors near LA 20,000 have caused the decline in surface water and riparian vegetation that is evident today. In the 17th century, these areas would have been similar.

The earliest years encompassed by the analyzed 2015-G samples correspond approximately to AD 1517-1595, reflecting the period prior to the Spanish occupation of the site. This interval shows that LA 20,000 was located near a riverine environment, characterized by the presence of trees such as cottonwood/aspen and willow, which prefer moist environments near rivers and streams. Similar to Edwards' data there is a high proportion of Cheno-Ams and grasses are declining. Edwards' data indicated that the pre-Hispanic environment was dominated by a meadow-like landscape with high levels of ruderal taxa based on the relative percentages of high-spine Asteraceae and Cheno-ams (Edwards 2015:60–61), along with small amount of cattail and members of the parsley family (Apiaceae). Together, these species suggest moist meadow and perhaps standing water. The presence of these particular taxa in Edward's study is unsurprising, due to the fact that the core was taken from pond sediment in a wetland. The LA 20,000 pollen column profile also indicates a proximity to water as there is a small number of cattail and buttercups which thrive in and near water.

The 17th-century inhabitants of LA 20,000 had access to a flowing stream, rather than wetlands like Leonora Curtin. These differences in hydrology – one with marshy, standing water and the other with a running stream – could contribute to the observed differences in the pollen record.

A major difference between the Leonora Curtin core and the LA 20,000 pollen column is the divergence in populations of low-spine Asteraceae and Cheno-ams. Edwards' data show higher levels of low-spine Asteraceae as compared to the 2015-G data. Conversely, the LA 20,000 data show higher levels of Cheno-ams than Edwards' data. This, too, could be attributed to the different hydrology at LA 20,000 and Leonora Curtin. Schoenwetter (1962) suggests that Cheno-ams prefer to grow in dissected floodplains with low water tables, whereas low-spine Asteraceae are associated with wet, marshy environments with higher water tables. Since the area around LA 20,000 was characterized by the La Cienega stream, it is likely that the Cheno-ams proliferated in the soil disturbed by this stream. Conversely, the wet sediments of Leonora Curtin would have been more hospitable to low-spine Asteraceae (Edwards 2015; Schoenwetter 1962).

During the occupation of LA 20,000, pollen patterns include steady herb and shrub levels, high proportions of ruderal pollen including low spine Asteraceae, and high percentages of pine pollen. The relative percentages and proportions of taxa are similar between Edwards' data and LA 20,000 column data. That is, both datasets demonstrate relatively high percentages of pine – likely due to the significant pollen production and wide dispersal range of these wind-pollinated trees – as well as high proportions of Cheno-ams, but lower levels of insect pollinated high-spine Asteraceae. The increase in pine is well documented in the region and may have climatic rather than anthropogenic basis (Hall 1977). One maize pollen grain was recovered from Edwards' Zone III; the only maize pollen from LA 20,000 column was found at relatively the same time. Furthermore, different profiles of cottonwood and juniper between Leonora Curtin and LA 20,000 suggest localized patterns relating directly to the establishment of LA 20,000. Edwards' data show low and steady levels of these trees throughout the profile, whereas at LA 20,000, juniper, Cupressaceae and cottonwood/aspen decline. This suggests that there were changes to juniper and riverine trees in the early 17th century that were localized to LA 20,000 and did not extend to the wider region.

Ponderosa pine, pinyon pine, and fir all increase as juniper and cottonwood decrease at LA 20,000. Ponderosa pine and fir do not grow near LA 20,000, rather preferring alpine zones. This suggests the long distance transport of pollen from trees growing in the mountains. According to the column data, over time, pine pollen experiences a steady increase, like the pollen core from Leonora Curtin. But the Curtin core does not show a similar decrease in cottonwood and juniper (TCT). This suggests the decrease at LA 20,000 is a local phenomenon, probably related to household activities such as construction and fuel. Additionally, a spike in the Cheno-ams early in the historic period suggests field clearance and the presence of livestock, as these plants thrive in soils disturbed by agriculture.

Spot Samples

While the column data focus on the ecological history of LA 20,000, the on-site data provide an even more site-specific understanding of land use and agricultural activities at 17th-century ranches. The on-site data tackle the importance and environmental implications of the Spanish-introduced Iberian agro-pastoral complex which centered on Old World grains and domesticated mammals. Sheep, cattle, horses, and other Old-World mammals were introduced in the 16th and 17th centuries with the advent of Spanish settlement in the region. Animal husbandry required large tracts of grassy plains for grazing.

There were significant ecological costs associated with the introduction of the Iberian agro-pastoral complex. Generally, the most visible deforestation, desertification, and erosion in New Mexico's ecological history occurred when Anglo-Americans began flooding into the west, causing significant environmental damage due to the dramatic increase in population (Liebmann et al. 2016:696). However, there were detectable ecological fluctuations caused by Pueblo agriculture, as well as substantial landscape changes wrought by Spanish colonists in the early colonial period. The introduction of animal husbandry is apparent in the palynological record on both a large and small scale. The emergent patterns in the column data, discussed above, allude to regional changes in the environment in the decades following the introduction of domesticated herbivores. On a smaller scale, pollen analysis of domestic surfaces in archaeological contexts has shown that taxa identified from indoor floors suggest foddering and bedding practices.

At LA 20,000, the importance of livestock is demonstrated architecturally by the relatively extensive barn and corral complex. Pollen sampling from manure layers in the barn and corrals suggest what types of plants that the animals on the site were consuming. Determining whether wild grasses, domesticated cereal grains or other plants appear in animal manure illuminates foddering practices (Rosen 2005:2). For this reason, I specifically targeted strata containing layers of manure in the barn and corral. Samples 439, 442, 450, and 451 were samples from manure layers in order to analyze the diets of the livestock on-site. However, not all of the on-site samples are associated with manure layers. Samples 321 and 323 were collected above and between burn layers. Samples 420 and 454 were collected from historic floor surfaces. These samples, taken from the barn and the house, were collected in order to understand how pollen deposited differently across the site and how those patterns correspond to activity areas.

In the following discussion, data from the on-site samples are displayed in pie charts on a map rather than as a pollen diagram. This kind of spatial analysis, while common for other types of archaeological data, is relatively rarely done in palynological studies. The first map of the on-site data with pie charts showing the proportions between types of vegetation shows the relationships between arboreal, herb, and domesticate species (Figure 2.4). For the sake of simplicity, shrub species are included in the arboreal category. In this map, arboreal and herb species dominate, so it is overall difficult to understand the spread of domesticate species. However, it is important to note that while arboreal and herb pollen dominate, there is an observably high level of domesticated species in the barn and corral areas. It is also interesting that arboreal and herb pollen is so common across the site, even inside the house. This suggests that the pollen rain from these species was significant enough across the site that wind-blown pollen was deposited inside the structures and people perhaps also tracked it into the house. It is particularly noteworthy that the herb species appear in relatively high quantities; in almost all the units, there is even more herb than arboreal pollen. In the column samples, it is the reverse – there is more arboreal pollen than herb pollen. This supports the data from the column samples that indicates ruderal weeds—the most frequent type of herb species in the data—thrived at LA

20,000, further indicating disturbance at the site. Grasses are conspicuously more common in the on-site samples, perhaps relating to the use of grasses as fodder (grazing) and the use of grasses in roof construction.

In order to more closely examine the patterns of domesticate cereal pollen deposition across the site, it is necessary to distill the most relevant species onto the map and eliminate the background taxa. Excluding arboreal and herb pollen (except for wild grasses) makes it easier to understand more specifically which taxa appear in the manure layers. Based on macrobotanical evidence from the site, it is possible that livestock were consuming some Old World grains, particularly barley, which was grown as animal feed, along with non-domesticated grasses and herbs that grow well in disturbed soils (Trigg 1999:157). The on-site pollen data corroborates the macrobotanical evidence that Old World grains were being produced at the farm and further suggests that livestock were eating grasses and Old World grains (Figure 2.5).

Figure 2.4 Proportions of arboreal/shrubs, herbs, and domesticates at various locations around the site.

In two of the units with manure —2017-H and 2017-F— there is a relatively high proportion of Old World cereals, suggesting that the livestock were eating wheat and/or barley plants or chaff. In Spain, barley was a lower-status grain and was mostly used for animal feed (Simmons 1996:72). Thus, it seems likely that barley may have been a source of food for the livestock at LA 20,000, therefore accounting for the presence of Old World pollen grains in the manure layers of the barn and corral. Alternatively, the livestock could have been stubble grazing the farm’s wheat fields after they had been harvested (Raish 1996:190). Maize, a New World grain appeared in overall greater quantities than Old World cereals. The preponderance of New World grains in these samples may corroborate documentary evidence that Spanish livestock encroached on and grazed the Pueblos’ maize fields. (Kessell 2013:40) or the colonists’ own fields. Maize stalks, leaves, and cobs may also have been used as fodder. Furthermore, this evidence indicates that there were maize and wheat fields near LA 20,000.

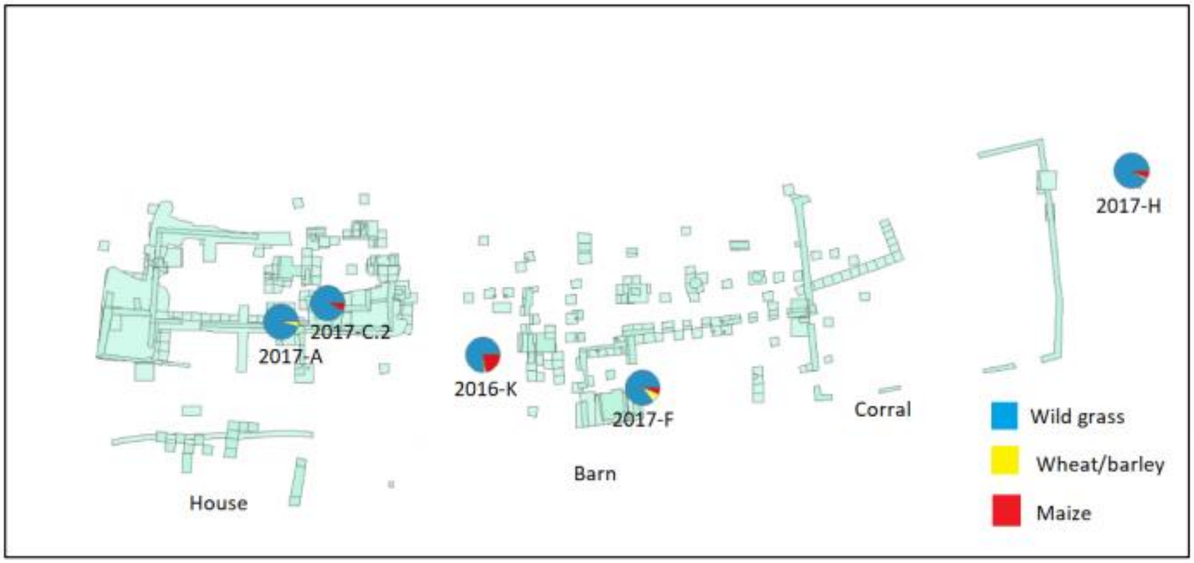


Figure 2.5. Proportions of wild grass, wheat/barley, and maize at various locations around the site.

An interesting pattern emerged from the proportions between Old and New World grains in 2017-A and 2017-C.2. Both of these units are inside the house. They are both dominated by wild grasses, but 2017-A has a higher incidence of Old World species, while maize dominates 2017-C.2. A possible interpretation for this could be that both these cereals were being made into food items (such as bread or tortillas) inside the house, thus accounting for the deposition of pollen inside. Several species of horticultural pollen were found in 2016-K, where wheat pollen was also found. Garden plants are grown on a smaller scale than agricultural field crops. A horticultural taxon found in this data includes a species in the Cucurbitaceae family. This suggests that the area surrounding 2016-K may have once been the home of a kitchen garden. Prickly pear cactus (*Opuntia* spp.) pollen was found at the site. Cactus was an important source of food for many years for Pueblo communities across New Mexico (Reinhard et al. 2006:104) and may have also been consumed at LA 20,000. These data, along with macrobotanical remains of horticultural plants such as peaches and apricots, suggest the production of small-scale garden plants to supplement food procured through agriculture and foraging. The higher percentage of maize in 2016-K may indicate that the inhabitants on the site were perhaps shucking corn in this area, which would deposit high levels of maize pollen.

The palynological data from LA 20,000 exemplifies how the colonization of New Mexico altered the character of the physical landscape. Pueblo agriculture shaped the environment, while the Spanish introduction of agropastoralism left a distinct ecological footprint at LA 20,000. The palynological signatures observed at LA 20,000 demonstrate perceivable differences from the characterization of the Leonora Curtin Wetland Preserve, thus illuminating local patterns. Meanwhile, synchronic data from the site illustrates the nature of agriculture and animal husbandry.

Conclusion

The main goal of this study was to identify localized variation in the long-term pollen profile of LA 20,000, with a focus on the period of settlement between 1630-1680 and to characterize the palynological signatures of agro-pastoral practices at LA 20,000 through the analysis of barn and house deposits. Two sets of data—one diachronic, the other synchronic—were used to explore these questions. The diachronic samples collected from a pollen column on the southern edge of the site showed fluctuations in plant communities which represent the dynamic nature of the physical landscape changing in response to human land-use. This dataset was also used to define local versus regional environmental patterns using previously analyzed data observed in a pollen core taken from lake sediment at the Leonora Curtin Wetland Preserve. These complementary data illuminate a few important patterns: that LA 20,000 was located near a perennial stream, while Leonora Curtin was significantly more marshy with standing water; and that there was likely more intensive, earlier deforestation at LA 20,000 than Leonora Curtin. Some of the changes ushered in by Spanish colonists have had long-lasting impacts and have directly informed the character of the landscape of La Cienega today.

The on-site data tell a slightly different story. The presence of Old World cereal pollen on the site is significant in itself, as this is the first time that such pollen has been securely identified at LA 20,000. The presence and distribution of domesticated cereal grains elucidates foddering and agricultural practices. Both New and Old World crops were recovered from the sediment samples collected at LA 20,000, supporting documentary and macrobotanical evidence that colonists were growing maize, wheat, and barley. The spatial distribution of these species illuminates foddering practices, suggesting that livestock probably subsisted primarily on wild grasses, supplemented by stubble grazing on their agricultural fields.

References Cited

Brand, Donald D.
1936 *Notes to Accompany a Vegetation Map of Northwest Mexico.* University of New Mexico, Albuquerque, NM.

Brugam, Richard
1978 Pollen Indicators of Land-Use Change in Southern Connecticut. *Quaternary Research* 9:349–362.

Bryant, Vaughn M.
1974 Prehistoric Diet in Southwest Texas: The Coprolite Evidence. *American Antiquity* 39(3):407–420.

Bryant, Vaughn M., and Stephen A. Hall
1993 Archaeological Palynology in the United States: A Critique. *American Antiquity* 58(2):277-286.

Bryant Jr, V.M. and R. G. Holloway
1985 A late-Quaternary paleoenvironmental record of Texas: an overview of the pollen evidence. *Pollen Records of late-Quaternary North American Sediments*, pp. 39-70.

Calderone, Nicholas W.
2012 Insect Pollinated Crops, Insect Pollinators and US Agriculture: Trend Analysis of Aggregate Data for the Period 1992–2009. *PLoS ONE* 7(5): e37235.

Carlquist, Sherwin
1989 Wood and Bark Anatomy of the New World Species of Ephedra. A*liso: A Journal of Systematic and Evolutionary Botany* 12(3):441-483.

Cronon, William
2003 *Changes in the Land: Indians, Colonists, and the Ecology of New England*. Hill and Wang, New York, NY.

Dean, Glenna, and H. Wolcott Toll
1995 In Search of the Rare: Pollen Evidence of Prehistoric Agriculture. In *Soil, Water, Biology, and Belief in Prehistoric and Traditional Southwestern Agriculture*. H. Wolcott Toll, editor, pp. 353-359. New Mexico Archaeological Council, Albuquerque.

Dick-Peddie, William A.
1999 *New Mexico Vegetation: Past, Present, and Future*. University of New Mexico Press, Albuquerque, NM.

Edwards, Kevin J., Ralph M. Fyfe, Chris O. Hunt, and J. Edward Schofield
2015 Moving forwards? Palynology and the human dimension. *Journal of Archaeological Science* 56: 117-132.

Edwards, Kyle W.
2015 *Environmental Dimensions of Colonial Settlement: A Palynological Investigation of La Cienega, New Mexico.* Master's thesis, Department of Anthropology, University of Massachusetts, Boston.

Edwards, Kyle W., and Heather B. Trigg
2016 *Intersecting Landscapes: A Palynological Study of Pueblo, Spanish, and Anglo American Land Use in New Mexico*. Historical Archaeology 50(1):135–153.

Endfield, Georgina and Sarah O'hara
1999 Degradation and Drought, and Dissent: An Environmental History of Colonial Michoacan, West Central Mexico. Annals of the Association of American Geographers 89:402-419.

Fisher, Christopher T., Helen P. Pollard, Isabel Israde-Alcántara, Victor H. Garduño-Monroy, and Subir K. Banerjee
2003 A reexamination of human-induced environmental change within the Lake Patzcuaro Basin, Michoacan, Mexico." *Proceedings of the National Academy of Sciences* 100(8): 4957-4962.

Ford, Richard
1979 Paleoethnobotany in American Archaeology. *Advances in Archaeological Method and Theory* 2:285–336.

Fuller, Janice L., David R. Foster, Jason S. McLachlan, and Natalie Drake

1998 Impact of Human Activity on Regional Forest Composition and Dynamics in Central New England. *Ecosystems* 1(1):76–95.

Gruber, Anya
2018 *Palynological Investigations of Agropastoralism and Ecological Change at LA 20,000, New Mexico*. Master's thesis, Department of Anthropology, University of Massachusetts, Boston.

Hall, Stephen A.
1977 Late quaternary sedimentation and paleoecologic history of Chaco Canyon, New Mexico." *Geological Society of America Bulletin* 88 (11): 1593-1618.

1981 Deteriorated Pollen Grains and the Interpretation of Quaternary Pollen Diagrams. *Review of Palaeobotany and Palynology* 32(2):193–206.

1985 Quaternary Pollen Analysis and Vegetational History of the Southwest. In *Pollen Records of Late-Quaternary North American Sediments*, Vaughn M. Bryant, Jr. and Richard G. Holloway, editors, pp. 95-123. American Association of Stratigraphic Palynologists Foundation, Dallas, TX.

Hammond, George P., and Agapito Rey
1953 *Don Juan de Oñate: Colonizer of New Mexico.* University of New Mexico Press, Albuquerque, New Mexico.

Hansen, Barbara S., and Edward J. Cushing
1973 Identification of Pine Pollen of Late Quaternary Age from the Chuska Mountains, New Mexico. *GSA Bulletin* 84(4):1181–1200.

Hevly, Richard H., Peter J. Mehringer, and Harrison G. Yocum
1965 Modern Pollen Rain in the Sonoran Desert. *Journal of the Arizona Academy of Science* 3(3):123–135.

Jacobucci, Susan and Heather Trigg
2011 *Environmental History and Local Land Use Practices in the Spanish Southwest: Palynology at a 17th-Century New Mexican Ranch*. Paper presented at the 34th annual conference of the Society of Ethnobiology. May 4 -7. Columbus, OH.

Kapp, Ronald O.
1969 How to Know Pollen and Spores. William C. Brown Company Publishers, Dubuque, Iowa.

Kelso, Gerald K., and Mary C. Beaudry
1990 Pollen Analysis and Urban Land Use: The Environs of Scottow's Dock in 17th, 18th, and Early 19th Century Boston. *Historical Archaeology* 24(1):61–81.

Kessell, John L.

2003 *Spain in the Southwest: A Narrative History of Colonial New Mexico, Arizona, Texas, and California*. University of Oklahoma Press, Norman, OK.

Klein, Alexandra-Maria, Bernard E. Vaissi re, James H. Cane, Ingolf Steffan-Dewenter, Saul A. Cunningham, Claire Kremen, and Teja Tscharntke
2007 Importance of Pollinators in Changing Landscapes for World Crops. *Proceedings of the Royal Society of London B: Biological Sciences* 274(1608):303–313.

Loureiro, Iñigo, María Concepción Escorial, José Luis González-Andujar, José Maria García-Baudin, and María Cristina Chueca
2007 Wheat Pollen Dispersal under Semiarid Field Conditions: Potential Outcrossing with Triticum aestivum and Triticum turgidum. *Euphytica* 156:25–37.

Liebmann, Matthew, and Robert W. Preucel
2007 The Archaeology of the Pueblo Revolt and the Formation of the Modern Pueblo World. *Kiva* 73(2):195–217.

Melville, Elinor G. K.
1990 Environmental and Social Change in the Valle Del Mezquital, Mexico, 1521-1600. *Comparative Studies in Society and History* 32(1):24–53.

Mudie, Peta J., and Roger Byrne
1980 Pollen Evidence for Historic Sedimentation Rates in California Coastal Marshes. *Estuarine and Coastal Marine Science* 10(3):305-316.

Pearsall, Deborah M.
2015 *Paleoethnobotany: A handbook of procedures*. 3rd Edition. Left Coast Press, Walnut Creek, CA.

Raish, Carol
1996 Historic land use and grazing patterns in northern New Mexico. In *Desired Future Conditions for Southwestern Riparian Ecosystems: Bringing Interests and Concerns Together*, Douglas W Shaw, Deborah M. Finch, editors, pp. 189-198. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Reinhard, Karl J., Sherrian Edwards, Teyona R. Damon, and Debra K. Meier
2006 Pollen Concentration Analysis of Ancestral Pueblo Dietary Variation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 237(1):92–109.

Rosen, Arlene M.
2005 Phytolith Indicators of Plant and Land Use at Çatalhöyük. In *Çatalhöyük Project Volume IV: Inhabiting Çatalhöyük*, Ian Hodder, editor, pp. 203–212. MacDonald Institute, Cambridge University, Cambridge.

Schoenwetter, James

1962 The Pollen Analysis of Eighteen Archaeological Sites in Arizona and New Mexico. *Fieldiana. Anthropology* 53:168–209.

Shyrock, Daniel F., Caroline A. Havrilla, Lesley A. DeFalco, Todd C. Esquel, Nathan A. Custer, Troy E. Wood
2015 Landscape genomics of *Sphaeralcea ambigua* in the Mojave Desert: A multivariate, spatially-explicit approach to guide ecological restoration. *Conservation Genetics* 16:1303–1317.

Simmons, Marc
1996 *Coronado's Land: Essays on Daily Life in Colonial New Mexico*. University of New Mexico Press, Albuquerque, NM.

Traverse, Alfred
2008 *Paleopalynology*, 2nd ed. Springer. Dordrecht, NL.

Trigg, Heather B.
1999 *The Economy of Early Colonial New Mexico, A.D. 1598-1680: An Investigation of Social Structure and Human Agency Using Archaeological and Documentary Data.* Doctoral Dissertation (Anthropology) University of Michigan.
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, AZ.
2017 *Cultural and Environmental Investigations of a 17th-Century Spanish New Mexican Household: 2017 Excavations at LA 20,000*. University of Massachusetts Boston.

Tsukada, Matsuo
1967 Chenopod and Amaranth Pollen: Electron-Microscopic Identification. *Science* 157(3784):80–82.

Tweddle, John C., Kevin J. Edwards, and Nick R. J. Fieller
2005 Multivariate Statistical and Other Approaches for the Separation of Cereal from Wild Poaceae Pollen Using a Large Holocene Dataset. *Vegetation History and Paleoethnobotany* 14(1):15-30.

Waines, J.G. and S.G. Hegde
2003 Intraspecific gene flow in bread wheat as affected by reproductive biology and pollination ecology of wheat flowers. *Crop Science*, *43*(2), pp.451-463.

Wilcock, Chris and Ruth Neiland
2002 Pollination Failure in Plants: Why It Happens and When It Matters. *Trends in Plant Science* 7(6):270–277.

Chapter 3
An Analysis of Faunal Remains from LA 20,000

By Ana C. Opishinski

Introduction

This chapter explores the faunal remains recovered from LA 20,000. This early colonial ranch is one of the few 17th-century Spanish sites in New Mexico where the faunal remains have been systematically analyzed. As part of an agrarian society, the Spanish settlers relied heavily on crops and livestock to develop their colony and produce goods. Animal husbandry engaged not only the colonists in New Mexico but Indigenous people as well, and animals and their secondary products were important for the colony's economy and trade with the colonial core in Mexico. Domestic animals were used for traction, in combat, their hides for a myriad of uses, and perhaps most importantly, animals were an important component of colonists' diet.

Understanding food and diet at LA 20,000 means interpreting how Spanish colonists brought domesticated Eurasian animals and new plant species into an environment where they had not previously existed *and* into contact with Indigenous people who had their own, separate foodways traditions and methods of acquiring food. The groups the Spanish colonists interacted most closely with were the Pueblos because they lived in permanent settlements along waterways. Though the Spanish called the Pueblos by one name, "Pueblo," and they shared some cultural traits, they were not a single unified tribe and possessed no common language (Liebmann 2015:2). Besides living in permanent villages, the Pueblos' main shared cultural trait was their practice of agriculture, but hunting was an important part of their food acquisition. For meat, Pueblos hunted rabbits, hares, squirrel, and other small game, and occasionally larger species such as deer, mountain sheep, and pronghorn (Roberts and Roberts 1986:39; MacCameron 1994:30). Pueblo groups also acquired meat through trade with Plains peoples (Spielmann et al. 2006:103). Besides Pueblos, several nomadic Indigenous groups, such as the Apache and Navajo, inhabited parts of New Mexico and the Southwest. As nomadic hunters and gatherers, these groups relied on wild plants and local game, such as deer, bison and elk, and traded with the Pueblos for maize; after the arrival of European animals in the area, they also consumed cattle, sheep, and horse meat.

European Exploration and the Colonization of New Mexico

Although the first explorations by Europeans into New Mexico began early in the 16th century, the first large, organized expedition occurred in 1540, led by Francisco Vásquez de Coronado. This was followed by several other expeditions that were unsuccessful in developing a permanent settlement in New Mexico. Primary sources reporting these expeditions often contain information about the difficulties the explorers had procuring food and navigating the landscape. For example, one member of Coronado's expedition wrote that when they arrived at Zuni Pueblo they found "something [they] prized more than gold or silver, namely much maize, beans, and chickens larger than those here of New Spain, and salt better and whiter than [they] have ever seen" (Cárdenas 1540:33). Another explorer in 1572 wrote, "They [the Indians from Tularosa village] guided us down through more than fifty leagues, mostly over rugged mountain desert so dry there was a dearth of game, and we suffered great hunger" (Cabeza de Vaca quoted in Roberts and Roberts 1986:56). These and other similar sentiments demonstrate the difficulties colonial expeditions had in sustaining themselves and the rugged, food-sparse environment they encountered and for which they were unprepared.

Throughout the latter half of the 16th century, no Spanish ventures into New Mexico were successful in colonizing the region. These expeditions all faced difficulties in provisioning and feeding themselves and relied on Pueblo peoples for food, sometimes trading for victuals, sometimes taking them by force. These interactions often led to unfriendly or hostile relations between the colonists and the Pueblos, and set the tone for Juan de Oñate's expedition, the Spanish venture that succeeded in colonizing New Mexico in 1598.

Juan de Oñate's expedition set out for New Mexico on May 4, 1598, bringing with it at least 2,098 head of cattle, 1,547 horses, 118 other equids (i.e., donkeys, mules), 4,376 caprines (sheep and goats), 55 hogs, and 202 unspecified animals, all of which are listed in the government inspection performed before Oñate and his party left Mexico (Salazar 1598; Opishinski 2019:14). These inspection documents do not mention other small animals, such as chickens or dogs, which would have undoubtedly been brought on the expedition. Oñate also brought a plethora of plant extracts and oils with him, including chamomile, dill, citrus, myrtle, fennel, rose, quince, marshmallow, and borage, and a following expedition brought saffron, aniseed, almonds, hazelnuts, sesame, walnuts, lavender, rosemary, Jamaica tree fruit, native and Castilian spices, marjoram, pepper, capers, olives, raisins, coriander, and cinnamon (Trigg 2004:228). Later, once the colonists developed farming in New Mexico, they grew cabbage, onions, garlic, lettuce, cucumbers, radishes, artichokes, and carrots (Trigg 2004:228). The many animal and plant species brought by Oñate and members of his expedition indicate both a preparedness for provisioning themselves and a preference for growing and eating familiar European foods that would not be found in New Mexico.

Under *encomienda*, Spaniards were allotted Indigenous people to oversee in exchange for tribute items, such as maize or hides; an *encomienda* grant could last for several generations (Spielmann et al 2006:103; Barrett 2012). The *repartimiento* system allowed Spaniards to force Indigenous people to work for them; colonists were supposed to compensate them for their work, but typically paid little to nothing (Roberts and Roberts 1986:99; Spielmann 1989:106). These systems ensnared many Indigenous laborers into working on Spanish-owned farms and missions, preventing them from working their own land and resulted in diminishing their capacity to produce foods for their own subsistence and for *encomienda* tribute.

Based on the size of LA 20,000, the family living there was wealthy and may have had an *encomienda* grant and therefore had Pueblo and Indigenous servants or slaves working there as farm laborers. Certainly, artifact evidence suggests the presence of Pueblo cooks. Because of this the inhabitants of LA 20,000 were intricately tied together in an economic system revolving around food and food production.

Materials and Methods

Faunal materials from LA 20,000 for this analysis were collected by two different excavation projects: Dr. Marianne Stoller and David Snow's 1980-1995 field schools and by Dr. Heather Trigg's 2015-2017 excavations. Samples from the earlier excavations appear to come from many locations across the whole of LA 20,000 although much of the provenience and excavation information has been lost. An extant bag inventory from David Snow indicates that a portion of faunal samples from his excavations may still be missing from the current collection. Trigg's faunal samples came from various locations, including several midden deposits, the house, barn, corral, and extramural spaces between the structures, and these were generally sieved through a 1/4-inch screen although some feature fill was screened through 1/8-inch mesh. Flotation samples were taken from features for paleoethnobotanical interpretation and would have recovered faunal material smaller than ¼ inch in the heavy fraction. The heavy fractions were visually scanned for diagnostic fragments or complete bones that would have been missed with a 1/4-inch screen.

Each specimen in the extant collection was identified to taxon, element, and side, and was examined for butchery marks, burning, pathologies, and evidence of taphonomic processes according to anatomical and zooarchaeological guidelines outlined by Sisson and Grossman (1953), Olsen (1968,1980), Wheeler and Jones (1989), Hillson (1992, 2005), Fisher (1995), Gilbert, Martin, and Savage (1996), O'Connor (2000), Reitz and Wing (2008), and Beisaw (2013). Many mammalian specimens could not be precisely identified to taxon, so they were sorted into the following size categories based on bone density, curvature, and thickness: Small mammals were considered rabbit-sized or smaller, large mammals were larger than a deer, and medium mammals include everything between those ranges.

After identification was completed, the data set was interpreted by studying and calculating the number of identified specimens (NISP), minimum number of individuals (MNI), potential meat weight, butchery patterns, and kill-off patterns and age profiles; these methods were selected to better interpret the collection for information about diet and butchery practices. Due to the short occupation period of LA 20,000 coupled with the incomplete provenience information for portions of the collection, the whole collection was analyzed as a single unit; spatial analysis was not attempted in this study.

Results

Taxonomic Frequency: NISP and MNI

The collection was made up of a total of 8,832 specimens, weighing 13.36 kg. The specimens were identified to the most specific taxonomic identification, and these fell into 43 different identification groups overall, representing 27 different taxa (Table 3.1). Of these, 3.4% by count could not be identified further than an indeterminate vertebrate category, due to fragmentation or burning that made them unidentifiable. By NISP, mammals dominated the collection, making up 96.4% of the collection, followed by birds (Aves) at 3.1%, boney fishes (Osteichthyes) at 0.4% and amphibians and reptiles (Amphibia/Reptilia) at 0.1%.

When the collection is examined by the most specific scientific classification of each sample, more diversity can be seen (Figure 3.1). In the mammalian category, there were 6,263 specimens that were not able to be identified more specifically than class. By NISP, these made up 70.9% of the whole collection and 76.1% of all identified mammalian specimens. For clarity, they were not included in Figure 3.2. Disregarding these unidentified fragments, the collection shows a dominance of medium-sized mammals, including *Ovis/Capra*, Cervidae, and *Sus scrofa*, and the general "Mammalia-medium" classification, all of which together make up 16.5% of the whole collection by NISP and 64.3% when the unidentifiable fragments are excluded. Large mammals, which include the generic "Mammalia-large" category, *Bos taurus*, and equids, are second-most common and make up 4.9% of the collection or 19.1% when unidentifiable fragments are excluded. The remainder of the collection is comprised of small mammals, fish, reptiles, birds, and amphibians.

Table 3.1
Summary of the LA 20,000 Faunal Collection

Taxonomic ID	Common Name	Count	Weight (g)	MNI
Cervidae	Deer	1	19.1	1
cf. Cervidae	Deer	3	36.8	
Bos taurus	Cow	45	918.9	2
cf. *Bos taurus*	Cow	4	35.2	
Equus caballus	Horse	5	808.2	1
Equus sp.	Horse/Donkey/Mule	34	553.4	1
Ovis/Capra	Sheep/Goat	175	1213.5	6
cf. *Ovis/Capra*	Sheep/Goat	8	70.3	
cf. *Ovis aries*	Sheep	2	37.9	
Suidae	Pig	4	19.4	
Sus scrofa	Domestic Pig	14	111.6	2
Procyonidae sp.	Raccoon	1	0.5	1
cf. *Procyonidae*	Raccoon	1	0.9	
Rodentia	Rodent	2	0.3	1
Sciuridae sp.	Squirrel	2	0.6	
Leporidae sp.	Rabbit/Hare	2	<0.1	1
cf. *Sylvilagus*	Cottontail Rabbit	1	1.1	1
Artiodactyl	Even-toed Mammals (i.e. cow, sheep, pig)	13	35	1
Large Mammalia		346	3363.9	
Medium Mammalia		1253	2450.6	
Small Mammalia		49	19.2	
Mammalia, unid.		6264	3581.5	
Anatidae	Duck/Goose/Swan	1	0.2	1
cf. Anatidae	Duck/Goose/Swan	1	2.1	
Anserinae	Duck/Goose	2	2.1	1
cf. Phasianidae	Ground-living Birds	2	1.2	1
Galliformes	Ground-living Birds	2	1.9	2
Gallus gallus	Chicken	4	4.7	1
cf. *Gallus gallus*	Chicken	1	0.5	
Aves	Birds	248	22.7	2
Cypriniforms	Ray-Finned Fish	4	0.6	1
Perciforms	Ray-Finned Fish	1	0.6	1
Osteichthyes	Fish	28	0.8	
Lacertilia	Lizard	1	<0.1	1
Anura	Frog	2	<0.1	1
Bufonidae	Toad	1	0.2	1
Ranidae	True Frog	2	<0.1	1
Amphibia/Reptilia	Amphibians and Reptiles	3	<0.1	
Vertebrate		298	36.7	
Gastropod	Snail	1	<0.1	
Total		8831	13352.2	

When the mammalian samples are examined separately and only include specimens identified to a sub-class level, a preference for *Ovis/Capra* emerges (Figure 3.2). Although only 317 mammalian bone specimens were identified to a sub-order level, *Ovis/Capra* makes up 58.4% of them, with a total of 185 specimens. This is followed by *Bos taurus,* at 15.5%, which is closely followed by equids at 12.3%. All three of these are European-introduced domesticates. If the four Suidae specimens are assumed to be European swine (Opishinski 2019:47), then introduced domesticated species make up 91.1% of these identified mammals by NISP, clearly dominating the assemblage. In the mammalian category, very few local species were identified, comprising only 1.3% of the identified mammals and less than 1% of the whole collection by NISP. These include one Cervid and three cf. Cervidae bones, representing the only big-game-sized native species, one single *Leporidae* specimen, and one *Sylvilagus* specimen, both of which were traditionally part of the Puebloan diet as small game mammals.

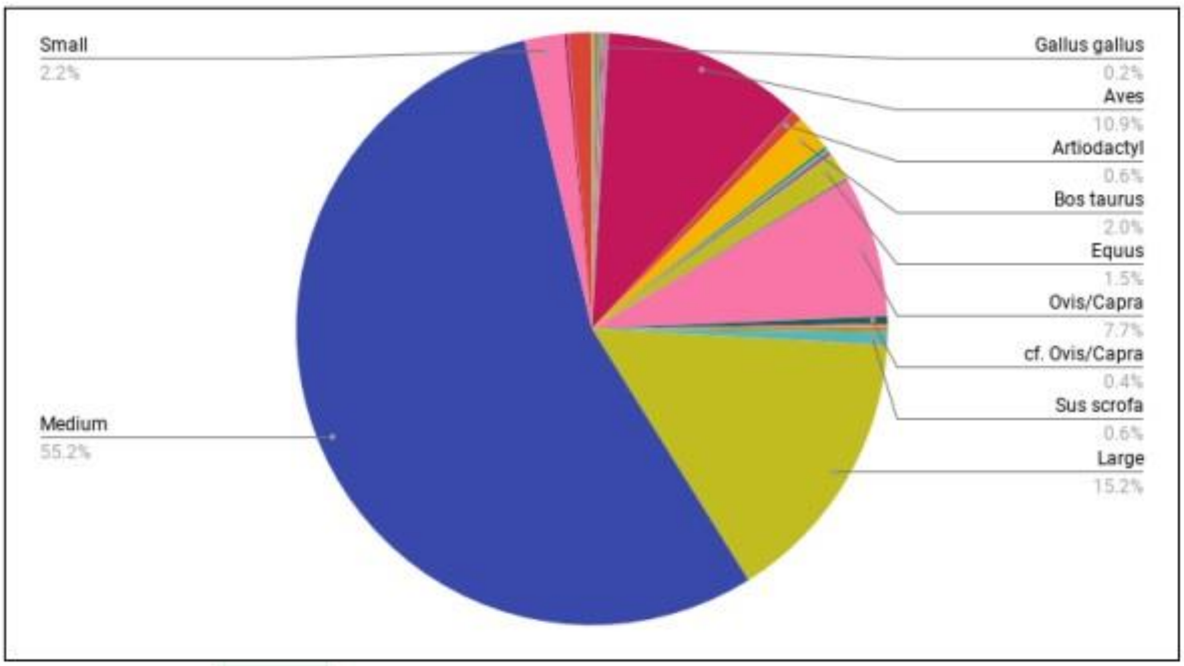


Figure 3.1. LA 20,000 taxa identified by NISP (N=2,269).

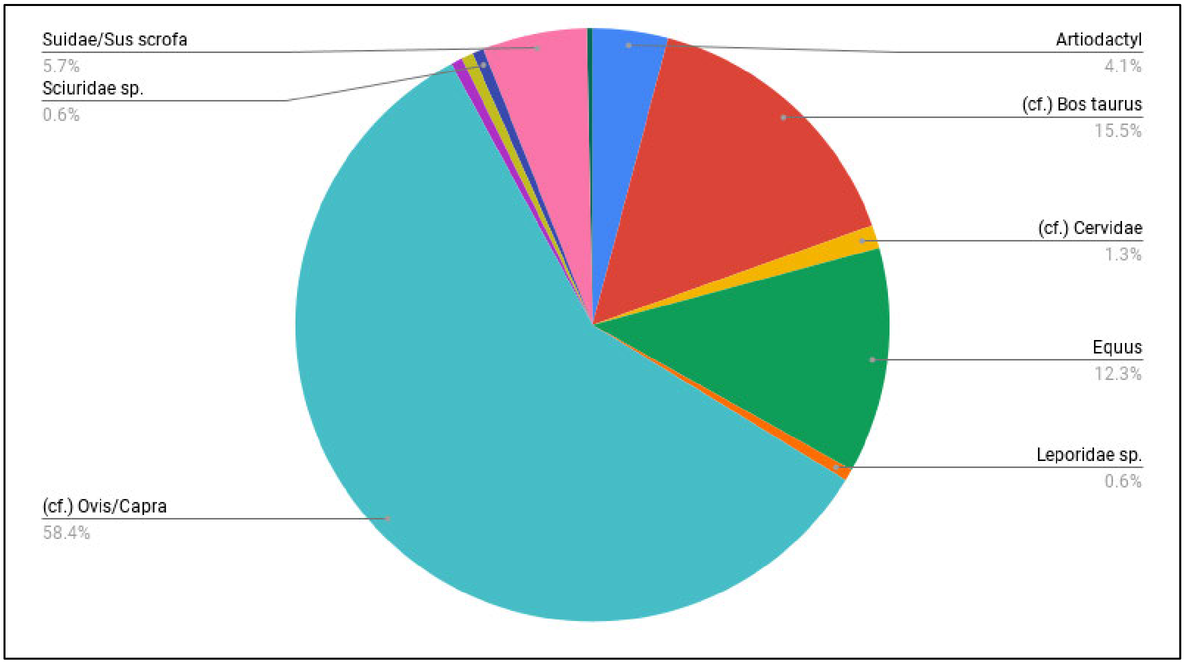


Figure 3.2. Mammalian taxonomic identifications by NISP (N=317).

Of the avian specimens in the collection, 146 were eggshell fragments, so if these are disregarded, only 115 specimens can be attributed to Aves and they comprise a mere 1.3% of the collection. Within this taxon, 102 specimens could not be identified further than the class Aves, and the remaining bones included 2 (cf.) Anatidae, 2 Anserinae, 2 cf. Phasianidae, 3 Galliformes, and 4 *Gallus gallus* specimens. Since most of these are identified to a family or order level, they are not specific enough to know if they represent Old World (Eurasian/African) or New World (American) species; *Gallus gallus*, the domesticated chicken, is the only identified Old World bird species at LA 20,000. The few fish in the collection include 4 Cypriniforms, 1 Perciforms, and 28 general Osteichthyes. Though only 33 fish specimens were recovered, their presence indicates inhabitants of the site were consuming local, freshwater fish species. LA 20,000 is situated on an arroyo that used to be a running stream, so the fish may have been acquired from here or from the nearby Cienega Creek.

Because MNI calculations were only made for specimens identified to a degree more specific than taxonomic order, MNI was only calculated for a total of 24 taxonomic groups (Figure 3.3). In total the MNI for the collection was 33. The most common taxon is O*vis/Capra*, with an MNI of 6, followed by a three-way tie for second place between *Galliformes*, *Bos taurus*, and *Suidae*/*Sus scrofa,* each of which had an MNI of 2. Although MNI calculations tend to underestimate the number of animals that lived at a site, the dominance of *Ovis/Capra* again indicates that sheep/goats were quite prominent at LA 20,000.

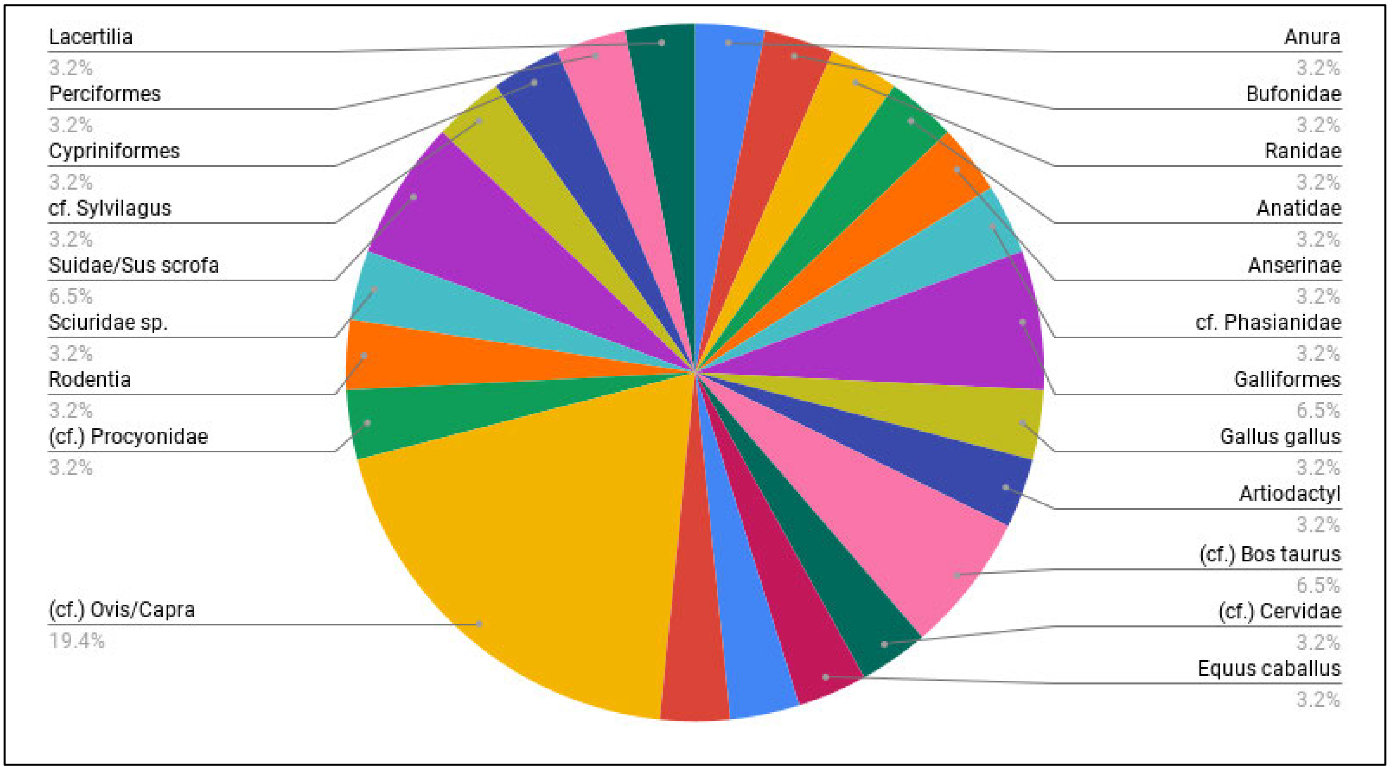


Figure 3.3. LA 20,000 taxa by MNI (N=33).

Potential Meat Weight

Potential meat weight was calculated by finding the estimated weight of all the individuals in a collection by their MNI, and then using predetermined percentages to measure how much of that weight would represent edible meat. This method is based on known relationships between an animal's total weight, skin weight, visceral weight, skeletal weight, and muscle weight taken from published averages, so potential meat weight was calculated using the standard percentages outlined by Reitz and Wing (2008): 70% of the body mass for birds and short-legged mammals and 50% for long-legged mammals. Unfortunately, no data exist on the size or weight of domestic animals in 17th-century New Mexico. To overcome this, other species' known average weights had to be substituted.

To represent the historical domesticated species, the author selected heirloom breeds descended from introduced Spanish domestic stock because they are closest to livestock breeds used before the rise of agribusiness. The heritage breeds selected were the Navajo-Churro Sheep, Spanish Goat, Texas Longhorn, Galiceno Horse, and Choctaw Hog (The Livestock Conservancy 2018). For birds, most were assumed to be wild species, except for *Gallus gallus* (domesticated chicken). For the Anatidae, *Anas platyrhynchos* (mallard) was selected as the sample species because it is one of the most commonly eaten ducks and is native to New Mexico. The example species selected for Anserinae was *Branta canadensis* (Canadian goose) since they are common across and native to New Mexico; the example species selected for cf. Phasianidae was *Meleagris gallopavo* (wild turkey), since they were kept by Pueblo peoples and could have been an easily accessible food source. For the Cypriniforms, the River Carpsucker was chosen as the example species because it inhabits the Rio Grande River basin where LA 20,000 is located and because they are an edible fish. The weights of *Micropterus salmoides* (largemouth bass) and

Micropterus dolomieu (small mouth bass) were averaged together to create the sample species for Perciforms because they are common freshwater fish in New Mexico and are regularly consumed (New Mexico Department of Game and Fish 2015). The average weight for each sample species was multiplied by its MNI and then by the standard percentage to calculate the whole potential meat weight represented in the assemblage.

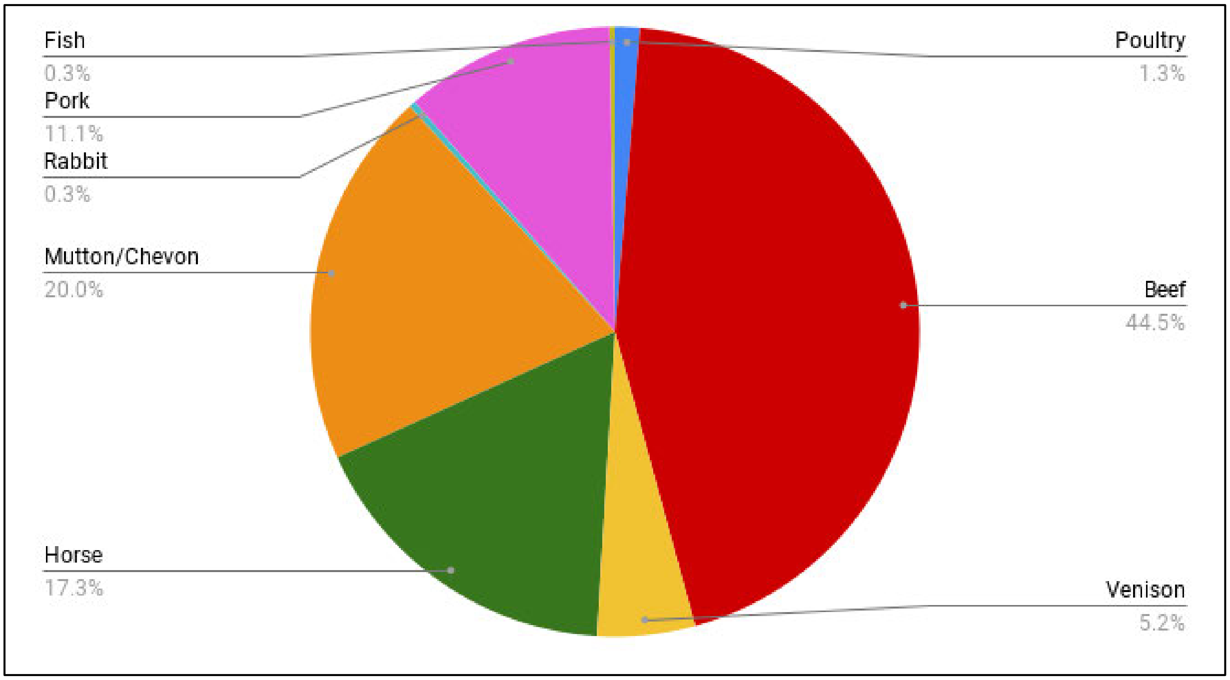


Figure 3.4. Edible meat weight of food species by common name.

Figure 3.4 displays the results of the potential meat weight analysis in terms of common food names. More detailed results can be found in Opishinski 2019:56. Based on this analysis, the most prevalent type of meat at LA 20,000 is beef, accounting for 44.5% of the potential meat weight. Beef was common in the Spanish diet prior to the colonization of the Americas, but the availability of cattle in the Spanish colonies made beef even more popular. Beef and veal are also featured in many 16th-century Spanish recipes, as well as related foods such as beef broth, cow's milk, and butter (De Nola 1529). Though cattle were outranked by *Ovis/Capra* in terms of NISP, the size of cattle compared to these sheep and goats means they potentially contributed more meat to the diet at LA 20,000, as well as dairy products which are not directly reflected by faunal data. Mutton and chevon, especially based on the prominence of *Ovis/Capra* specimens in the collection, would have also been a substantial part of the meat-based portion of the diet at LA 20,000 and represent 20% of the collection's potential meat weight. Recipes from 16th-century Spain include the meat of sheep, lambs, goats, and kids, as well as sheep's or goat's milk and cheese, so, like cattle, these animals and their dairy products were very much a part of historical Spanish cuisine; some 16th-century recipes exist for kid pie, pottage of marinated mutton, sheep spleens, and cheeses (De Nola 1529). Sheep, goats, and cattle are all domesticated herd animals, so their dominance of the diet by potential meat weight is likely the result of them being easily accessible sources of food, especially considering LA 20,000 was a working *estancia*.

Surprisingly, third in rank is horse meat. Although horses were not considered edible in

Spanish culture (Gifford-Gonzalez and Sunseri 2007), the presence of *Equus caballus* bones in the collection with butchery marks indicates at least one horse was butchered, presumably for food, at LA 20,000. This single horse represents 17.3% of the collection's potential meat weight, although beef and mutton likely constituted most of the regular meat intake and horses were probably not eaten often by the colonists. Pork, making up 11.1% of the potential meat weight, was also somewhat common in the diet of those residing at LA 20,000.

Following pork is venison, which accounts for 5.3% of the potential meat weight; sequentially, this is the first wild game species represented in the diet. Varieties of deer were eaten in medieval Europe, such as fallow deer in England (Thomas 2007), and several species of deer inhabit the Iberian Peninsula, but, based upon existing 16th-century Spanish recipes, deer does was apparently not a regular part of Spanish cuisine. Deer were, however, hunted and consumed by the Pueblos and other Indigenous groups of the Southwest and may have been viewed as a viable source of meat by Spanish colonists because of their existence in the medieval European diet, so venison's presence in the assemblage is not entirely unusual. What is surprising is how little of the assemblage it accounts for, as it was a readily available and accepted source of wild game that could be acquired both through hunting and trading.

Poultry, fish, and rabbit make up 1.9% of the potential meat weight combined. Though poultry, which accounts for 1.3% of the potential meat weight, is a mix of domesticated chicken and wildfowl, this subsistence strategy was not uncommon for Spanish cuisine. Recipes containing a variety of wild and domesticated fowl, including peacock, capon, hen, woodpigeon, geese, wild doves, and wild ducks exist in 16th-century Spanish cuisine (De Nola 1529). Therefore, the presence of wild birds in the assemblage is not indicative of one food tradition or another. Fish and rabbit were also consumed by Europeans and Indigenous groups alike, so their presence, again, does not signify one particular tradition. Overall, the data indicates the diet at LA 20,000 was dominated by the meat of European domesticates: beef and mutton, followed by horse meat and pork with a small addition of locally available fish, poultry, and venison.

Bone Modifications: Butchery and Heat Modifications

In the collection, 1,856 specimens showed signs of human modification; 1,388 were calcined, 306 were burnt, 47 had cut marks, 38 had chop marks, 25 were sheared, 1 was punctured, 5 had saw marks, and 46 had spiral fractures. All 162 anthropogenic butchery marks were recorded on only ten taxonomic groups: *Bos taurus, Equus, Ovis/Capra,* Cervidae*, Sus,* Aves, and small, medium, large, and unidentified mammals (Figure 3.5). All large mammals combined (large mammals, *Bos taurus*, and *Equus*) contained 35.8% of all butchery marks, whereas all medium mammals combined (medium mammals, *Ovis/Capra*, *Sus*, and Cervidae) contained 53.8%. Only two small mammalian bones were found to have butchery marks, while a single avian tibiotarsus had a cut mark. Based on these numbers and the previous data, large and medium domesticated mammals were unsurprisingly targeted for food. Fish, small mammals, and poultry may have been a larger part of the diet, but as these smaller creatures do not need as much processing before being cooked, so their lack of butchery marks is not odd.

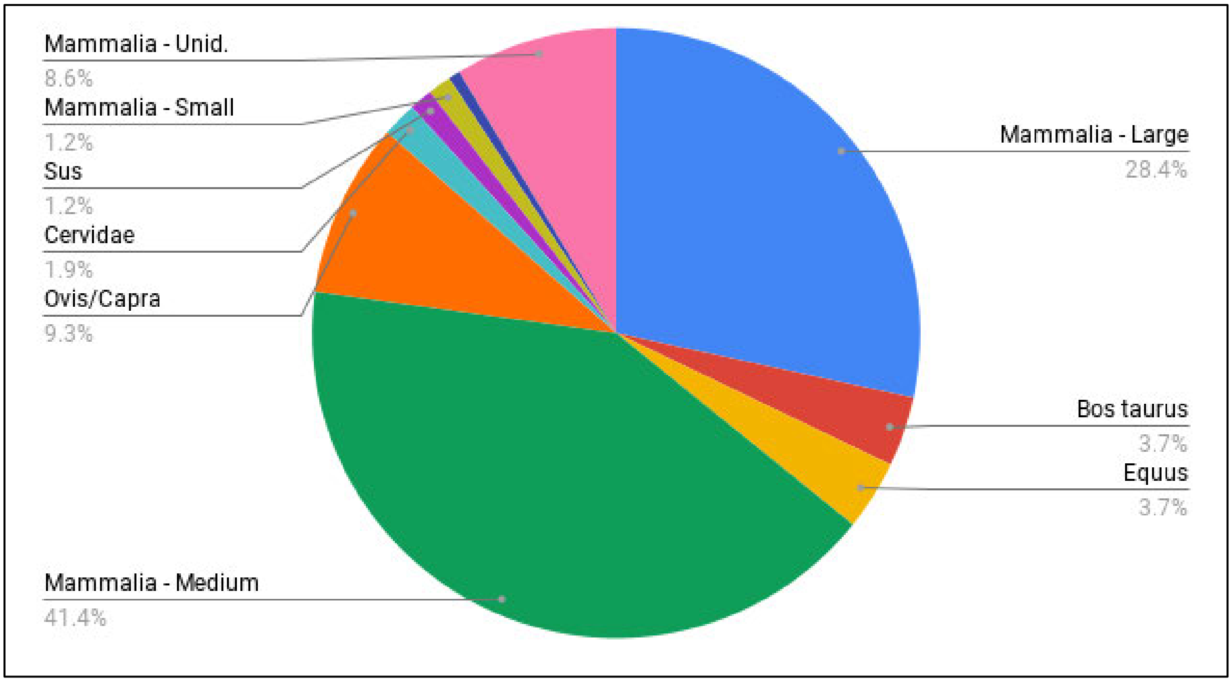


Figure 3.5. Distribution of butchery marks by taxon (N=162).

Mutton, beef, and pork were all common foods in the European diet, and these animals show the most signs of butchery at LA 20,000. As stated before, deer were eaten in Europe and by Indigenous groups and they made up a small percentage of the potential meat weight, so the presence of a few butchered deer is expected. The most surprising taxa with butchery marks is *Equus*. Equid bones contained as many butchery marks as *Bos taurus*, although eating horse meat was taboo in Spanish society (Gifford-Gonzales and Sunseri and 2007). Indigenous groups had far less experience with horses since they were introduced by the colonists in the 16th century. Horses may have been killed and butchered for several reasons, including an act of mercy (if a horse was injured, sick, or old), an act of last resort (if no other food was available), an act of resourcefulness (i.e., Indigenous groups making use of a previously unavailable food source), or an act of defiance (i.e., Indigenous people killing Spaniards' work animals). Overall, the butchery patterns indicate that mostly medium and large domesticates were being butchered by the inhabitants of LA 20,000.

The location of butchery marks can indicate how animals were processed during both primary and secondary butchery and is also shaped by the butchers' tastes, traditions, religion, and market guidelines (Landon 1996:58). In their analysis of 17th-century faunal remains from Santa Fe, Snow and Bowen (n.d.) determined that Spanish butchery patterns followed the same structure as English patterns in which the head was removed first, the carcass split longitudinally, and the limbs disarticulated at the joints. Chop and cut marks at the skull, down the spine, and at the epiphyses of long bones indicate primary butchery, whereas cut marks along bone shafts indicate secondary butchery. Some variation may be the result of differences in tertiary butchery as cuts of meat are prepared and cooked for consumption.

In this collection only *Ovis/Capra*, *Bos taurus*, and *Equus caballus* contained enough butchery marks for deeper analysis of their butchery patterning. *Ovis/Capra* had the most butchery marks, with the patterning most closely resembling both primary and secondary butchery in the typical "Spanish" method outlined above (Opishinski 2019:64). There were fewer butchery marks on *Bos* bones, but they do indicate primary butchery of cattle. The *Equus* butchery patterns are interesting because they do *not* follow the same butchery patterning as the other two domestic species. The ends of long bones were sheared, and a few long bone shafts were spirally fractured, as if these horses were opportunistically consumed rather than methodically slaughtered for food.

In terms of the types of butchery marks, a summary can be found in Figure 3.6. The types of butchery marks from the collection point to primary and secondary processing of carcasses. Primary butchery, or the initial disarticulation of the carcass, is associated with shearing, saw, and chop marks, which make up 42% of the total butchery marks in the collection. Secondary butchery, where meat is removed from bones for consumption, is often associated with cut marks, which account for 29%. This patterning means most animals at LA 20,000 were butchered and dressed on-site and were intended more for food than for secondary goods, such as hides. Other secondary goods, like wool or milk could have been a large part of the production goals of the *estancia*, but unfortunately do not leave signatures on the faunal remains.

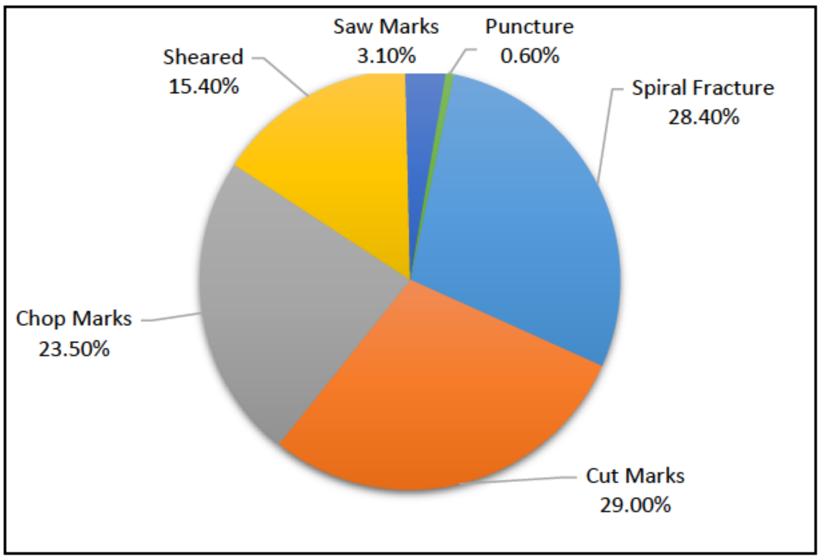


Figure 3.6. Types of butchery marks by specimen count (N=162).

The two most common butchery marks found in the collection were cut marks and spiral fractures. Typically, spiral fractures are caused by humans when they twist a fresh bone to break it to access the marrow cavity (Meyers et al. 1980; David B. Landon 2018, pers. comm.). Bone marrow is high in fat, calcium, magnesium, and phosphorous, and other trace minerals, and is consumed by countless cultures worldwide. Humeri, tibiae, and femurs contain the most marrow and the most meat, so they are typically targeted first for food; the radii and metapodia are often targeted only once food becomes scarce (Chapin-Pyritz 2000:203). Radii and metapodials from LA 20,000 contained both butchery marks and spiral fractures, meaning these lower priority cuts were necessary to the diet. This, coupled with the fact that horses were consumed demonstrates that food was occasionally scarce at LA 20,000 despite its being a working farm. Food scarcity and the consumption of these poorer foods may have been during times of famine or if better cuts of meat were traded away for profit, leaving the inhabitants with the meat-poor leftovers; they could also reflect the social hierarchy within the site, with the farm family getting the better cuts of meat while Indigenous laborers had access to the leftovers. Overall, the butchery patterns illuminate LA 20,000 as a working farm that managed the primary and secondary butchery of domestic animals and likely traded meat locally, and whose inhabitants periodically dealt with food scarcity or differential social access to food.

In addition to butchery, burnt and calcined bones can indicate how meat was prepared or how bones were disposed. In the collection, 1,388 specimens were calcined, which was defined as grey to white/blue in color, and 306 were burnt, which were defined as brown to black. Of these, 88.7% of them by NISP (or 53.5% by weight) were considered unidentifiable mammalian specimens, each with an average weight of only 1.54 grams. After these, the most common types of heat modified bone were long bone shafts, cranial fragments, and the innominate. By NISP, cranial fragments made up 5.7% of the burned/calcined bones, long bones 3.4%, the innominate 0.6%, and ribs 0.5%.

Although ascertaining why bones were heat modified is difficult, it is possible that elements dropped into fires during cooking, bones used as fuel sources, or bones discarded as waste will be calcined, whereas burning observed on articular surfaces of bones is the result of roasting (Chapin-Pyritz 2000:97). The vast number of heat modified specimens that were heavily fragmented indicate these bones were not burnt during cooking, but were likely used as fuel in fires or burnt as part of waste disposal. The elevated representation of cranial and innominate fragments, which are usually considered waste products, also indicates that bones were likely being burnt as fuel or as a process of waste removal. The presence of a thermal feature in Unit 2017-C.5 filled with burnt and calcined cranial and innominate fragments, long bone shafts, and unidentified fragments supports this notion.

Only one bone was found with burning on its articular surface, indicating roasting: an *Equus caballus* distal right femur (Figure 3.7). It also had a spiral fracture and was sheared, evidence it was prepared by humans for consumption and then roasted for food. The lack of evidence for roasting on other elements may be the result of bones being discarded into the fire, reused as fuel or a preference for other preparation methods, such as boiling or drying.

Figure 3.7. A right, distal *Equus caballus* femur with burning on its articular surface (EU 2016-K, Cxt. 170, Level 9, FS# 266).

Pathological Modifications

Three specimens in the collection showed signs of pathological modifications: the acetabular branch of a pubis (Figure 3.8), an astragalus (Figure 3.9), and a sesamoid (Figure 3.10). The pubis bone came from a medium sized mammal, was thinned, and had developed small bone elongations due to multiple pregnancies (Peles 2010:50; David Landon 2018, pers. comm.). Given the size of the specimen and the fact that LA 20,000 was a working farm, this pubis likely came from an *Ovis/Capra* that was bred multiple times as part of an animal husbandry strategy. The astragalus bone in the collection, which came from an *Equus*, also experienced stress and developed arthritis. The specimen is distorted and has grown many bony protuberances from being overworked. The severity of the pathology is from work as a weight-bearing animal over a long life. The sesamoid bone in the collection came from a *Bos taurus*. Sesamoid bones are small nodules located where a tendon passes over joints in the feet, so they are located at points of skeletal stress. This sesamoid appears condensed and warped, the result of a physically demanding existence and overworking (David Landon 2018, pers. comm), meaning this cow experienced stress in its feet, likely from work as a draft animal. These three specimens speak to the rigorous life and hardiness of the domestic animals brought to New Mexico by the settlers to help with the rigorous task of founding a colony.

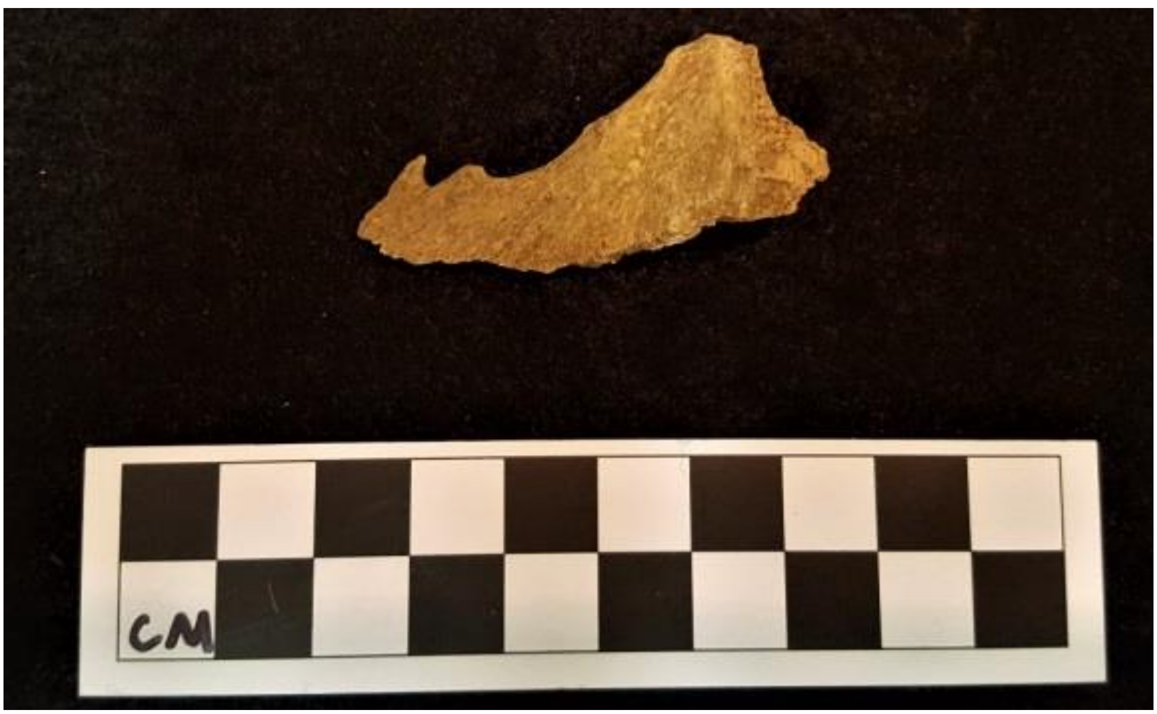


Figure 3.8. The acetabular branch of a pubis from a medium-sized mammal affected by pregnancies (UMB# 1990-21).

Figure 3.9. Four views of a left *Equus* astragalus with a stress-related pathology (EU 2015-J, Cxt. 66, Lev. 8, FS# 219).

Figure 3.10. Three views of a *Bos taurus* sesamoid with a stress-related pathology (EU 2015-J, Cxt. 66, Level 8, FS# 219).

Aging and Kill-off Patterns

During analysis, the level of fusion on epiphyseal growth plates was noted on all long bones, vertebral bodies, and phalanges to help determine age at death. Bone ossification levels cannot determine a numerical age but can be grouped into early-middle-and late fusing bones and divvied into juvenile, subadults, and mature adults, respectively. Although a sample size of about 30 MNI would be needed to accurately estimate age profiles (Crabtree 1990:184), the summary of the age-related data from the collection is included here. Of the examined species, *Ovis/Capra* was the most numerous, with a total of 38 specimens that could be classified into ossification age groups. All the specimens in the early-fusing category were fused, so no juvenile specimens were present; bones from the middle and -late fusing categories were a mixture of fused and unfused, representing both subadult and mature adult sheep/goats.

In addition to bone ossification rates, teeth were assigned tooth wear stages (TWS) according to the Grant Dental Attrition Age Estimation Method (Figure 3.11) and tooth rows were assigned chronological ages according to the Payne Method (Figure 3.12). The author used updated charts available in Hillson (2005), which provide the wear charts for cattle, sheep/goats, and pigs. With this method, each tooth was compared against the chart and assigned a score, called a tooth wear stage (TWS), which range from 1-20 (Hillson 2005:327). By both TWS and chronological age, the *Ovis/Capra* teeth tend to cluster into two age categories: by TWS 7-12 and 15-17 and by chronological age, 6 months to 2 years and 3-8 years. These two clusters demonstrate that sheep/goats were either slaughtered in their prime or were permitted to reach sexual maturity and old age. Patterns like these tend to represent patterns of culling males from herds while letting females live long enough to reproduce multiple times (David Landon 2018, pers. comm.). The general spread of ages at death indicates that *Ovis/Capra* were raised *and* consumed at the site, with some living longer for reproductive reasons or for their wool or milk (Reitz and Wing 2008:192).

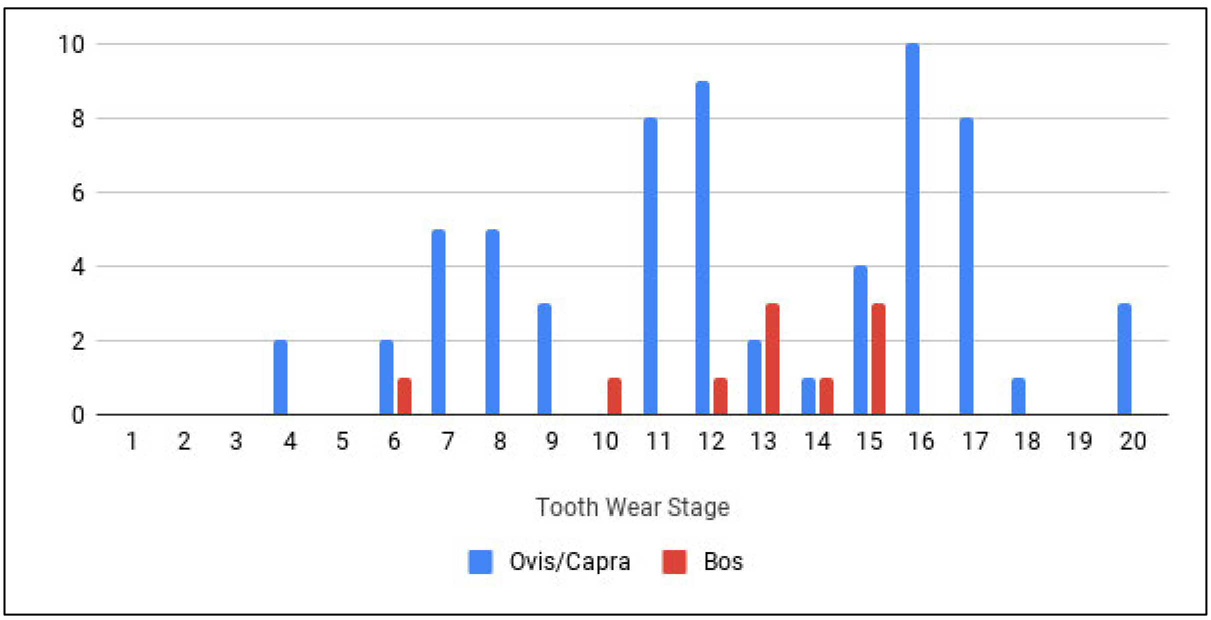


Figure 3.11. *Ovis/Capra* (N=63) and *Bos* (N=10) age estimation by Grant Dental Age Estimation Method.

Second in number, *Bos taurus* had only seven bones that were assignable to age classes, as well as ten teeth that were given a TWS. The results are remarkably dissimilar from the *Ovis/*Capra, as no specimens whatsoever were assigned to the late-fusing category and no middle-fusing bones were ossified; the *Bos taurus* age profile seems to be almost wholly made up of subadults and juveniles. The teeth also match this pattern. Though there were no *Bos taurus* tooth rows that could be given a chronological age, the TWS patterning compared to *Ovis/Capra*'s is telling. *Ovis/Capra* was divided into two clusters, yet, as seen on Figure 3.11, the majority of the TWS for *Bos* sits right between these two clusters. Since tooth wear stages are comparable, then one can assume that the *Bos* specimens were from prime-aged, subadult individuals, a perfect age for slaughter for meat. This could suggest that, when necessary, cattle were imported from other farms and slaughtered for food at LA 20,000 rather than raised onsite (Reitz and Wing 2008:192). But more likely, the bones of older cattle are among the significant quantity of indeterminant large mammal bones (Table 3.1).

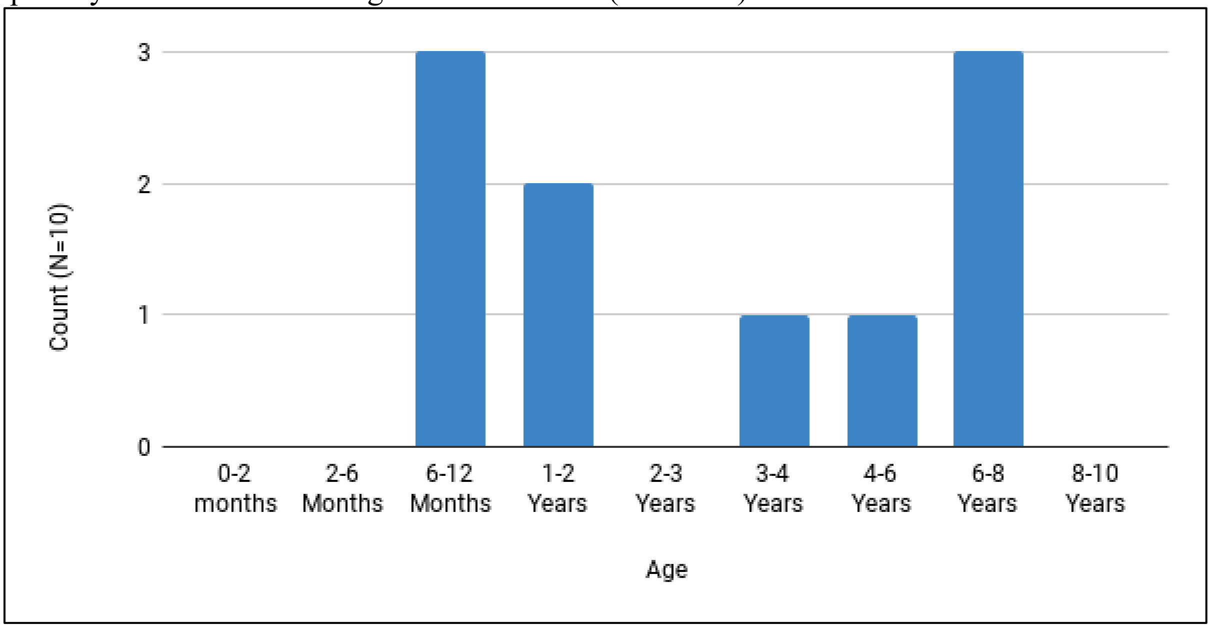


Figure 3.12. *Ovis/Capra* age at death by the Payne System for recording attrition.

The equines at LA 20,000 have a different age patterning than the other domestic species because they are not typically subject to animal husbandry practices that would raise them for food. Besides one deciduous premolar, other ageable specimens all indicate that the equids of LA 20,000 lived into adulthood. All but one specimen, a radius without an ulna fused to it, were fused, indicating horses and equids lived to full maturity. There was also an *Equus* scapula with deep vascular grooves and an astragalus with a stress-related pathology (Opishinski 2019), indicating the horses at LA 20,000 lived long and hard lives.

Results from the 1990s Catalog

Three additional catalogs pertaining to LA 20,000's faunal collection were held by the El Rancho de Las Golondrinas Living History Museum, and were analyzed separately from the physical collection. The data contained within them refers to material excavated by Snow and Stoller between 1980 and 1995 with bone identifications to taxon and element, and when possible, which region of each bone fragment was present. Based on the provenience information listed in these documents, many bones listed in the catalog are absent from the present collection. Since these specimens are missing and their identifications cannot be verified, the data are discussed separately from the rest of the collection below, but the two datasets will be integrated in the final analyses. From these catalogs, the deepest level of information that can be reliably gleaned from them is a species list and the NISP.

Altogether, the catalogs represent about 20 taxonomic groups, with an NISP of 448 (Table 3.2). Most of the classifications from the catalog overlap with taxa found in the present collection, with a few additions. The additional identifications in the catalog were *Antilocapra* (pronghorn), *Canis* (dog/coyote), *Citellus* (ground squirrel), *Cynomys* (prairie dog), *Meleagris* (turkey), *Odocoileus* (American deer), *Spermophilus* (ground squirrel), and Tayassuidae (peccary). By NISP, *Ovis* dominates, with *Bos*, and *Equus* making up the next two largest categories and altogether comprising 73.9% of the catalog taxa, reflecting similar patterns for the dominance of European domesticate species in the extant collection.

The wild taxa identified in the catalogs include *Sylvilagus*, *Canis* (if not a domesticated dog), *Lepus*, *Cynomys*, *Odocoileus*, *Spermophilus*, *Citellus*, Osteichthyes, *Cervus*, *Meleagris*, and Tayassuidae. Altogether they make up 13.2% of the total catalog collection by NISP, though in the physical collection local species make up only 1.87%. *Sylvilagus* (cottontail rabbit) are the most common with an NISP of 14, followed by the closely-related *Lepus* (hares and jackrabbits) with 8. Rabbits and hares were an easily accessible and common source of meat in the traditional Puebloan diet. Deer, identified both as *Cervus* and *Odocoileus* in the catalogs, was one of the few sources of large game for Indigenous groups, yet here only seven deer bones were identified. The presence of two *Meleagris* (turkey) bones is interesting because turkeys are native only to the

Table 3.2
Summary of Faunal Specimens Reported in Old Catalogs

Taxonomic Identification	Common Name	NISP	MNI
Antilocapra	Pronghorn	2	1
Artiodactyl	Even-toed Mammals (cow, sheep, pig)	2	1
Bos	Cow	59	2
Canis	Dog/Coyote	10	1
Cf. *Capra*	Goat	3	1
Cervidae (*Cervus*, *Odocoileus*)	Deer	7	1
Ovis	Sheep	242	14
Equus	Horse/Mule	30	2
Sus	Pig	1	1
Leporidae (*Lepus, Sylvilagus*)	Rabbit/Hare	22	*Lepus:* 2 *Sylvilagus:* 2
Cynomys	Prairie Dog	6	1
Spermophilus/Citellus	Ground Squirrel	6	*Spermophilus:* 1 *Citellus:* 1
Tayassuidae	Peccary	2	1
Large mammal (Large, *Bos/Equus*)		13	
Medium mammal		8	
Small mammal (Small, Unspecified Rodent)		2	Rodent: 1
Aves (*Gallus, Meleagris)*	Chicken/Duck	19	Aves: 2 *Gallus:* 1 *Meleagris:* 1
Fish/Osteichthyes		3	1
Frog		2	1
Indeterminate		9	
Total		448	39

Americas and were kept by Pueblos for their feathers, which were used for clothing, blankets and ceremonial objects (Barrett 2012; Sorensen 2016). The presence of turkey bones indicates that turkeys were still being utilized in the area, either for food or for feathers, though by whom is unclear.

Discussion and Conclusion

The data from the faunal collection at LA 20,000 can be summarized as a heavy dominance of *Ovis/Capra*, followed by other European domesticates: *Bos taurus*, equids, and *Sus scrofa*, in that order. The age profiles and butchery patterns indicate that *Ovis/Capra* were the primary animal raised at the *estancia*, as young males were culled from the herds and other individuals were bred multiple times to perpetuate the herd. Prime-aged *Ovis/Capra* were slaughtered, following typical European butchery practices and primary and secondary butchery were undertaken on site. Some evidence suggests that *Bos taurus* were traded to the site, used as draft animals, and butchered for food when necessary. They were potentially raised at LA 20,000 but only in small numbers. They did, however, provide a substantial amount of meat to the diet, so their importance should not be disregarded. Horses were also used as draft animals and for transportation, although direct evidence shows they were slaughtered and roasted for food.

Wild animals in the assemblage were sparse, but do point to the consumption of fish, birds, deer, and small mammals by the inhabitants. These species may have been acquired directly by those living at the *estancia* or through trade. The presence of small wild mammals may indicate periodic food scarcity and the consumption of "lesser foods" to combat hunger; it may demonstrate that at LA 20,000 the best cuts were traded away for profit, leaving the farmers themselves with lower quality foods; or it may represent the presence of multiple ethnic groups living at one site and interacting in the colony. Overall, the meat portion of the diet shows a heavy reliance on domestic herd animals because they were most easily accessible, but does not discount the mixture of different food traditions and ethnicities present at the site.

The conclusions we can draw about LA 20,000 was that it was a large sheep/goat farm operated by an extended family of colonists and Indigenous laborers, so its owners were almost certainly high status, and the head of house was possibly an *encomendero* who received tribute and labor from Pueblos. The meat-based portion of the diet at the site was mostly from European domesticates, especially sheep/goats and cattle, with very few local species. The emphasis on European-introduced domesticate animals for food comes from not only their accessibility, but also from their association with the colonists' sense of Spanish status.

The relationship between Spanish colonists and Indigenous people, which played out across New Mexico and other Spanish colonies, produced complex attitudes surrounding food that were influenced by food availability, the demand for some European foods and dishes as status symbols, regular interactions between colonists and Indigenous people at the household level, and the intermingling of different social classes and ethnicities on the frontier. The faunal remains from LA 20,000, which reflect both the newly European-introduced livestock and the local, wild game species, help illuminate how these tensions played out at a household level.

References Cited

Barrett, Elinore M.

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

Beisaw, April M.
2013 *Identifying and Interpreting Animal Bones: A Manual*. Texas A&M University Press, College Station, Texas.

Cárdenas, García Lópes de
1540 On the Coronado Expedition. In *An Illustrated History of New Mexico*, Thomas E. Chávez, editor. University of New Mexico Press, Albuquerque.

Chapin-Pyritz, Regina Louise
2000 *The Effects of Spanish Contact on Hopi Faunal Utilization in the American Southwest*. Doctoral Dissertation, Department of Anthropology, University of Arizona, University Microfilms International.

Crabtree, Pam J.
1990 Zooarchaeology in Complex Societies: Some Uses of Faunal Analysis for the Study of Trade, Social Status, and Ethnicity. *Archaeological Method and Theory* 2:155-205.

Crosby, Alfred W.
2003 Old World Plants and Animals in the New World. In *The Columbian Exchange: Biological and Cultural Consequences of 1492 (Vol. 2)*, pp 64-121. Greenwood Publishing Group, Westport, Connecticut.

De Nola, Ruperto
1529 Libre de Coch, Brighid ni Chiarain, translator. Barcelona. <http://www.florilegium.org/?http%3A//www.florilegium.org/files/FOOD-MANUSCRIPTS/Guisados1-art.html>.

Fisher, John W. Jr.
1995 Bone Surface Modifications in Zooarchaeology. *Journal of Archaeological Method and Theory* 2(1):7-68.

Gifford-Gonzalez, D. and K. Sunseri
2007 Foodways on the frontier: animal use and identity in early colonial New Mexico. In *We Are What We Eat: Archaeology, Food, and Identity*, edited by K. Twiss, pp. 260-287. Occasional Paper No. 34. Center for Archaeological Investigations, Southern Illinois University.

Gilbert, B. Miles, Larry D. Martin, and Howard G. Savage
1996 *Avian Osteology*. Missouri Archaeological Society, Inc., Columbia.

Hillson, Simon
1992 *Mammal Bones and Teeth: An Introductory Guide to Methods of Identification*. Institute of Archaeology at the University of College London.
2005 *Teeth*, 2nd Edition. Cambridge Manuals in Archaeology, Cambridge University Press, Cambridge.

Landon, David B.
1996 Feeding Colonial Boston: A Zooarchaeological Study. *Historical Archaeology* 30(1):1-153.

Liebmann, Matthew
2015 At the Mouth of the Wolf: The Archaeology of 17th -Century Franciscans in the Jemez Valley of New Mexico. In *Franciscan Evangelization in the Spanish Borderlands II*, Timothy J. Johnson and Gert Melville, editors, pp 1-18. Academy of American Franciscan History, Oceanside CA.

The Livestock Conservancy
2018 Heritage Breeds. *The Livestock Conservancy*. <https://livestockconservancy.org/index.php/heritage/internal/conservation-priority-list>. Accessed 28 September 2018.

MacCameron, Robert
1994 Environmental Change in Colonial New Mexico. *Environmental History Review* 18(2):17-39.

Meyers, Thomas P., Michael R. Voorhies, and R. George Corner
1980 Spiral Fractures and Bone Pseudotools at Paleontological Sites. *American Antiquity* 45(3):483-490.

New Mexico Department of Game and Fish
2015 Native New Mexico Fish. *New Mexico Department of Game and Fish*. <http://www.wildlife.state.nm.us/fishing/native-new-mexico-fish/>. Accessed 24 September 2018.

Roberts, Calvin A. And Susan A. Roberts
1986 *A History of New Mexico*. University of New Mexico Press, Albuquerque.

O'Connor, Terry
2000 *The Archaeology of Animal Bones*. Texas A&M University Press, College Station.

Olsen, Stanley J.
1968 *Fish, Amphibian, and reptile Remains from Archaeological Sites: Southeastern and Southwestern United States*. Papers of the Peabody Museum of Archaeology and Ethnology, Harvard University 56(2), Cambridge, Massachusetts.
1980 *Mammal Remains from Archaeological Sites: Southeastern and Southwestern United States*, 3rd Printing. Papers of the Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, Massachusetts.

Opishinski, Ana C.

2019 Eat This in Remembrance: Eat This in Remembrance: The Zooarchaeology of Secular and Religious Sites in 17th-Century New Mexico. Master' Thesis, Department of Anthropology, University of Massachusetts, Boston.

Peles, Ashley
2010 *Production and Consumption on a 19th -Century Spanish New Mexican Homestead: Exploring Daily Life Through Floral and Faunal Analyses*. Master's Thesis, Department of Anthropology, University of Massachusetts Boston. University Microfilms International.

Reitz, Elizabeth J. and Elizabeth S. Wing
2008 *Zooarchaeology*, 2nd Edition. Cambridge University Press, Cambridge

Salazar, Juan de Frias
1598 Inspection made by Juan de Frias Salazar of the Expedition. In *Juan de Oñate: Colonizer of New Mexico, 1595-1628*, George P. Hammond and Agapito Rey, translators, pp 199-308. University of New Mexico Press, Albuquerque.

Scholes, France V.
1935 Civil Government and Society in New Mexico in the Seventeenth Century. *New Mexico Historical Review* 10(1):71-111.

Sisson, Septimus and James Daniels Grossman
1953 *The Anatomy of Domestic Animals*, 4th Edition. Press of W.B. Saunders Company, Philadelphia.

Sorensen, Eric
2016 *Researcher: Turkeys a Major Part of Ancestral Pueblo Life*. WSU Insider, Washington State University.

Snow, David H.
1990 Tener Comal y Metate: Protohistoric Rio Grande Maize Use and Diet. In *Perspectives on Southwest Prehistory*, Paul E. Minnis and Charles L. Redman, editors, pp. 289-300. Westview Press, Boulder, Colorado.
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, New Mexico.

Snow, David H. and Joanne Bowen
n.d. No Scum, No Vermin: Seventeenth-Century Faunal Remains from the Santa Fe, New Mexico, Downtown Historic District. Ms. in Possession of the Author.

Spielmann, Katherine A.
1989 Colonists, Hunters, and Farmers: Plains-Pueblo Interaction in the Seventeenth Century. In *Columbian Consequences: Archaeological and Historical Perspectives on the Spanish*

Borderlands West, David Hurst Thomas, editor, pp. 101-113. Smithsonian Institution Press, Washington, DC.

Spielmann, Katherine A., Tiffany Clark, Diane Hawkey, Katharine Rainey, and Suzanne K. Fish
2006 "...being weary, they had rebelled.": Pueblo Subsistence and Labor Under Spanish Colonialism. *Journal of Anthropological Archaeology* 28:102-125.

Thomas, Richard
2007 Food and the Maintenance of Social Boundaries in Medieval England. In *The Archaeology of Food and Identity*. Edited by Katherine Twiss, pp 130-151. Center for Archaeological Investigations, Occasional Paper No 34.

Trigg, Heather B.
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*. The University of Arizona Press, Tucson.

Wheeler, Alwyne and Andrew K.G. Jones
1989 *Fishes*. Cambridge Manuals in Archaeology, Cambridge University Press, Cambridge.

Chapter 4
Flaked Stone Artifacts from LA 20,000

By Clint Lindsay

Assemblage Overview

The LA 20,000 flaked stone artifact assemblage derives from surface collections and excavations conducted at various locations across the entirety of the site north of the arroyo, including the midden, house, barn, corral, and Unit D (eastern edged of the site) areas. The assemblage represents some five decades of lithic reduction, production, and use from an unknown number of individuals, likely of multiple ethnic and cultural affiliations including Spanish, Puebloan, and, possibly, Plains peoples. Flaked stone artifacts consist of a total of 317 objects: 285 pieces of lithic debitage and 73 flaked stone tools (Table 4.1 and Table 4.2). Because strike-a-light flints and informal tools are pieces of debitage that show evidence of utilization or slight modification and, in the case of flakes, retain their striking platforms, they are included in both the debitage counts and the flaked stone tool counts. Flakes (complete, proximal, and fragments) make up slightly over 53% of the debitage assemblage, while angular shatter and bipolar flakes comprise the remaining 47%. 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 debitage that functioned as informal tools and one unidentified tool fragment. Seventeen flaked stone tools can be definitively associated with Spanish introduction and consist of nine gunflints and eight strike-a-light flints. Tools, in general, are not uncommon and comprise 23% of the total flaked stone assemblage.

Table 4.1
Lithic Debitage Assemblage from 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 CCS (cryptocrystalline silicate)	*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%***

Table 4.2
Flaked Stone Tool Assemblage Site LA 20,000

Material	Cores	Formal Tools	Informal Tools	Gunflint	Strike-A-Light Flint	Unidentified	Total
Obsidian	4 *18.2%*	8 *36.4%*	10 *45.5%*	- -	- -	- -	**22** ***30.1%***
Pedernal Chert	- -	2 *28.6%*	2 *28.6%*	1 *14.3%*	2 *28.6%*	- -	**7** ***9.6%***
Nonlocal Chert	- -	1 *100%*	- -	- -	- -	- -	**1** ***1.4%***
Chert, Chalcedony, Other CCS	6 *15.8%*	1 *2.6%*	17 *44.7%*	8 *21.1%*	5 *13.2%*	1 *2.6%*	**38** ***52%***
Quartz	- -	- -	2 *66.7%*	- -	1 *33.3%*	- -	**3** ***4.1%***
Quartzite	- -	- -	1 *100%*	- -	- -	- -	**1** ***1.4%***
Basalt	1 *100%*	- -	- -	- -	- -	- -	**1** ***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%**

Flaked Stone Materials

Flaked stone material type counts, frequencies, and weights identified at the site are summarized in Table 4.3. In terms of raw materials, the flaked stone assemblage is dominated by lithic materials available within 15 km of the site. These local materials make up nearly 79% of the assemblage and over 88% of total material by weight. Only three nonlocal materials were identified - obsidian, Pedernal chert, and a nonlocal chert – and comprise the remainder of the assemblage. The nearest obsidian and Pedernal chert sources, geographically, are found in secondary deposits of alluvial gravels along the Rio Grande approximately 25 km west of the site; while primary deposits of obsidian are found over 40 km to the north, west, and southwest of the site throughout the Jemez Mountains. The nearest primary Pedernal chert deposits occur approximately 75 km north of the site (Church 2000; Moore 2001b:64; Shackley 2002).

By total counts and frequency, locally available CCS materials (e.g., cherts, chalcedonies, silicified woods, etc.) make up most of the total assemblage (nearly 68%) and comprise nearly 70% of the debitage and 52% of the flaked stone tool assemblages (Figure 4.1 and Figure 4.2). All other material types contribute less than 15% of the total assemblage individually and each type makes up less than 12% of the debitage assemblage and, other than obsidian (30.1%), no more than 10% of the flaked stone tool assemblage. Based on material type frequencies, the flaked lithic assemblage at LA 20,000 appears to be dominated by locally available materials, with a few nonlocal materials also present contributing to a meaningful portion of the assemblage.

Since weight may more accurately represent material abundance than simple flake counts, lithic materials were also compared by total weight. To correct for bias created by the presence of a few large cores of certain materials, Table 4.3 includes average and total weights and percentages by raw material without cores.

Table 4.3
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%***	-	-

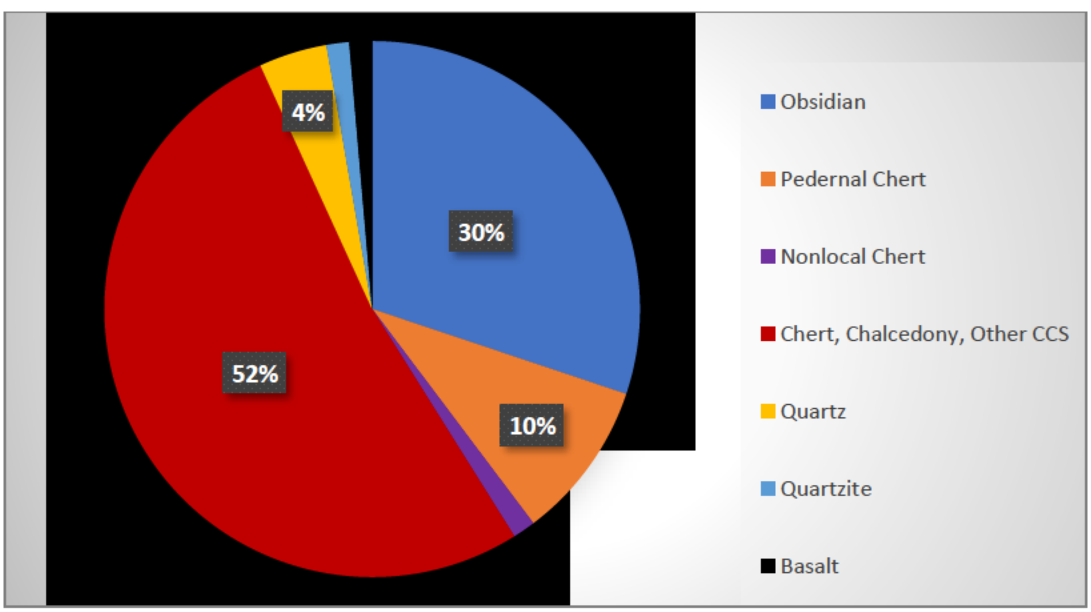


Figure 4.1. Debitage raw material frequency.

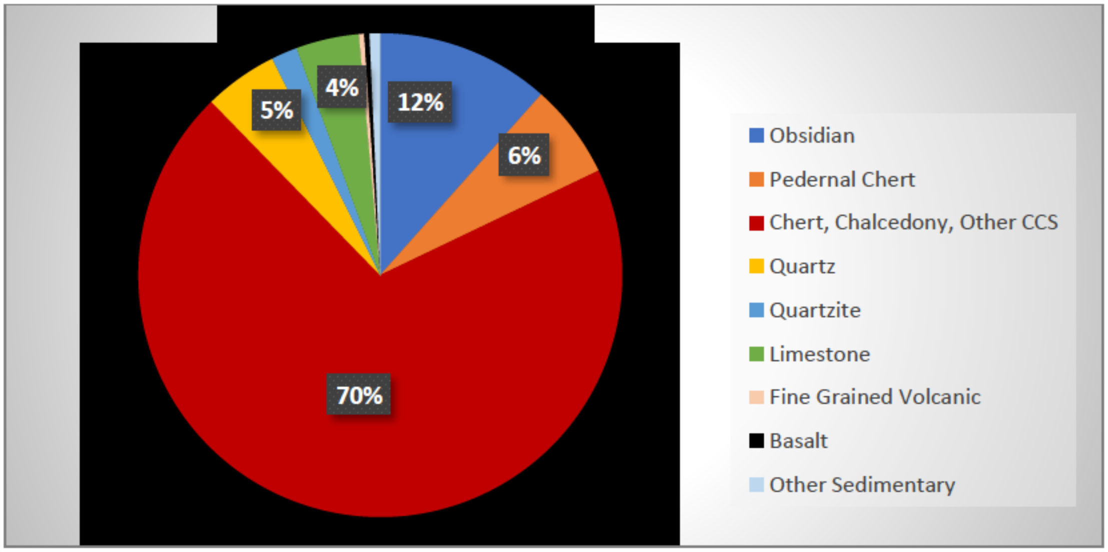


Figure 4.2. The frequency of different raw material used for stone tools.

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, local 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, small and light. Basalt and quartzite show the opposite trend and 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 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 local CCS materials represent 60% of the total material weight, this group of materials has the second lowest average artifact weight for all materials represented by more than one artifact. Furthermore, when the weight of six cores is 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 most flaked stone tools in general.

Obsidian Sourcing

Nondestructive portable X-ray fluorescence (pXRF) analysis was used to identify the geochemical composition of LA 20,000 obsidian artifacts to ascertain geological sources (Lindsay 2020:89-109, 2021). 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; Liebmann 2017; Shackley 2005; Shackley et al. 2016). Biplots of Strontium to Yttrium and Niobium to Zirconium achieved the most precise discrimination among sources and revealed the presence of four distinct obsidian geochemical groups at LA 20,000: Cerro Toledo Rhyolite (CTR), Valles Rhyolite (VR), El Rechuelos Rhyolite (ERR), and Canovas Canyon Rhyolite (CCR) (Figures 4.3 and 4.4).

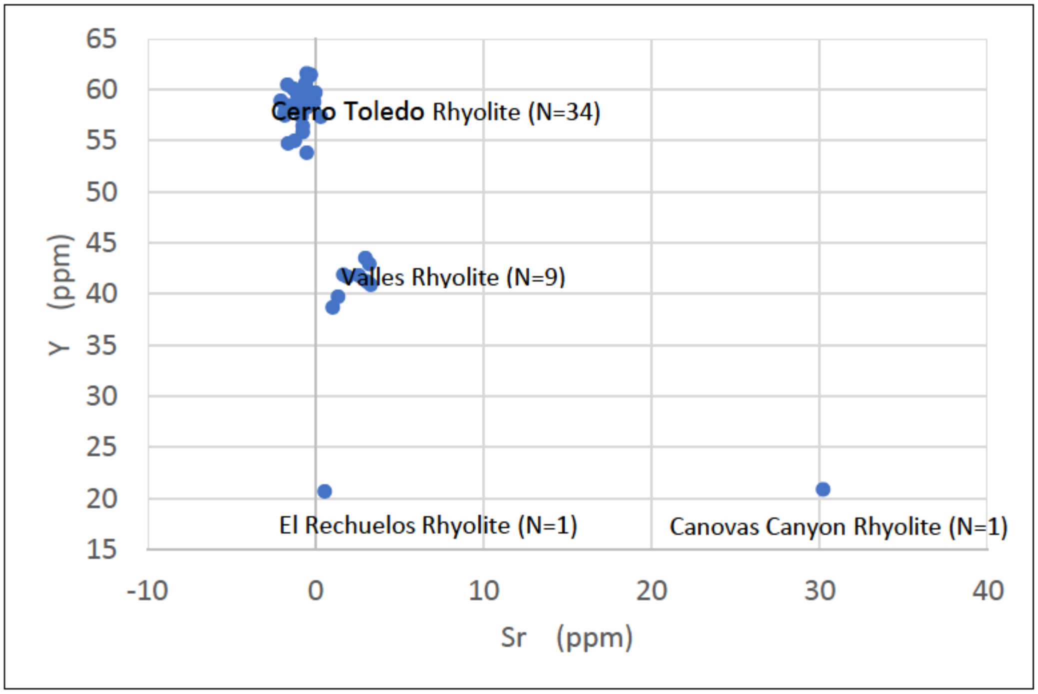


Figure 4.3. Bivariate plot of strontium (Sr) and yttrium (Y) parts-per-million (ppm) values for LA 20,000 obsidian sourcing samples.

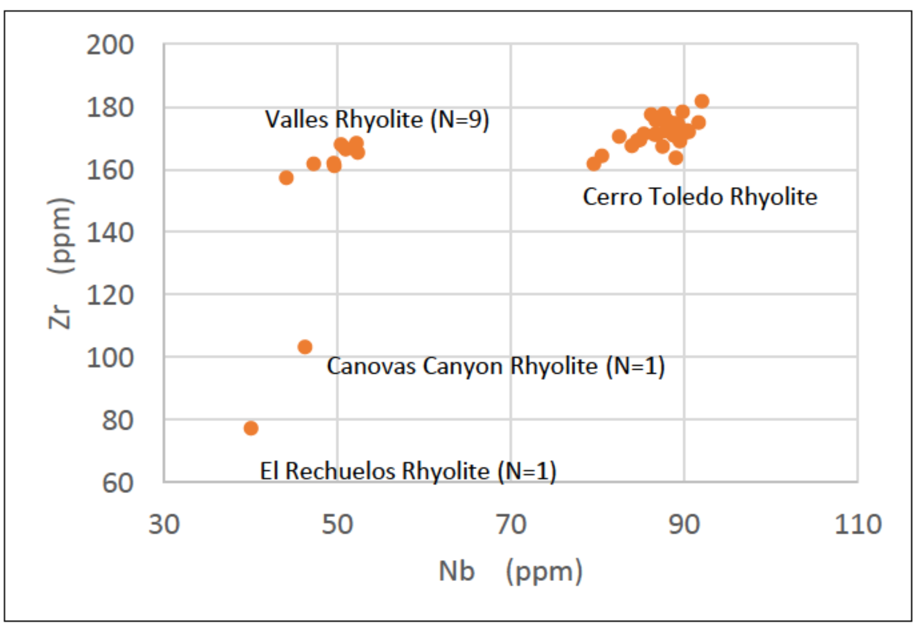


Figure 4.4. Bivariate plot of niobium (Nb) and zirconium (Zr) parts-per-million (ppm) values for LA 20,000 obsidian sourcing samples.

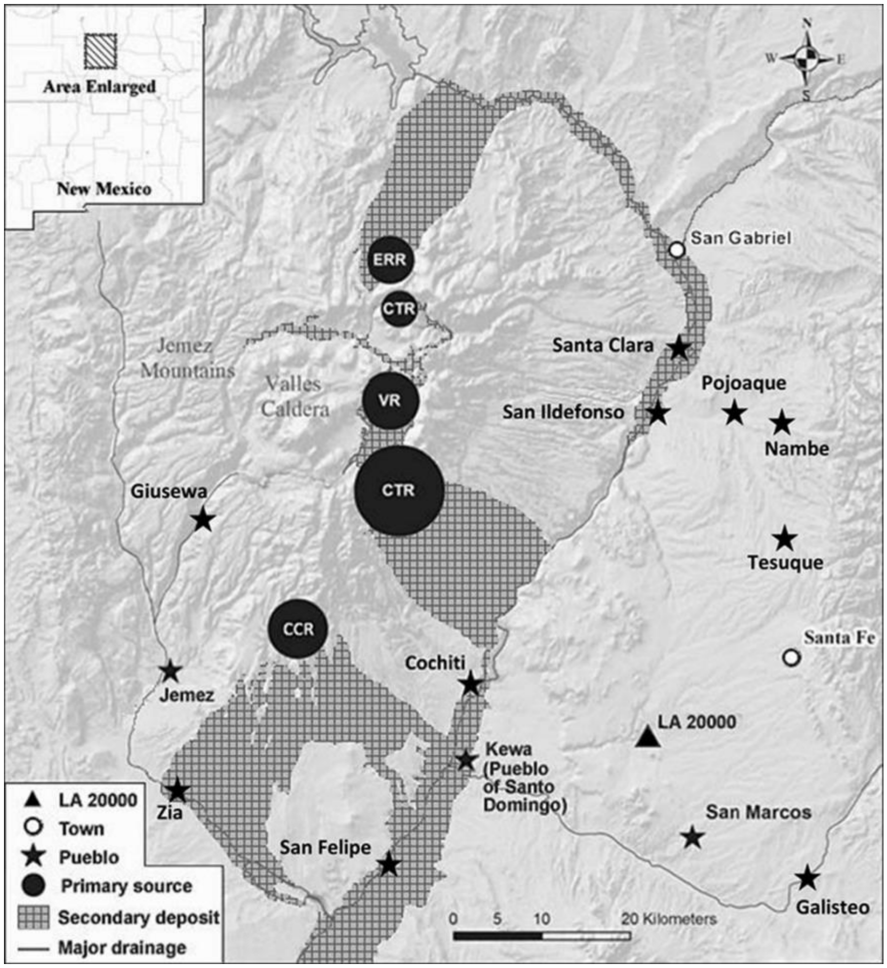


Figure 4.5. Map showing LA 20,000 in relation to 17th-century Pueblos and Spanish towns, and the geographic distribution of LA 20,000 sourced obsidian geochemical groups - Canovas Canyon Rhyolite (CCR), Cerro Toledo Rhyolite (CTR), El Rechuelos Rhyolite (ERR), and Valles Rhyolite (VR) (Lindsay 2021:5).

Figure 4.5 shows primary and secondary source areas for obsidians present at LA 20,000. Black circles signify the location and horizontal extent of geologically mapped primary obsidian deposits, while cross-hatched parts designate areas that either contain or have the potential to contain secondary deposits of useable obsidian. Cross-hatched areas signifying CCR secondary deposits are broadly defined, and the abundance and extent of artifact-quality obsidian is less than depicted (Lindsay 2021:10; Ramenofsky et al. 2017:160 – 161).

Besides primary sources, three of these obsidians (CTR, ERR, and CCR) are 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 the site, but obtaining VR obsidian would have required travel into the Valles Caldera or some form of indirect procurement (Liebmann 2017:651–652).

In terms of total count, total weight, and technological variability CTR obsidian is most abundant, while VR is the next most abundant in all categories (Tables 4.4 and 4.5). VR has the heaviest average weight of all obsidian types and is also heavier on average than equivalent forms of CTR across most technological categories. These two sources account for all obsidian tools, while ERR and CCR contribute minimally to the obsidian assemblage, as each is represented by single flake.

Table 4.4
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**

Table 4.5
Obsidian Flaked Stone Tool Frequencies

Source	Non-Flake Tool	Flake Tool	Biface	Projectile Point	Drill	Core	Total
CTR	3	6	1	2	1	3	**16**
VR	1	-	4	-	-	1	**6**
Total	**4**	**6**	**5**	**2**	**1**	**4**	**22**
Total %	**18.2%**	**27.3%**	**22.7%**	**9.1%**	**4.5%**	**18.2%**	**100%**

The abundance of CTR makes sense given that its secondary deposits are located only some 25 km from the site. Although located nearly the same distance away, CCR is not frequently found in archaeological contexts due to its exceedingly small nodule size, most being less than 2 cm in diameter. This effectively results in lower proportions of useable CCR compared to larger and more recent high-quality gravels of the CTR, as well as VR, and ERR sources (Shackley 2009:78).

Distance can also be used to explain the lack of ERR in the site's obsidian assemblage since its primary source is farthest from the site. This greater distance likely results in any ERR secondary deposits being outnumbered by both CTR and CCR, 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 obsidians can be easily explained in terms of spatial contexts, the relative abundance and large weight of VR in the assemblage is less straight forward. Unlike other obsidian sources, spatial proximity does not explain for the abundance of VR since it does not occur in nearby secondary deposits so had to be obtained either directly from the Valles Caldera or through some other means.

Based on pXRF and typo-technological analyses (Lindsay 2020:93-109, 2021), the only obsidian type that appears to have been brought to LA 20,000 as nodules and reduced there was CTR. Evidence for other source types, 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, types were brought to LA 20,000 in different package configurations and reduced there differently.

In terms of procurement, CTR was likely procured by site occupants (Spanish or Indigenous) from secondary deposits in Rio Grande alluvium roughly 25 km west of LA 20,000 and reduced on-site. 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. CCR and ERR groups are rare in the assemblage and there is little evidence to suggest on-site reduction of these nodules. 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, mobility of Puebloan laborers to and from the site, secondary recycling by site occupants, or a combination of any of these procurement strategies. Similar procurement strategies also likely applied to at least some CTR, and each ERR and CCR obsidians. As a rural *estancia* that likely relied upon native peoples for trade, labor, and other services (Trigg 2005), residents of nearby La Cienega, San Marcos, Cochiti, or Kewa (Santo Domingo) Pueblos could have been responsible for some of the obsidian present at the *estancia* (Lindsay 2020, 2021).

Debitage Analysis

Debitage Type and Condition

Debitage accounts for nearly 90% of the total flaked stone assemblage. Debitage type counts and relative percentages (Table 4.6) show that flakes (complete, proximal, and fragments) make up 53.3% of the debitage assemblage, while angular shatter and bipolar flakes make up 37.2% and 9.5%, respectively. Lithic reduction experiments (Amick and Mauldin 1997; Jeske and Lurie 1993; Kuijt et al. 1995; Morrow 1997; and Prentiss 1998) 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 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 in the assemblage rules out poor material restrictions. 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 premise at LA 20,000.

Table 4.6
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%**

Another way to infer whether tool manufacture was occurring at the site is to consider the ratio of complete and broken flakes to shatter. Although the production of angular shatter is contingent upon several variables (Amick and Mauldin 1997; Jeske and Lurie 1993), the ratio of flakes tends to increase as lithic artifact production progresses because later reduction practices and tool manufacture are generally carried out with more care and control than earlier lithic reduction. This suggests that a low flake to shatter ratio should indicate early reduction, while a high flake to shatter ratio should suggest late reduction or tool manufacture.

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 low, indicating early reduction practices. This low ratio supports previous angular shatter-bipolar flake findings and suggests that early reduction or expedient practices were substantial at the 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 4.7 shows that as complete flakes decrease in grade size so too does their average length, width, and thicknesses. Experiments by Morrow (1997:65) show 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 and, if anything, 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 was occurring on-site with any regularity or magnitude.

Table 4.7
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**	-	-	-	-	-

Besides biface reduction, differences in flake size have also been linked to the intensity of lithic reduction. More intensive reduction often results 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 portion (39%) of the site's complete flake assemblage, thickness-to-width ratio findings indicate that this is not the result of bifacial reduction or tool maintenance. Instead, the presence of bipolar flakes, bipolar 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 4.8, 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 4.8
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 investigate if any variability in the overall debitage assemblage as it may relate to reduction strategies exists, the debitage and platform categories were combined into three distinct groups (Table 4.9). 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 4.8) alone, suggesting that the overall debitage assemblage is reflective of early and/or expedient reduction debris.

Table 4.9
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 4.10. 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 4.10
Type of Debitage by Amount of Cortex

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

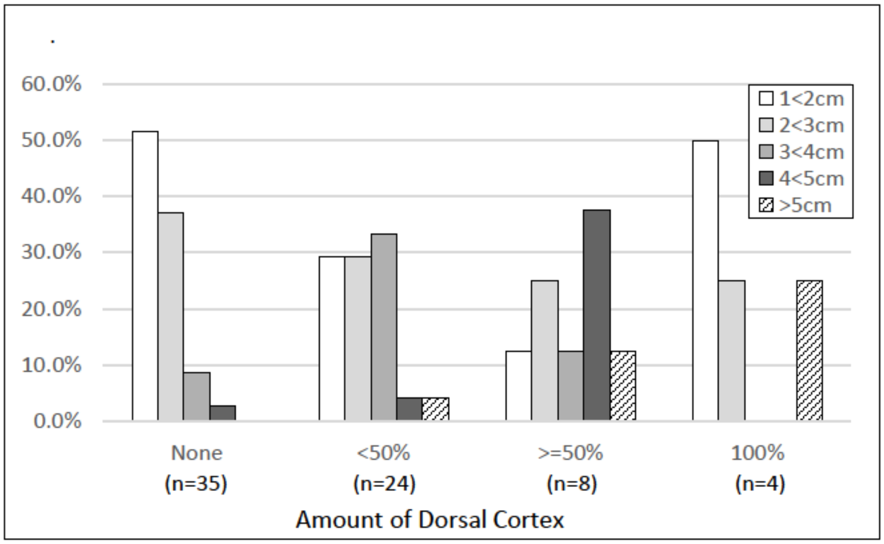


Figure 4.6. Combined percentage of dorsal cortex and size for all complete flakes.

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 4.11). 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 4.11
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 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 4.7 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.

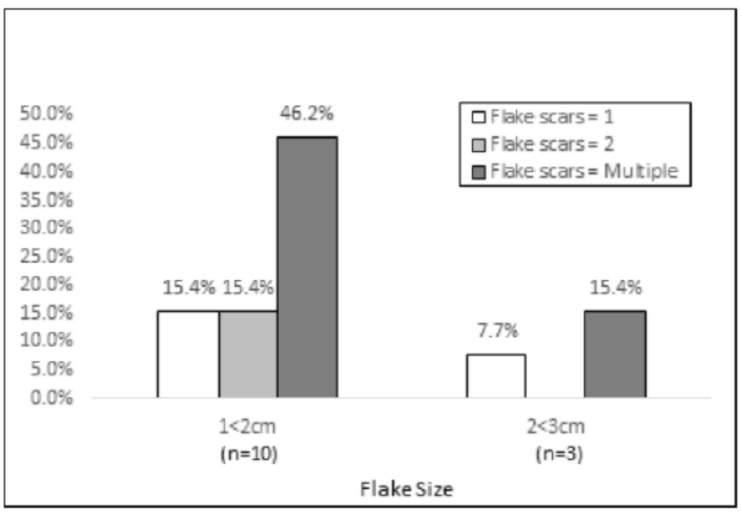


Figure 4.7. Complete non-cortical flakes with modified platforms by flake size and flake scar counts.

Local versus Distant Lithic Material Reduction

To investigate whether reduction strategies differed between locally and distantly acquired materials, the previous reduction strategy indicators were divided into local and distant material categories. Table 4.12 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 4.12
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 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 4.2).

In Table 4.13 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 4.13
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 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 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 4.2).

Table 4.14 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 4.14
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 4.15 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 4.13 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 4.13, 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 4.15
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 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 4.8 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.

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

Most of the 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 4.16. 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 the site. 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 4.16
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

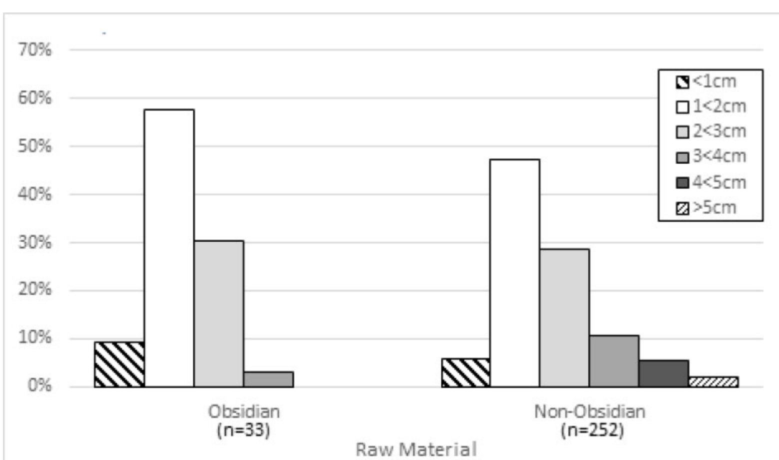


Figure 4.8. Percent of debitage size for obsidian and non-obsidian materials.

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 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 4.17). 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. pXRF analysis (discussed previously) indicates that all obsidian tools derive from two geochemical sources located in the Jemez Mountains – Cerro Toledo Rhyolite (CTR) and Valles Rhyolite (VR).

Table 4.17
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%**

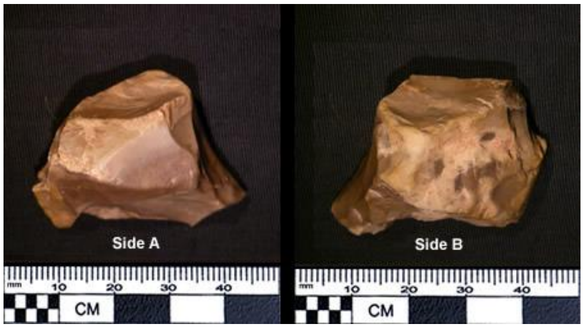
Most cores (64%) are of locally available lithic materials, while obsidian constitutes the only nonlocal core material (36%). Similarly, most expedient tools (63%) are made from locally available materials, with the remaining expedient tools being made from obsidian (31%) and Pedernal chert (6%). Conversely, 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 4.1, Figure 4.1), it is over 30% of the flaked stone tool assemblage (Table 4.2, Figure 4.2). 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, or scavenged, 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

One obvious indication of flaked stone reduction on-site is the presence of cores. Of the 11 cores recovered at LA 20,000, 6 are multidirectional, 4 are bipolar, and 1 is unidirectional (Table 4.18, Figure 4.9). All are less than 5 cm in maximum dimension and expedient in form. Most cores are of locally available materials, while obsidian constitutes the only nonlocal core material. Cortex is present on 91% of cores, with Core-1, Core-3, Core-7 and Core-10 having water-worn cortex indicating procurement from stream deposits or ancient river gravels.



Core-1

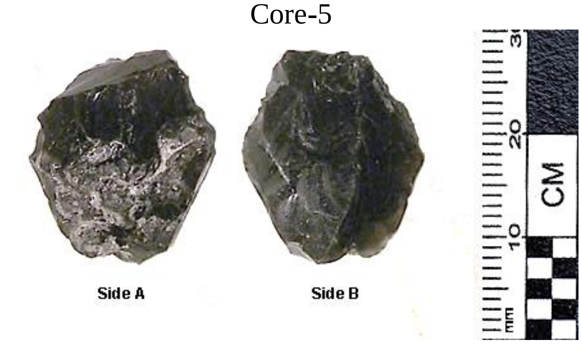
Core-2

Core-3

Core-4

Core-5

Core-6



Core-7

Core-8

Core-9

Core-10

Core-11

Figure 4.9. Cores from LA 20,000.

Table 4.18
Cores

Artifact	FS #	Type	Material	Color	Max Length (cm)	Max Width (cm)	Max Thickness (cm)	Mass (g)	Flake Scars	Cortex
Core-1	89	Multi-directional	Chert	Mottled brown-gray cream	3.8	3.4	2.2	21.66	8	< 50%
Core-2	171	Multi-directional	CTR Obsidian	Transparent black	2.5	1.5	0.8	2.61	5	< 50%
Core-3	200	Multi-directional	Chert	Dark brown-gray and red	2.5	1.9	1.4	7.64	7	< 50%
Core-4	135	Bipolar	Chert	Black with pinkish-white cortex	1.7	2.1	1.8	6.07	7	100%
Core-5	167	Multi-directional	Chalcedony	Dark brown with red mottling	3.6	2.8	2.0	14.82	6	< 50%
Core-6	209	Uni-directional	Chalcedony	Mottled opaque white and dark gray	3.0	4.6	1.8	16.6	6	< 50%
Core-7	F-0-1990	Bipolar	CTR Obsidian	Semi-transparent black	2.1	1.7	1.0	3.24	10	< 50%
Core-8	206	Multi-directional	Chalcedony	opaque light gray with white inclusions; cortex is mottled cream and brown	4.0	4.2	1.8	32.98	6	< 50%
Core-9	39	Bipolar	VR Obsidian	Semi-transparent black	2.6	3.1	0.9	7.92	10	0
Core-10	1J-54	Bipolar	CTR Obsidian	Semi-transparent black with light brown caliche cortex	3.7	1.8	1.3	8.16	3	100%
Core-11	92-0-2	Multi-directional	Basalt	Dark gray and fine-grained	4.3	4.5	2.0	45.3	14	< 50%

Additional observations about specific cores are as follows: Core-1 has patination present on all surfaces and likely originated from a river gravel; Core-2 has smooth patinated cortex present on its exterior surface and likely originated from a piece of recycled angular shatter; Core-3 has patination present on all surfaces and all edges are sub-angular in morphology. Its cortex suggests that it originated from a river cobble, while three crushed and abraded adjacent surfaces indicate that this core was likely held in place on a hard surface (such as an anvil) and struck to remove flakes from opposite sides of one of the edges. The patination and rounding of edges, including flake scars, suggest that Core-3 has been heavily subjected to weathering actions such as sheetwash and/or wind abrasion by sand; Core-7 has water-worn cortex and one pointed and three crushed platforms; Core-8 has patination present on all surfaces; Core-9 has three battered platform edges; Core-10 has water-worn caliche cortex and is an obsidian cobble that has been split using bipolar technique; Core-11 has flat opposing ends - one used as a platform and the other as a resting end. Both lateral margins have platform remnants with abraded edges. There is approximately 10% cortex present on the core's bottom right dorsal surface near its flat base/resting end.

According to Patterson (1987:51), multidirectional and amorphous cores can result from a variety of manufacturing situations. These 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 the presence of dorsal cortex on all but one core suggests that cores likely started out small since more intensive reduction should result in the removal of most or all dorsal cortex.

Table 4.19 shows core type by average size (Core-2 was excluded from calculations since it is not a complete multidimensional core). Average length, width, thickness, and mass measurements reveal that bipolar cores are 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 local materials, while only one multidirectional core fragment is made of a nonlocal obsidian. Taken together, these results indicate 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 obsidian.

Table 4.19
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 (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 opportunistic flake removal, 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 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 4.20, Figure 4.10). Locally available raw materials were most often used as informal tools (62.5%), with nonlocal obsidian and Pedernal chert also occurring. Flake tools are by far the most common type, while unifaces are the least. Informal tools account for the majority (nearly 44%) of the flaked stone tool assemblage 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 harder materials does not always result in discernable edge damage (Grace 2012). Consequently, only a small portion of informal tools were likely identified in the assemblage, and these do not reflect the full range of informal tools at the site.

Table 4.20
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%***

Figure 4.10. Examples of informal tools from LA 20,000. Bipolar flake tools (left) used to scrape and incise materials of medium hardness (e.g., wood) and a modified CCS flake (right) used to bore medium to hard materials (e.g., wood, soft stone, or bone).

Debitage attributes associated with informal tools indicate that early reduction flakes were most often selected for use (25%), with angular shatter (22%), bipolar flakes (19%), and late reduction flakes (6%) also used. 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. From the 32 informal tools, 56 different used edges and edge angles were recorded (Table 4.21). Most informal tools have either one or two use-edges, with unimarginal and bimarginal 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, and the most common use-edge angles occur between 30-60 degrees. Striations were observed on only 16 (29%) of the edges, with transverse orientations being the most prevalent. Oblique, parallel, and combination parallel and transverse striations were also observed. Edge fractures include feather, snap, step, hinge, and crushed 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).

Informal Tool Use Interpretations

Tool wear motion patterns and use interpretations were determined following methods presented by Grace (2012). Suggested wear motions were identified for 43 of the 56 used edges (Table 22) 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.

Table 4.21
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%**

Table 4.22
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%**

Edge wear analysis suggests that informal tools were produced for a variety of functions (Table 4.22). Scraping, cutting, and incising 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. 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%) such as plants, woody plants, soft wood, fish, and leather being most common. Harder materials like dry wood, antler, bone, shell, and 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.

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 4.23). Formal tools account for less than 17% of the flaked stone tool assemblage and less than 4% of the entire flaked stone artifact assemblage. Four of the formal tools are complete, while eight are incomplete (five identifiable and three unidentifiable portions). Of formal tools, 92% 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, or scavenged 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 4.23
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	VR 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	VR Obsidian	2.9	1.9	0.5	2.54	3.80	Near Complete
BF-4	119	Biface	CTR Obsidian	3.3	2.1	0.5	3.89	NA	Fragment
BF-5	51-258	Biface	VR Obsidian	3.2	1.7	0.9	3.35	NA	Fragment
BF-6	52-183	Biface	VR 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	CTR Obsidian	2.0	1.6	0.7	2.06	2.29	Complete
PP-1	4	Projectile Point	CTR 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	CTR 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 4.23, Figure 4.11) consist of the following: BF-1) the blade portion of a VR 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 VR 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 a CTR obsidian biface fragment exhibiting a perverse fracture; BF-5) a VR obsidian biface fragment that was intentionally broken and reused as a spokeshave; BF-6) the distal end of a VR 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.

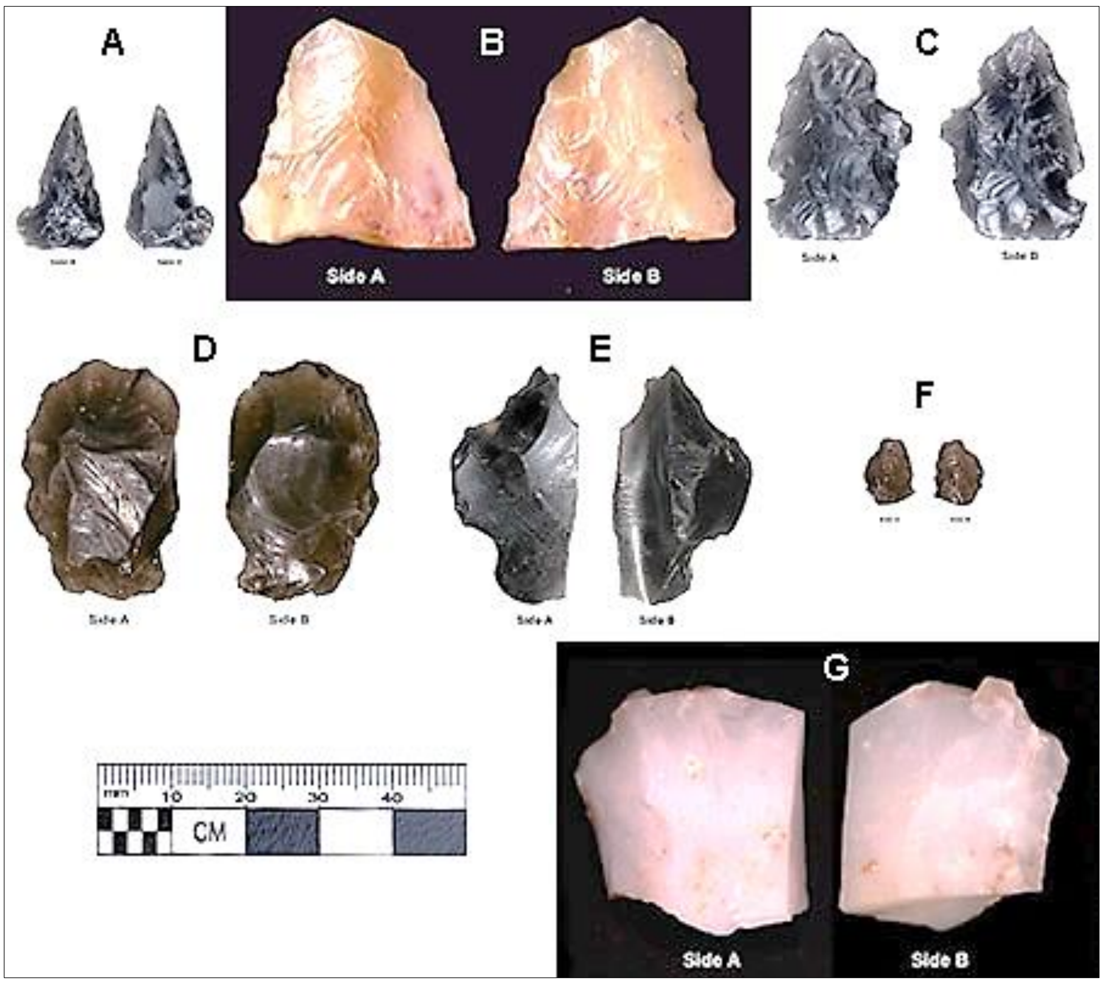


Figure 4.11. Bifaces from LA 20,000. A) BF-1; B) BF-2; C) BF-3; D) BF-4; E) BF-5; F) BF-6; G) BF-7.

Projectile Points

Projectile points include two complete and two broken examples (Table 4.23, Figure 4.12). 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.

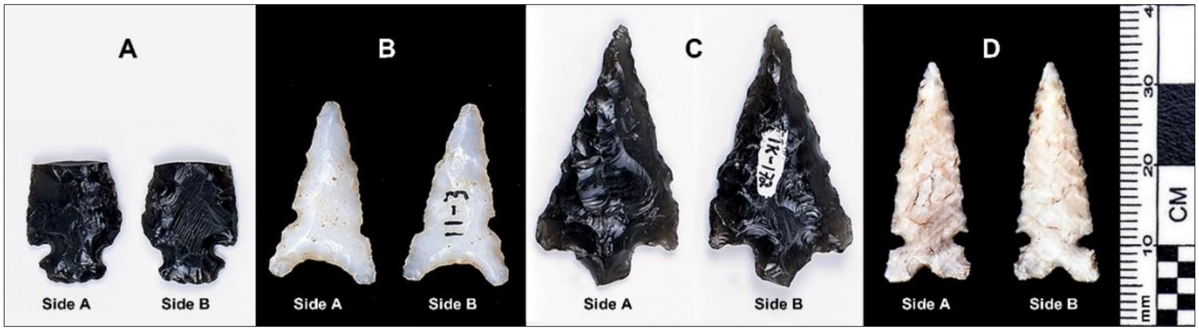


Figure 4.12. Projectile points from LA 20,000. A) PP-1; B) PP-2; C) PP-3; D) PP-4.

PP-1 is the proximal portion of a CTR 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).

PP-3 is the blade and neck portion of a CTR 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, provide evidence of trade between inhabitants of LA 20,000 and Native groups, or reflect the scavenging and curation of a lost artifact.

Drill

One bifacial drill (Drill-1) was recovered at LA 20,000 (Table 4.23, Figure 4.13). The drill is complete, made of CTR 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 4.13. 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 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

Eight strike-a-light flints were identified in the flaked stone assemblage at LA 20,000 and provide evidence for the use 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 4.24, 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 4.14).

Table 4.24
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 4.14. 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. It seems 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 (Moore 2001b:76-77). 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 4.25, Figure 4.15), 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. Average lengths and widths for these two different gunflint types are essentially identical, while differences in average thicknesses and weights likely reflect the more intensive reduction associated with bifacial production.

Table 4.25
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 4.15. 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 the reduction of gunflint material types on-site from debitage analysis hints at the likelihood that some gunflint manufacture 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). Differing flake scar patterns suggest not only different manufacturing techniques, but likely also different manufacturers (Spanish and Indigenous) (Durst 2009; Kenmotsu 1990:98-102; Kent 1983).

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).

Figure 4.16. Bend-break (left) and radial fracture artifacts (right) from LA 20,000.

At LA 20,000 nine flaked stone artifacts were intentionally broken using direct impact (Figure 4.16). 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 exhibit evidence of reuse, recycling, or multifunctional use (Table 4.26) 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. 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.

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).

Table 4.26
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

Of the 12 formal tools (Table 4.23), 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 wealthy or had better access to goods than other colonists since firearms were presumably expensive and difficult to acquire in 17^{th}-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 Spanish and Puebloan, and possibly even Plains peoples, were likely responsible for the production and use of flaked stone tools at LA 20,000.

Spatial Analysis

To identify location(s) of lithic related activities carried out at LA 20,000, the distribution of flaked stone artifacts across the site was analyzed (Lindsay 2020:110-124). While no specific flaked stone activity loci were identified at the site through spatial analysis, a discussion of lithic artifacts by general location provides insights into flaked stone related activities.

Artifact and material distributions (Figures 4.17, 4.18, and 4.19) 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 paucity of flaked stone artifacts associated with the Corral reveals that very little activity requiring the reduction, production, or use of flaked stone occurred in this area. This may reflect the use of the Corral area being a space utilized to hold livestock and not generally associated with flaked stone related activities. The presence of strike-a-light flints in House and Unit D suggest that fire making activities occurred in these areas.

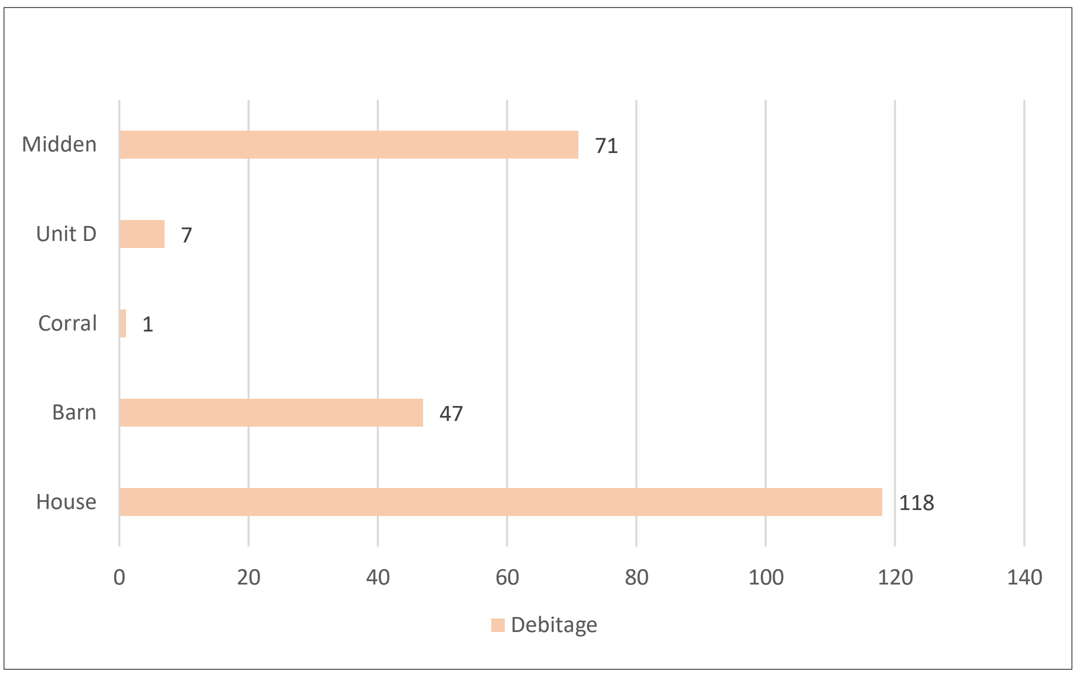


Figure 4.17. Debitage count by analytic unit.

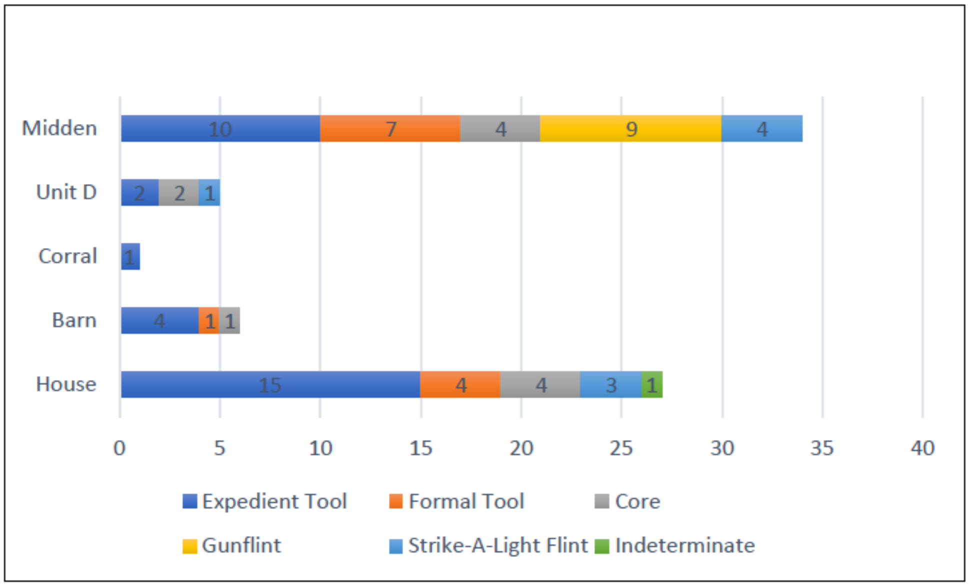


Figure 4.18. Tool type by analytic unit.

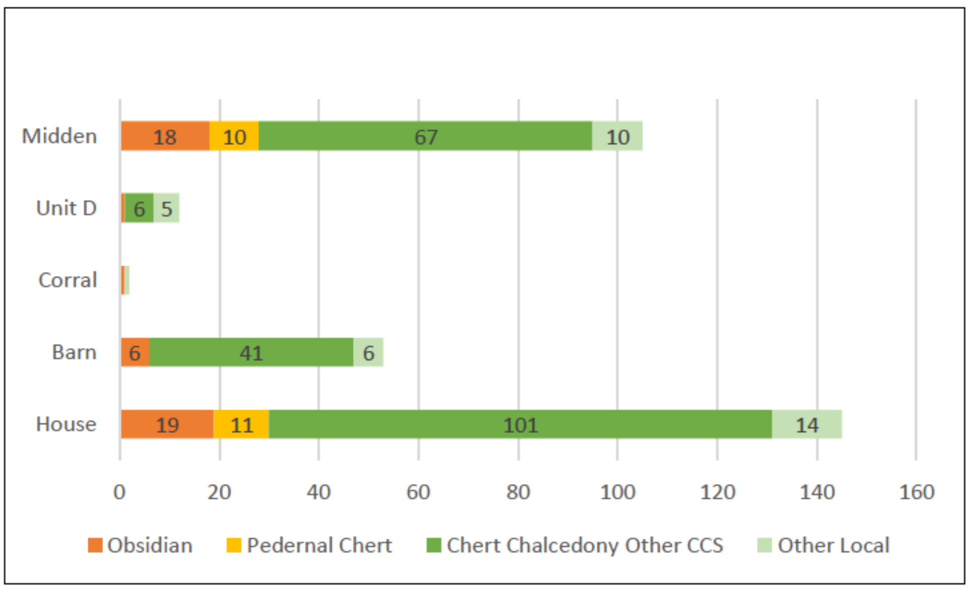


Figure 4.19. Material type by analytic unit.

Differential use of raw materials by locality and quality was also observed at the site (Figure 4.19). In general, locally available lithic materials dominate each area indicating that easily accessible materials were the most heavily reduced and utilized across the site as a whole. More restricted distributions of Pedernal chert and obsidian point to the likely importance of these materials in household activities in the House area, while obsidian also appears to have been utilized in the Barn area for cutting related tasks.

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, non-local, high-quality lithic materials for use as formal and specialized tools over this time span.

In addition to site-specific information, data relating to flaked stone artifacts can provide a means for more regional synthetic interpretations. Comparing data from several early colonial Spanish ranches can provide information about the importance of lithics at these households including the prevalence of flaked stone utilization, material selection and reduction strategies between sites, and differential use; if utilization was related to household economic activities, socio-economic status, or proximity to other Spanish settlements, trade routes (e.g., *Camino Real*), or Puebloan settlements; and if use, reliance, or source exploitation changed over time. Comparing lithic data between early colonial households can also provide further insights into Indigenous material contributions and hybrid practices at Spanish ranches in the region (Snow 1992; Trigg 2020), helping to tie actions to group identity practices, rather than seeing objects as equaling identity (Silliman 2001; Trigg 2020). In turn, such insights contribute further understanding towards the development of seventeenth-century New Mexican culture (Payne 2012; Rothschild 2006; Trigg 2020). Comparing data between early colonial Spanish ranches and contemporary Indigenous sites can provide evidence for economic, social, political, and/or familial ties. Such comparisons may reveal which Pueblo(s) might have provided trade, tribute, labor, and individuals to the household, as well as indicate if relations were maintained or changed over time, or at least open avenues of inquiry to such questions (Lindsay 2021).

References Cited

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.

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 Jr., William

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.

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.

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

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

Daly, Patricia
1969 Approaches to Faunal Analysis in Archaeology. *American Antiquity* 34(2):146-153.

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.

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

Goodyear, Albert
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
2012 *Interpreting the Function of Stone Tools*. Ikarus Books.

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.

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.

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

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.

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

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

Lavin, James D.
1965 *A History of Spanish Firearms*. Herbert Jenkins, London.

Liebmann, Matthew
2017 From Landscapes of Meaning to Landscapes of Signification in the American Southwest. *American Antiquity* 82(4):642-661.

Lindsay, Clint S.
2020 *Form, Function, and Context: Lithic Analysis of Flaked Stone Artifacts at a 17th-Century Rural Estancia (LA 20,000), Santa Fe County, New Mexico*. Master's Thesis, Department of Anthropology, University of Massachusetts, Boston.
2021 pXRF Analysis of Obsidian Artifacts from a Rural Spanish Household: Investigating Spanish-Pueblo Interactions in Seventeenth-Century New Mexico. *Kiva* DOI: 10.1080/00231940.2021.1929715

Moore, James L.
1994 Chipped Stone Artifact Analysis. In *Studying the Taos Frontier: The Pot Creek Data Recovery Project Volume 2: Discussion and Interpretation, Archaeology Notes 268*, pp. 286-338. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.
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.

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

Odell, George H.
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.

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.

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.

Prentiss, William
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.

Ramenofsky, Ann F., Anastasia Steffen, Jeffrey R. Ferguson, Philippe D. Letourneau, and Adam Okun
2017 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.

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.

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.

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
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.
2009 Two Newly Discovered Sources of Archaeological Obsidian in the Southwest: Archaeological and Social Implications. *Kiva* 74(3):269–280.

Shackley, M. Steven, Fraser Goff, and Sean G. Dolan
2016 Geologic Origin of the Source of Bearhead Rhyolite (Paliza Canyon) Obsidian, Jemez Mountains, Northern New Mexico. *New Mexico Geology* 38(3):52–65.

Silliman, Stephen W.
2001 Theoretical Perspectives on Labor and Colonialism: Reconsidering the California Missions. *Journal of Anthropological Archaeology* 20:379-407.

Snow, David H.
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.

Trigg, Heather
2005 *From Household to Empire: Society and Economy in Early Colonial New Mexico*. University of Arizona Press, Tucson.

2020 Spanish-Pueblo Interactions in New Mexico's Seventeenth-Century Spanish Households: Negotiations of Knowledge and Power in Practice. *International Journal of Historical Archaeology* 24:618-641.

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

Chapter 5
The Archaeology of the Architecture at LA 20,000, a 17th-Century New Mexican Ranch

By Katherine A. Albert

Introduction

LA 20,000 is the largest and most architecturally complex 17th-century ranch that has been excavated in New Mexico. Over the last thirty years, archaeologists have recovered not only a rich artifact assemblage that shows its roughly fifty-year occupation from the late 1620s to the Pueblo Revolt of 1680, but also foundations and architectural remains. Reconstructing the architecture of LA 20,000 provides archaeologists with a sense of how 17th-century *estancias* were built and social space constructed in New Mexico.

Using 17th-century architectural artifacts and foundations of the structures at LA 20,000, as well as the field notes and site reports from the last thirty years of excavations, I offer a possible reconstruction of the structures. This research uses the accumulation of previous work performed at the site, specific tests and analyses on the artifacts, and documented spatial evidence to enhance the understanding of the architectural features. By synthesizing and organizing disparate data sources, I develop a unified and as complete a picture as possible of the architecture of the *estancia.*

The analysis in this work provides information not only about the appearance of the structures, but also about the raw materials used for the construction of the buildings. The *estancia* was not only a complex of buildings, but also a physical embodiment of Spanish colonization on the New Mexican frontier landscape. Therefore analysis provides a microscopic view of the process of colonization on the level of an individual household through the acquisition of materials from the regional landscape and the coordination of labor to create spaces for agricultural and domestic activities.

Seventeenth-century colonists settled among Pueblo peoples and relied on them for labor, food, and subsistence goods such as textiles and ceramics (Figure 5.1). There were several Spanish practices that institutionalized the appropriation of Pueblo goods and labor. *Encomienda* was a system of land and economic control, which granted distinguished Spanish subjects (*encomenderos*) the right to collect tribute in exchange for military protection of the colonial holdings and the neighboring Indigenous people (Douglass and Graves 2017:19-20). In New Mexico, *encomienda* was paid only by Pueblos and typically in the form of food and textiles (Trigg 2003:67).

The practice of *encomienda* had a long history, being first used during the Reconquista as a way of controlling land and paying soldiers. The Spanish government also used *encomienda* as a way to assuage the two opposing views about Indigenous peoples' status within the empire as both protected subjects and exploitable laborers (Deagan 2003:5). The process of *reducción* relocated Pueblo communities to larger villages held in *encomienda* where they could be converted to Catholicism. These tributes were intended to provide financial support for colonists, as well as provide colonists incentive to relocate to New Mexico, ensuring a continuous settlement of the region (Barrett 2015:27; Liebmann 2012:32). Pueblo people were also subjected to *repartimiento*, or corvee labor, which was used to build public works such as churches and irrigation systems.

While Santa Fe was the capital of the colony beginning in 1610, the majority of colonists established their bases on *estancias*, or ranches, where they oversaw agricultural enterprises that involved the production of livestock (cattle, fowl, sheep, and goats) and European-introduced and Indigenous crops (Trigg et al. 2022). As such, *estancias* were mostly self-sustaining, as they contained almost everything that a settler family would need to survive in the mercurial New Mexican landscape (Ivey 2006:77). Almost all *estancias* in New Mexico had the same basic components: dwelling structures (sometimes a large one for the household and a smaller herder's quarters), a space designated for keeping livestock (sometimes inside the residential structure or a corral) and storing crops (Ivey 2006:78). Due to colonial settlement regulations, *estancias* could not be located too close to Pueblo settlements or pasture livestock within 1.5 leagues of Pueblo villages and fields (Barrett 2015:30).

Over time, *estancias* became the economic powerhouses of colonial New Mexico, producing livestock and crops with different methods from the Pueblos (Ivey 2006:75). Archaeological evidence has indicated that the families who dwelt on *estancias* were most likely engaging in subsistence farming, with perhaps some production of yarn and yarn crafts; artifacts indicating specialization of crafts have rarely been recovered at 17th-century *estancias* (Trigg 2003:67). However, throughout the 17th century as Spanish colonial families struggled to survive the famines, epidemics, and other hardships of the early years of the colony's existence, the Spanish relied heavily on goods from local Indigenous populations and their labor (Trigg 2003: 67-69). No doubt, Indigenous people of New Mexico contributed to the creation of the structures on Spanish ranches.

Figure 5.1. Map of Pueblo ancestral territory. From Liebmann et al. 2005.

Comparative Architecture Studies

Although there have been archaeological investigations of the architecture of 17th-century colonial New Mexico, there has been little focus on that of *estancias*. Many of the most prominent examples of 17th-century colonial New Mexican architecture that are still standing on the landscape are Franciscan missions (e.g., Pecos and Hawikuh) or civic buildings (i.e., the Palace of the Governors). These structures are much larger than the structures on the documented *estancias*, and many have had later reconstructions or renovations that have allowed them to remain present on the contemporary New Mexican landscape. Similarly there are few well-preserved 17th-century sites that archaeologists have found in New Mexico (e.g., C. Snow 1974; D. Snow 1971; Alexander 1971). This is due to the ephemeral nature of many of the building materials, the small numbers of colonists during this early period of colonization (barely 3,000 by 1680) (Whitehead 2011:66), the violence of the Pueblo Revolt of 1680 that destroyed many colonial buildings, and later development and construction that disturbed or obfuscated those sites.

A survey of the architecture of the Pueblo communities and early Spanish colonists in the New Mexico (Table 5.1) show characteristics that Pueblo and Spanish structures have in common and several key elements that are distinguishing features of these two architectural traditions. There are practices of both Indigenous communities and colonists that helped construct shelters that would withstand the mercurial New Mexican environment.

Both Pueblos and Spanish colonists used adobe for creating structures. While the Pueblos more commonly used stone, they mounded adobe mud into domed turtle backs or "puddled" walls. Spanish colonial structures relied on molded adobe bricks. It may have been easier to assemble large quantities of adobe bricks with a coordinated labor force, especially with the use of standardized molds, rather than to locate, transport, and shape stones for all of the structural components. These structures also use a plaster to protect the adobes from the effects of weathering, or as a form of adornment. Plasters can be calcium-based (from caliche), adobe-based, or gypsum-based (e.g., gypsum or selenite) products. Finally both the Pueblos and colonists had a tradition of flat, mud-covered roofs.

Generally speaking, Spanish ranch structures that have been identified in the archaeological record are all a single story and composed primarily of adobe brick walls atop stone foundations, unlike multi-storied, typically masonry Pueblo dwellings (shown in Figure 5.2 left). The foundations and walls that remain also suggest that the Spanish preferred larger rooms than Pueblo rooms, which were not only small, but often also aggregated into substantial villages. Like Pueblo rooms (Figure 5.2 right), Spanish structures had flat roofs composed of *vigas* and *latillas* with a mud cap.

There is not a common floor plan to the Spanish domestic structures (Figures 5.3, 5.4). While each contains large, multipurpose rooms (Grizzard 1986:71) with common features that speak to domestic and utilitarian use such as fire pits and postholes, the configuration of these rooms varies from site to site. It seems likely that rooms were added on depending on the size and needs of the household, but the manner of expansion varied from house to house. There is also some variation in other architectural features present in Spanish houses such as the firebox in Las Majadas (D. Snow 1971:7), or the barn at LA 20,000.

Of the known 17th-century sites, there are few so rich in recovered artifacts, or so expansive architecturally as LA 20,000. As an *estancia* of significant size and structural investment, it is expected that the structure of LA 20,000 would have served the function of dwelling, living, agricultural production and storage rather than primarily defense.

With attributes from Pueblo and Spanish architectural traditions in mind (Table 5.1), it becomes easier to interpret the form of the architecture at LA 20,000. Any attributes that appear at LA 20,000 that are indicative of patterns in architectural styles suggest a sense of conformity, either as a cultural convention or a proven technique to provide effective and efficient construction. If there are deviations from these expectations, it may illuminate how the individual landowners at LA 20,000 adapted to the environment.

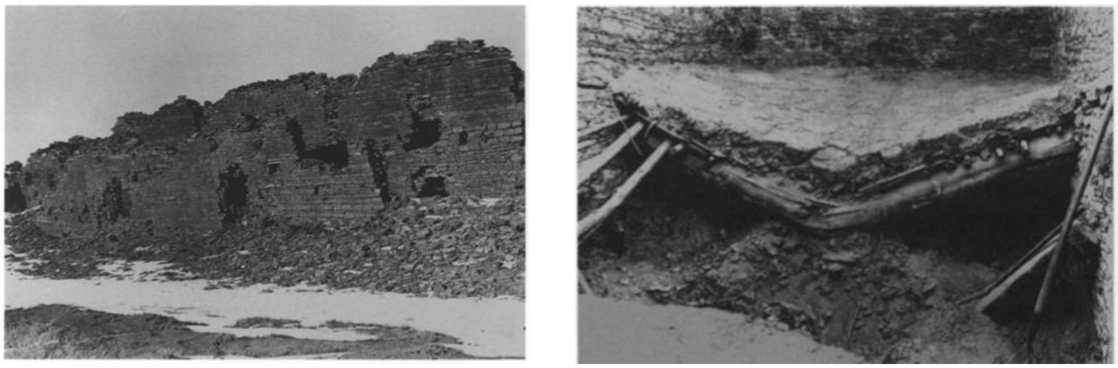


Figure 5.2. Pueblo architectural examples from Pueblo del Arroyo. Left: Stone walls (Photograph by Victor Mindeleff [U.S. Bureau of American Ethnology, 1887]). Right: Partial intact roof from second story floor at Pueblo del Arroyo. *Vigas, latillas* and mud layer visible. (Photograph by O.C. Havens [National Geographic Society, 1923]). From Windes 2010.

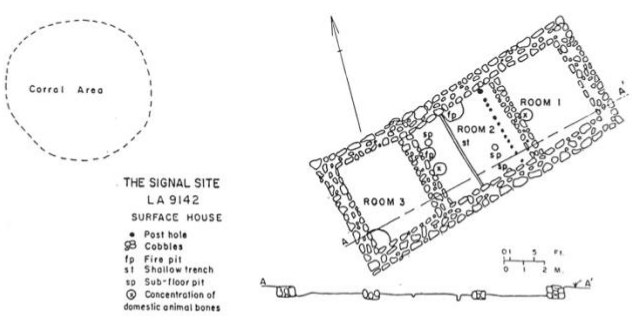


Figure 5.3. Foundation illustration and floor plan at the Signal Site (LA 9142). From Alexander 1971.

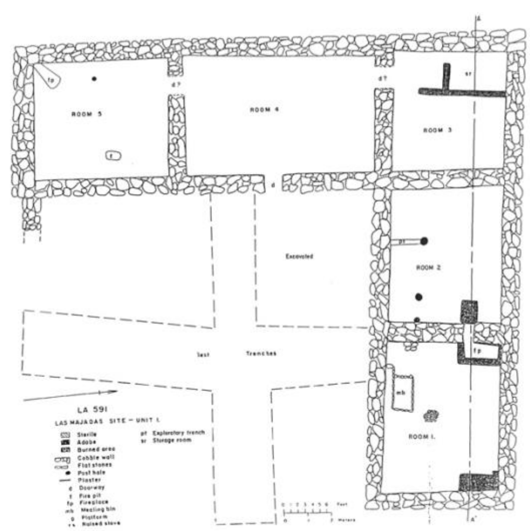


Figure 5.4. Foundations and floor plan of the house at Las Majadas (LA 951). From D. Snow 1973.

Table 5.1
Expected Architectural Attributes in 17th-Century New Mexico

	Pueblo Village	Colonial Spanish (vernacular)	Colonial Spanish (mission)
Examples	Chaco Canyon (Cameron 1999) Pueblo del Arroyo (Windes 2010)	Signal Site (LA 9142) (Alexander 1971) Las Majadas (LA 951) (D. Snow 1973)	Pecos Mission (Ivey 2005) Awatovi (Montgomery et al. 1948) Hawikuh (Burgio-Erikson 2019)
Structure	Multi-storied buildings with numerous small rooms (roomblocks) in close proximity to neighbors. Strategically placed for maximum harvest or water access. Made use of available materials	Single story structures in relative isolation from Spanish neighbors but often close to Pueblo villages, multiple buildings on properties. Large multipurpose rooms. Occasional out buildings for livestock or crop storage	Single or multi-story in relative isolation from each other, multiple rooms of varying size depending on function. Overall humble aesthetic (compared to Spanish churches in Mexico) despite massive size. Some built on top of sacred Indigenous structures.
Walls	Stone preferred, stone for foundations, Coursed adobe or rounded bricks, adobe mortar	Cobble and basalt foundations, adobe bricks lain with adobe mortar.	Cobble and basalt foundations, adobe bricks lain with ash and adobe mortar, and masonry
Adobe composition	Sand, clay, water, organic inclusions	Sand, clay, water, occasional organic inclusions	Sand, clay, water, occasional organic inclusions, recycled adobes
Wall decoration	Plaster and whitewash, murals on kiva walls	Plaster and whitewash	Plaster, occasional paint on plaster or mineral tiling
Windows	Selenite clerestories or open	Selenite pane windows, high and covered	Selenite clerestories in missions
Roof	Timber *vigas*, brush *latillas*, mud overlain	Timber *vigas*, wood and brush *latillas*, mud overlain	Timber *vigas*, wood and brush *latillas*, mud overlain; *canales* to help drainage
Doors	Roof access with ladders	Wooden or stone sills	Wooden or stone sills and lintels, iron nails and dowels for church doors
Structural Support	Sturdy stone walls	Timber posts for roof	Timber posts for roof, corbels to support *vigas*, buttresses, and drainage to protect erosion
Floors	Compacted earth	Compacted earth; adobe brick or cobbled (rare)	Compacted earth, flagstone tiles, or adobe brick or puddled adobe
Fire Places	Fire pits	Fire pits, hearths, raised fireplaces	Hearths
Construction	Buildings augmented and modified as population shifts	Buildings constructed based on need	Buildings constructed in phases
Labor	Community based, divided based on gender	Household or Indigenous labor, unknown division of tasks	Convert labor, Indigenous architectural knowledge required
Other	Often seasonal dwelling		Had access to wrought iron, leather, and brass hardware
Cultural Significance	The center of the community	The center of everyday Spanish life on the frontier; a reflection of an individual's status	Representation of the Catholic Church and Franciscan order; defensive structures

A Brief History of LA 20,000

LA 20,000 is an *estancia* located approximately 19 kilometers southwest of Santa Fe. Most of what is known about LA 20,000 comes from archaeological evidence. The identity of the family who owned the *estancia* on LA 20,000, and the number and identities of the Indigenous workers on the property are unknown.

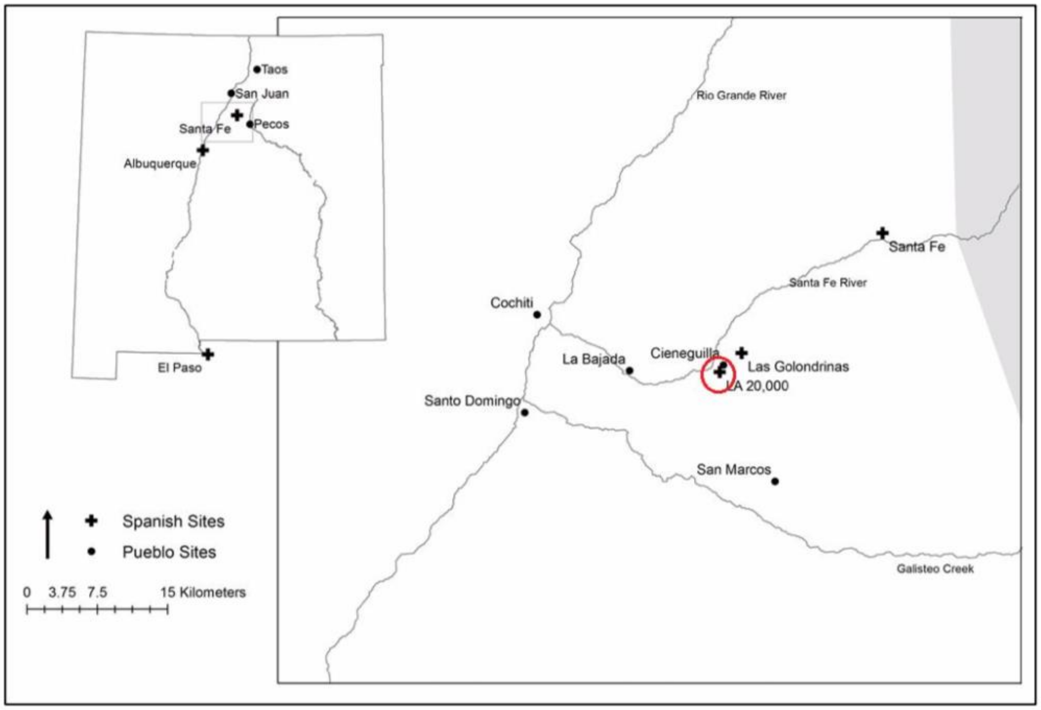


Figure 5.5. Map of LA 20,000 in relation to other Spanish and Pueblo villages. From Edwards 2015.

The first excavations at LA 20,000 began in the 1980s under the direction of the Museum of New Mexico, and then continuing from the late 1980s into the 1990s with David H. Snow and Dr. Marianne Stoller as principle investigators (Trigg et al. 2019:1). These early excavations determined that there were several structures associated with the 17th-century ranch. These included a large, mostly rectilinear house (with an attached *horno* and anomalous curvilinear platform), a barn, a corral (Figure 5.6), and a possible *torreon*. A dendrochronological study of two beams recovered from the barn has yielded an approximate date of construction around 1629 (D. Snow 1994:8). The presence of burned architectural material and other artifacts suggests that the structures were burned during the Pueblo Revolt. Along with ceramic evidence of styles that pre-date the Revolt, this also suggests that the *estancia* was not re-occupied following the Reconquista.

The excavations that Snow and Stoller conducted in the 1980s to the 1990s revealed much of the exterior foundations of the residential structure, as well as several other architectural features, such as a raised adobe platform, an adobe brick floor, and an *horno* (bread oven). David Snow posited that the southwestern corner of the residential structure may have been an earlier, smaller house that was later added on to as the family settled into the *estancia* or may have been the first part of the residential structure to be constructed. This is based on the stratigraphic positioning of the room's foundation stones, which are below the stones that make up the foundation of the large central rectangle (D. Snow 1987). The excavations reveal that this portion of the house was roughly a 5 by 5 meter structure. LA 20,000 was excavated again between 2015 and 2017 under the direction of Dr. Heather Trigg. These excavations revealed more details about the structures, including a glimpse at some of the interior foundations and room partitions, floors, and artifact distributions. These excavations, while they do not reveal all of the walls of the structure, do show the general extent of the foundations of the residential structure.

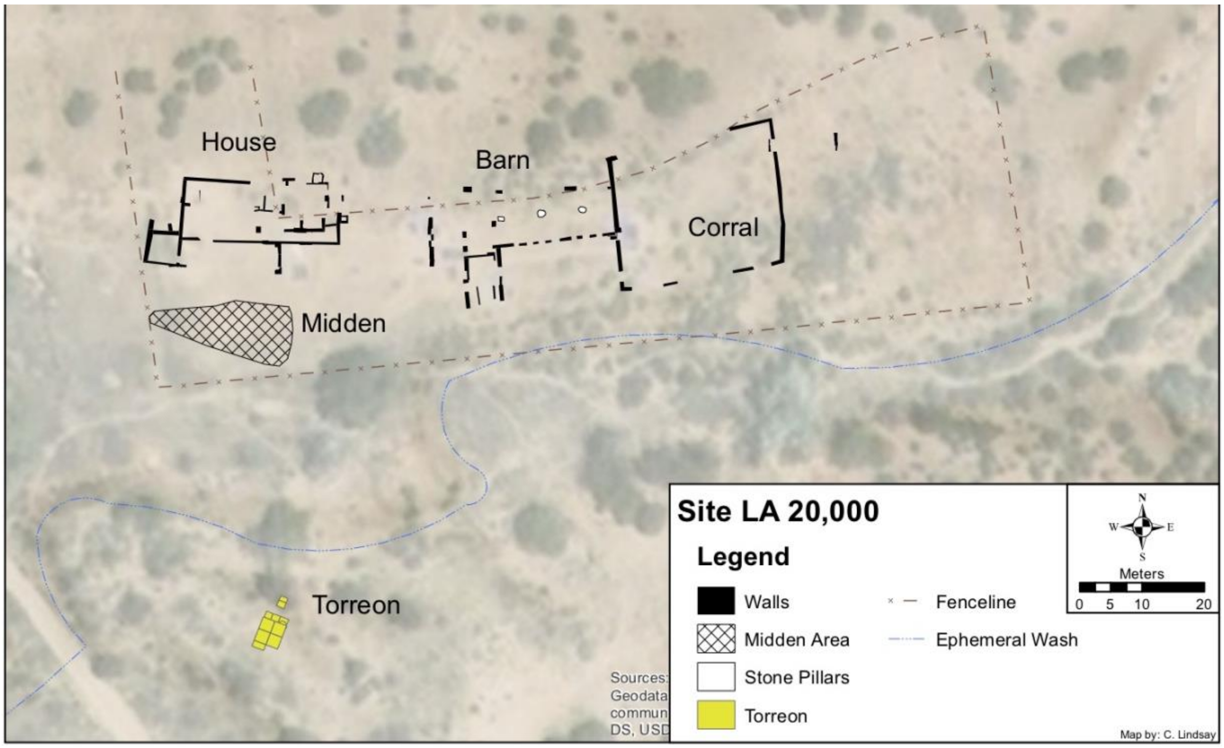


Figure 5.6. Known foundations of the house, barn and corral. Map by Clint Lindsay (2017).

Reconstructing the Architecture of LA 20,000

The site of LA 20,000 is approximately 13,500m^2 in area. The *estancia* is composed of three large structures: a house, a barn, and a corral, with a possible *torreon* located roughly 60 m south of the midden. This analysis will focus on the three main structures. The architectural components that are visible archaeologically are the foundations, but there is some material evidence of the walls, roofs, doorways, windows, supports, and other features such as fireplaces.

Table 5.2 shows the approximate metrics of the foundations for each of the three structures (Figure 5.7). These estimates only include walls that I am certain of their extent; this means I exclude many partial interior walls in the residential structure because I cannot define the full extent of the room size.

Table 5.2

LA 20,000 Architectural Metrics

	House	Barn	Corral
Total Foundation Length	119 m	90 m	78 m
Footing Width	0.5 – 0.8m	0.5 – 0.8m	0.8 m
Estimated Wall Height	2 m	2 m	30 cm
Footing Height	40 cm	40 cm	30 cm
Floor Area	402.5 m^2	239 m^2	594 m^2
Wall Surface Area	238 m^2	165 m^2	39.25 m^2
Roof Area	402.5 m^2	239 m^2	—

In order to make these estimates, I made certain assumptions that the archaeological data cannot specifically confirm. I have assumed that the structures at LA 20,000 are only one story, and that the walls stood as high as other contemporary single-story 17th-century colonial New Mexican structures. This is based in part on the measurements of the foundations, which, although varied in thickness across the site (e.g., some interior foundations are 0.5m thick (Figure 5.8)), are less than 1 meter thick across all the structures. Walls with a thickness of one meter are stable enough to support a single story approximately 2 meters high (Ivey 2005:170); thicker foundations are strong enough support the weight of multiple stories. I have observed in excavation units with plans of exterior walls (2017-A and 2017-K), that their thickness is approximately 0.8 m, so I use that number for all calculations.

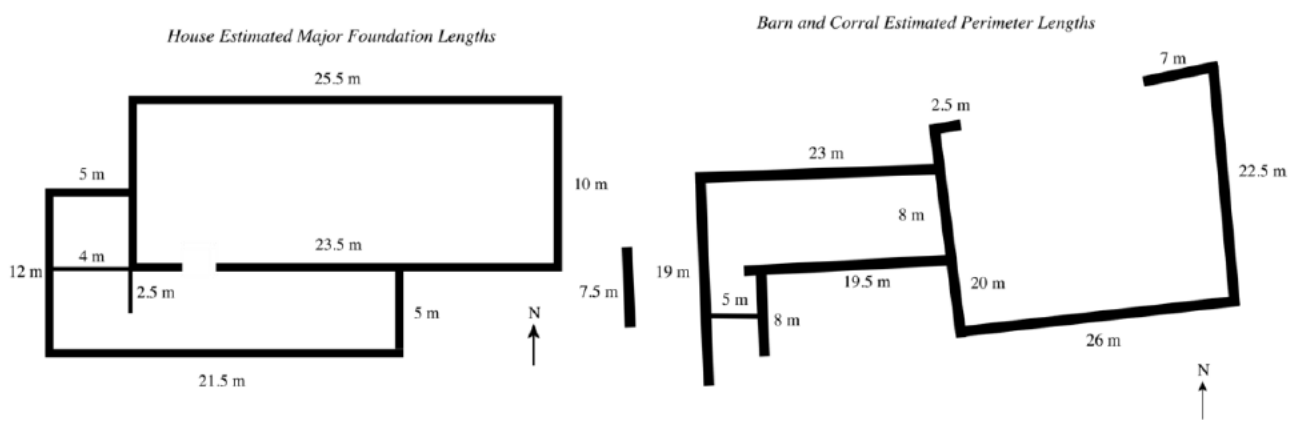


Figure 5.7. Major foundation lengths of the house (left), barn, and corral (right) used in metric calculations. From known and hypothetical foundations recorded in field notes and site reports.

Figure 5.8. Plan drawings of narrower interior foundations—approximately 50cm.

The majority of the foundations at LA 20,000 are at right angles to each other -- the exception being a curvilinear adobe platform on the northern wall of the residential structure, although this does not appear to be part of the major exterior structural foundations. As such, I have assumed that all corners in the foundations of the structures are right angles.

Finally, I am assuming that the barn and the house structures had roofs that completely covered the floor area. The presence of stone pillars in the interior of barn suggests that they would have provided structural support for a large roof. In contrast, not enough units have been excavated in the center of the house to indicate that there was an open-air *patio* at LA 20,000, even though there are contemporary sites, such as the Palace of the Governors (Snow and Post 2020), that show evidence of patios or open space within residential structures. Without concrete evidence of an open space in the center of the house, I will assume that the entire residential structure was covered with timber and adobe.

The House

The house on the *estancia* would have served as the primary residence for the family, and perhaps for the permanent Indigenous ranch workers as well. Its foundations are composed of basalt boulders and cobbles. The length of the stone foundations is 119 meters, though this does not account for all of the interior wall foundations. The approximate floor area of the residential structure is 402.5m^2, which, compared to other 17th-century colonial houses in New Mexico such as Las Majadas (177m^2), would have made the residential structure at LA 20,000 one of the largest of its kind (Figure 5.9).

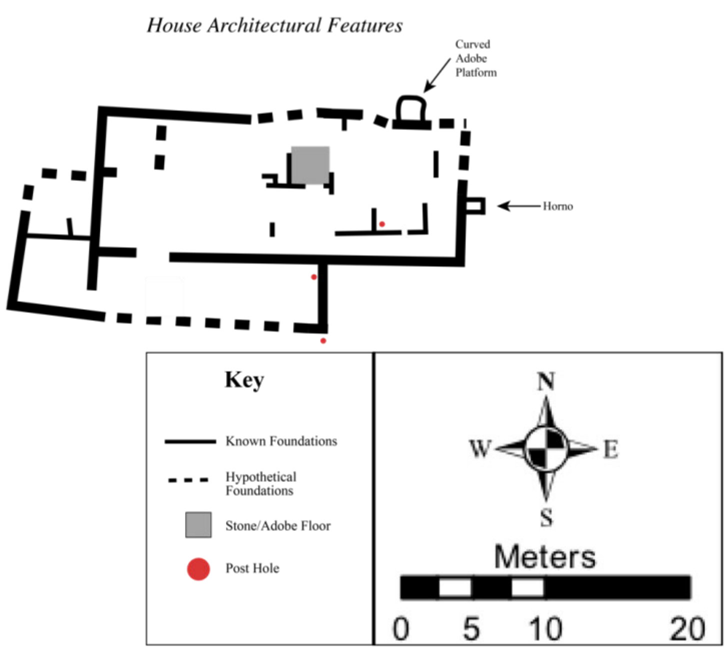


Figure 5.9. Known and hypothetical architectural features of the house at LA 20,000.

In the case of the house at LA 20,000, only a few of the excavation units have uncovered interior walls. The southeastern units of Snow and Stoller's excavations do not reach the 17th-century floor surface, and on the whole their excavation units do not cover much of the interior spaces. Other excavation units, such as in the southwestern portion of the house reveal disturbed contexts from the 20th-century occupation of the site. As such, the archaeology offers little insight as to the precise interior divisions of the space, although the interior walls are narrower than the exterior wall foundations. However, the view of the interior walls is in a unit from the Fiske Center excavations. Based on the interior walls in the plans of the 2017-C series (2017-C.1-2017-C.5), which show the divisions between at least two narrow rooms, it is clear that there would have been variability in the size of the rooms. Rather than have few, large multi-purpose rooms like ones present at the Signal site or Las Majadas, the 2017-C series foundations suggest that there were also some small rooms in the residential structure that might have perhaps been hallways or rooms used for storage.

The number of rooms in 17th-century residential structures varies substantially, ranging between two and eighteen rooms (Levine 1992:196). While I cannot say definitively how many rooms are at LA 20,000 structure, based on the number and size of rooms at a contemporary site, Las Majadas (5 rooms arranged in an L-shape with an average of 28.339m^2 per room) (D. Snow 1971:4), I would estimate that there were most likely around 14 rooms of varying size. This number is from dividing the average room size from Las Majadas by the floor area of the house at LA 20,000. These rooms may have been all contiguous with one another, or arranged around a center courtyard or *patio*, which would have reduced the amount of roofing material needed to cover the structure.

On top of the stone foundations, all of the walls for the interior and exterior were made from adobe mud bricks laid on top of multiple courses of basalt and river cobble foundations, with few exceptions such as such as the wall in EU 2015-A, in which the bricks are laid directly on top of the floor. The bricks were laid with a layer of adobe mortar in between them for support (Figure 5.10). Bricks would have been laid in an alternating pattern to increase their overall load bearing strength. Even though there is some variation in size among the bricks across the structures, their shape and consistent size indicates that the crew used standardized brick molds.

Figure 5.10. Adobe bricks and mortar in situ. Photo by Annie Greco and Christina Spellman, 2017.

Exterior walls would have been coated with plaster that would have served as a waterproofing or decorative coating. It is unclear whether this would have been on the interior face of all walls. While there is no evidence for painted murals on the walls, there are fragments of adobe with bright red coating and whitewash suggests some decoration on the walls (Figure 5.11). Any painted patterns or designs are unfortunately unknown, but surviving examples in mission structures reveal the possible compositions or patterns that might have been seen in these spaces such as polychromatic geometric patterns in plaster at Mission San Marcos (Thomas 2000:28), or geometric patterns made with mica and selenite such as the ones on the sanctuary and stair fronts at Hawikuh mission (Thomas 2000:43).

Other contemporary structures might have a layer of flagstones (e.g., the church at Awatovi) or in rare instances adobe bricks for floors, otherwise there would be floors of compacted dirt (Montgomery et al. 1948:71). At LA 20,000 there is limited data about the nature of the floors. The floors exposed in the southeastern portion of the house were informal – laminated, packed layers. However, at least one room in the house had an adobe brick surface, which may have been where specialized activities were performed (Figure 5.12).

Figure 5.11. Eastern wall of EU 2015-A with whitewash.

Figure 5.12. An adobe brick floor inside the house.

It is unclear exactly how many windows might have been a part of the structure, or how large the windows would have been. Contemporaneous *estancias* with windows have not preserved archaeologically, although the presence of selenite clustering near the foundations at Las Majadas suggests there was at least one window in the structure. The presence of selenite at LA 20,000 leads me to consider the possibility of windows in the residential structure. It is likely that the windows at LA 20,000 were small, rectangular, and strategically placed to provide maximum amount of light into interior spaces. Smaller windows also would have required fewer materials, and would have let in light without risk of also letting in the elements (Grizzard 1986:68).

The exact number of entrances or doorways is also unknown. While no wood or stone sills were recovered in the excavations, a visible internal doorway is located in the 2017-C series that connects units 2017-C.1 and 2017-C.2 (Figures 5.8, 5.13). There is a step between the two walls made of stone and adobe. There would have been other entrances into the structure and through the rooms, but they cannot be placed based on the archaeological evidence. The doors and all of their hardware components would have been made from wood and leather, as metal hardware would have been rare for a secular structure. The assemblage of mostly modern metal artifacts supports this, although there are some 17th-century nails recovered from the midden.

The roof would have resembled many other contemporary colonial structures in New Mexico. It would have been a flat surface (approximately 402.5m^2) constructed from timber *latillas* (Geiger 2012), most likely made of cottonwood, with a thick layer adobe daub and organic mats from reeds and grasses. This would have required a substantial quantity of adobe mud: approximately 98m^3 of mud were needed to spread over the roofs of the house and barn (based on the thickness observed at Pecos Mission [15.24cm] (Ivey 2005:366)).

Figure 5.13. EU 2017-C series: four corners, post hole, and entrance into an interior space. Photo by Heather Trigg, 2017.

The *latillas*, reed mats, and daub coating would rest on top of a series of ponderosa pine timber *vigas* spanning across the roof. Decorating these *vigas* with carvings would have been a common practice in Pueblo households and in Spanish missions in the 17th century, but since none of the *vigas* at LA 20,000 have preserved, I cannot determine if any were decorated. Ivey observes at Pecos that the *vigas* were approximately 0.25m in diameter, and were spaced roughly 0.35m apart from one another (Ivey 2005:368). I have used these estimates in my materials calculation.

There were also posts throughout the structure to provide additional support for the roof, as evidenced by postholes in the floor of excavation unit 2017-C. However, the species of wood used for some of the postholes appears to be piñon or juniper, relatively small but durable trees; such postholes of smaller diameter could have been used for benches rather than as support for the roof or walls.

Architectural features can also be indicative of household activities, such as hearths and fire pits. Excavations in the residential structure uncovered several thermal features. Those that have been identified include a corner fireplace in the southwestern room (Feature 52) and a raised hearth feature along the wall of EU 2017-C.1. Another thermal feature is an *horno,* or an oven, on the eastern exterior of the house (Figure 5.14) (D. Snow 1994:7). It was from made with a basalt cobble foundation and an adobe brick superstructure, and extended off the east side of the house. This is a fairly unusual feature for a 17th-century Spanish house, but it would have allowed for baking bread and other food staples on site. It also suggests that the kitchen or food preparation space was located somewhere on the eastern side of the structure.

Figure 5.14. *Horno* foundations. Photo by David Landon, 2015

One final unusual architectural feature of the house is a curved adobe platform on the northeastern exterior, composed of six courses of adobe laid directly on the surface (Figure 5.15). Inside this arc of bricks is a posthole. There is no additional archaeological evidence that indicates what this structures was intended for, the date of its completion, or even if there was an entrance into the space (Trigg et al. 2019: 42). This feature does not seem to be integrated into the walls or foundations of the north wall, so it may have been a later addition. I have not included it in my description of the house, or in my calculations of material estimates.

Figure 5.15. Adobe platform foundations in profile. Photo by Madelaine Penney, 2016.

The Barn

Barns are unusual on *estancias* in 17th-century New Mexico. Other *estancias* may not have required such a large space like a barn due to the size or nature of their agricultural enterprises. The presence of a barn at LA 20,000 suggests that the family was wealthy in terms of livestock or crops harvested on their land so as to require such a large space (Figure 5.16).

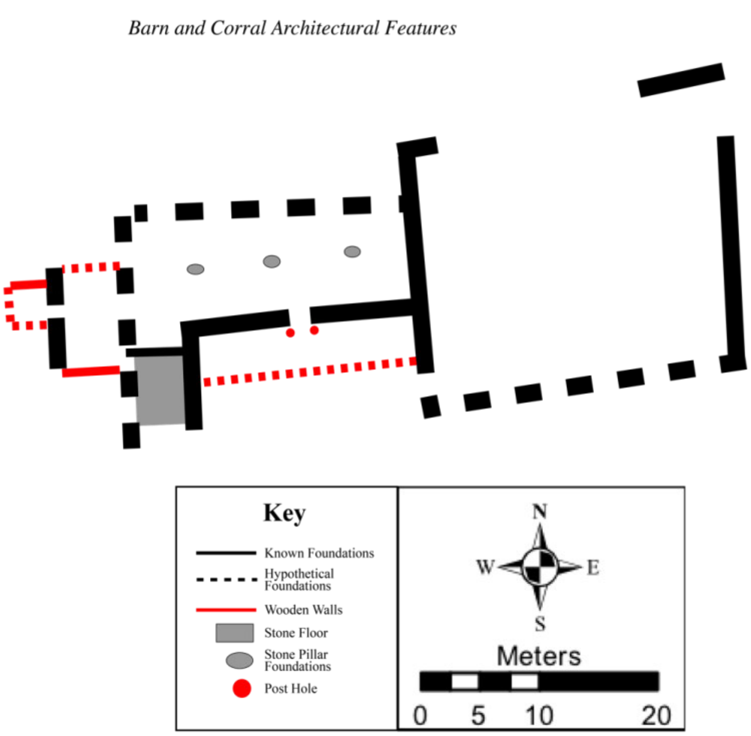


Figure 5.16. Known and hypothetical architectural features of the barn and corral at LA 20,000.

A zooarchaeological analysis reveals that the household at LA 20,000 kept horses, cattle, sheep and/or goats, pigs, and chickens (Opishinski 2019:84). The barn may also have stored the harvest. Anya Gruber's (2018) palynological analysis of manure layers in the barn shows that in addition to a variety of arboreal and herb pollen grains present in the manure, there was also a broad spectrum of pollen from grasses, including wild grass (which the livestock were consuming), maize, and smaller amounts of wheat and barley (Trigg et al. 2019: 71; Gruber 2019:64). Though the presence of the pollen grains in the manure layer indicates that these plants were the diet of the livestock, these crops may also have been stored in the barn for the family's consumption.

Like the residential structure, the barn's foundations are made from basalt and other cobbles. In the middle of the southern wall there is a gap approximately a 1.5m wide, where there are two units running north to south and an absence of wall. This could be an opening from the outside into the barn, which is supported by the presence of two postholes on either side of the gap. As such, I can assume that the wall foundations are continuous with the exception of that gap that roughly bisects the south wall.

Some of the barn walls were made of adobe bricks. There are also some architectural features of the barn that do not appear (or have not preserved) in the residential structure. One is a wooden superstructure on the western wall. This structure was likely burned, as there is a layer of ash layer on top of western wall of the barn.

Another architecture feature is the three large stone post foundations (95cm high and 1 meter wide) made of cobbles and basalt boulders joined with adobe mortar (Figure 5.17), and placed linearly through the interior (Trigg et al. 2019:56). These probably would have provided support a massive roof like the one in the residential structure, although this roof may have spanned a large portion of the barn's floor area. These pillars may also have divided the space roughly into thirds that could have been livestock enclosures, crop storage, or open workspace. There is no archaeological evidence of interior dividers, so these spaces may have been separated by wood, or by other ephemeral materials that have not preserved.

Figure 5.17. Pillar foundation in barn. Photo by Clint Lindsay, 2017.

The barn also has an area in the southwestern corner with a cobblestone floor (Figure 5.18). It is unknown what this space would have been used for, though it is interesting to note that it is the only cobbled floor surface on the site. Perhaps this would have been an entrance to the barn, or a paved workspace, or maybe even a storage space for crops or equipment. Not enough artifacts have been recovered from this area to provide clues as to the function of this space, although it may have been a space for processing animal products like butchering, or sheep shearing. The finished floor dedicated to the processing of animals further communicates the household's wealth (Landon, pers. comm.).

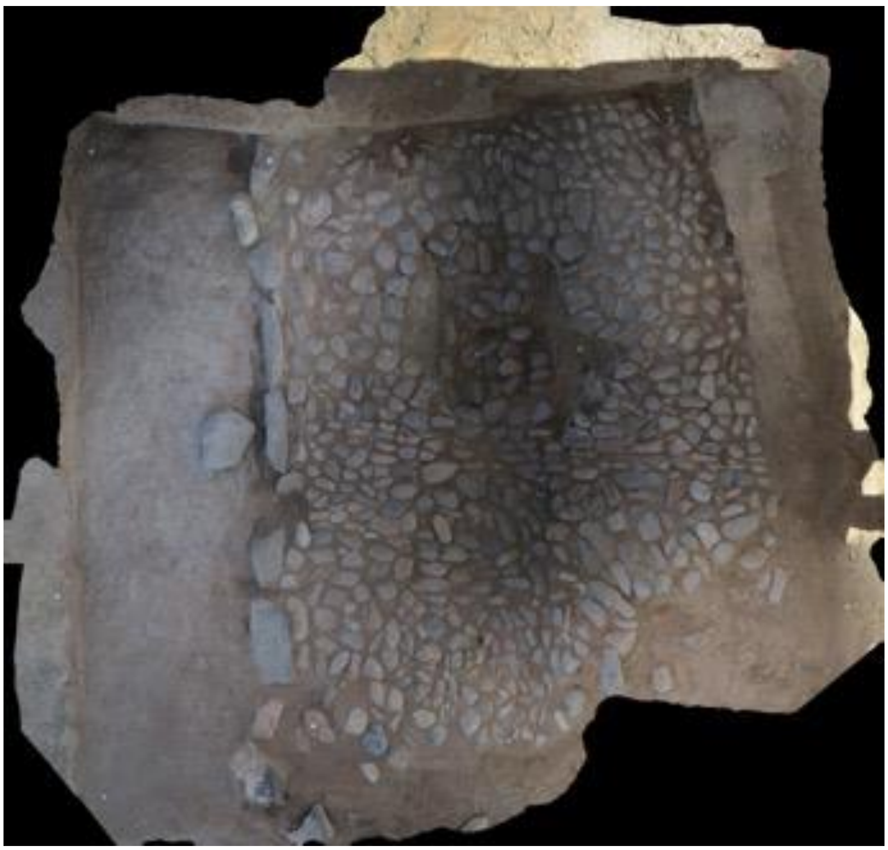


Figure 5.18. Photogrammetry of cobblestone floor in barn.

The Corral

Adjacent to the barn and integral to its eastern wall was the ranch's main corral. At the northeastern edge of the main corral was at least one smaller corral. The size of the main corral at LA 20,000 (594m^2) would have been sufficient to accommodate sheep, goats, cattle and horses.

The foundations of the corrals, like the other structures on the site, were laid primarily with basalt and river cobbles and boulders set in four courses (Figure 5.19) (Trigg et al. 2019:57). The length of the perimeter is 78 meters (see Figure 5.16), though it was only walled on three sides, as the exposed bedrock on the north side would have completed the enclosure.

Figure 5.19. Barn/Corral foundations. Photo by Melanie Lerman and Madelaine Penney, 2016.

It is likely that the walls would have been at approximately 30cm high (Snow 1994:4), requiring 42,274.44kg of stones to complete. The lack of adobe recovered from excavation units around the corral suggests that if there was a superstructure on top of the corral, it would have been wood or brush. Contemporary corrals also used wooden walls or fencing to enclose the livestock, but there is no definite evidence to suggest that such materials were used at LA 20,000, although the footings for the corrals are, for the most part, visible on the surface of the site so, if there had been fencing on top, it has not survived.

There is a gap in the wall of the barn-corral complex on the corral's western wall. While this is most likely the passage between barn and corral, it is not entirely clear how animals would have moved from outside the structure into the corral. However, the southern wall of the corral is highly impacted by erosion so gates or entryways may simply have been destroyed.

In addition to the large enclosure, there are also foundations to the west of the corral in EUs 2017-G and 2017-H. These two excavation units, though they are 10 meters apart, both have relatively shallow courses of basalt boulder footings, and the units' stratigraphic profiles have similar alternating layers of manure and reddish colluvial sediment (Trigg et al. 2019:59-60). Though 2017-G contained a horse mandible, artifact densities in these two units were low and there is no evidence of food preparation, consumption or fire, which suggest that this space was not herder's quarters or used as additional living space. Instead, it is likely that this was a smaller corral that was connected to the main corral (Trigg et al. 2019:61).

Data Analysis of the Architectural Materials

Attribute Analysis Methods

I examined a broad range architectural materials recovered during the Fiske Center's excavations. These materials included adobe bricks, daub, mortar, plaster, selenite, botanical remains, glass, and metal. I have noted which materials I examined for my analysis in Table 5.3, along with the relative abundance of each material that I had access to in the Fiske Center labs.

The methods of analysis varied depending on the material, though there was some overlap. In particular, I conducted an attribute analysis for the adobe and selenite samples (See Appendix A).

Adobe Bricks

Adobe bricks are a common building material on 17th-century *estancias*. At LA 20,000, bricks are used for walls, floors, and foundations. The adobe brick samples that I analyzed were in fragments rather than in whole bricks (Figure 5.20). Relatively few whole adobe bricks are recovered at LA 20,000, aside from those in the remnants of intact walls. However, the bricks that are present in excavation units have been documented in excavation notes and drawn in scale illustrations.

Table 5.3

Architectural Materials from LA 20,000 and Relative Abundance

Material	**Relative Abundance**	**Types of Analysis**
Adobe bricks	Abundant	Microscopy, Attribute, XRF
Daub	Abundant	Microscopy, XRF
Mortar	Somewhat abundant	Microscopy, Attribute, XRF
Wall Coating (e.g. plaster, whitewash, paint)	Somewhat abundant	Microscopy, Attribute, XRF
Wood	Rare	Microscopy, dendrochronology
Stone	Abundant in Place	Limited attribute analysis
Selenite	Abundant	Attribute, XRF
Glass	Rare in 17th-c. contexts	Limited attribute analysis
Metal	Rare in 17th-c. contexts	Limited attribute analysis

Figure 5.20. Adobe brick fragment.

Most adobe bricks that archaeologists recover from sites of Spanish occupation range in size from 23 by 13 by 13cm to 41 by 13 by 13cm (Brown and Clifton 1978:141), or as large as 47 by 22 by 10cm, as found at Mission at San Marcos (Thomas 2000:25). Using these illustrations of unit profiles and plans (Figure 5.21), I calculated measurements of brick dimensions (Table 5.4). Initial observations show that the bricks are all more or less rectangular in form, indicating that the crew used molds for drying the mud.

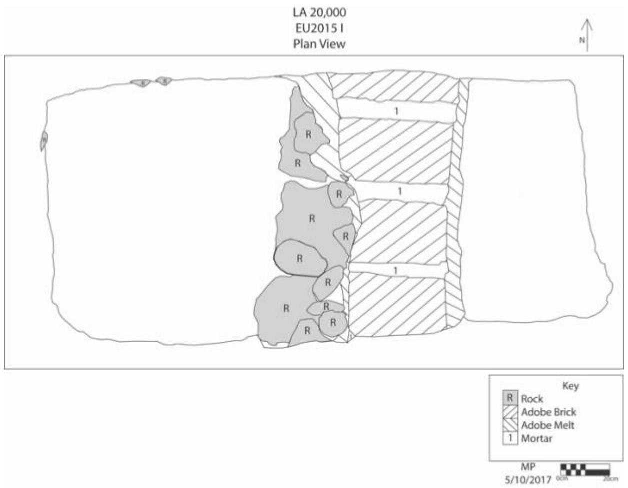


Figure 5.21. Illustration of mortared bricks in plan.

Table 5.4

Dimensions of Sample Whole Bricks from LA 20,000 Excavation Units

Structure	**Excavation Unit**	**Dimensions (cm)**	**Mortar Thickness (cm)**
House	AY10F South	48L x 8H	8
House	AY10F W	59L x 10H 42L x 8H	2-4 (top), min 3 (between)
House	2015-I	22W	
House	2017C1-2	52L x 26W	Unclear
House	2017-B	46L x 24W	8
Mean: House		48L x 24W x 9H	8

Structure	**Excavation Unit**	**Dimensions (cm)**	**Mortar Thickness (cm)**
Barn	2016-C	50L x 25W	4-6
Barn	2015-D	50L x 12H	6
Barn	2016-C	52L x 22W 52 x 23 50 x 23 42 x 24	Unclear
Barn	2017-F	56L x 20W	2 (top), 8 (between)
Mode: Barn		50L x 23W x 12H	6

After looking at samples of bricks, I found that the bricks from the barn are slightly larger than the range of dimensions noted by Brown and Clifton and bricks at other *estancias* (e.g., Brown and Clifton 1978:141; D. Snow 1971:4). Additionally, I found that there is a difference in the mode (or mean where there was no mode) adobe brick size between the six excavation units from the house and the four from the barn, as well as a difference in mortar thickness where it was visible in the illustrations. While this may partially be due to the effects of weathering, it may also indicate that there were two types of molds used for making bricks. It is not clear why the bricks for the barn would be larger than the bricks used for the house; perhaps these dimensions provided additional support for the roof, or allowed for some other structural advantage; perhaps these structures were built at different times.

Besides size, there are several attributes of adobe bricks that can be diagnostic indicators of historical processes including the chemical composition of the adobe, organic components of the brick, and texture and other qualitative attributes. At the mission at Pecos, the archaeologists noted that the color, composition, and texture of the adobes could be associated not only with different structures at the mission complex, but also different building episodes (White 1996:355). They also noted that some of the adobes contained recycled bricks as part of their composition (White 1996:358), which also helps date the structures.

I recorded Munsell color and texture of the fragments to see if there were correlations between colors and other attributes such as texture, inclusions, or evidence of burning. There is variation in other attributes of the bricks across the site, and even within the same excavation units. From the Fiske Center excavations of the house, the adobe fragments range from light red (10R 7/6) to very dark brown (10YR 10/3), and there does not seem to be correlation between color and the provenience of the sample. Instead, this variation of color may be the result of different ratios of sand to clay or organic inclusions that may have occurred either during production or naturally, or perhaps are due to burning or weathering, or other post-occupation processes.

In terms of the composition of the adobe bricks at LA 20,000, they contain a mixture of sand, silt, clay, water, and other organic or inorganic inclusions such as gravel or grass (Brown and Clifton 1978:139; Thomas 2000:25). The most stable adobe mixture contains a high sand-to-silty-clay ratio (70-80% sand to 10-15% silty-clay), with minimal gravel inclusions. Clay absorbs moisture in the bricks, so the higher the percentage of clay in the mixture, the less stability the bricks have (Brown and Clifton 1978:140). Almost all of the brick fragments that I examined with both a naked eye and at the microscopic level (10-40X magnification) have gravel and other small inclusions such as charcoal and plant fibers, which affect the strength and texture of the bricks.

Due to the variation in color and inclusions, there is also considerable variation in the texture of the adobe bricks. The most common texture is hard and grainy, though a few of the samples have a finer texture, or are more friable. There is little evidence of the use of plant materials as temper. This variation in texture and hardness is likely due to the mixture of clay and silt, which together act as a binder in the adobe; the right ratio of these two sediment types ensures that the sand will be properly dispersed throughout the matrix of the brick (Brown and Clifton 1978:140). The varying textures in the brick samples suggest that there was not a strict quality control in the mixing of components or in the drying of the bricks. It is also possible that this difference in texture is the result of weathering, though the original manufacturing of the bricks likely contribute to how much they have deteriorated over the centuries.

Daub and Roofing Material

Unlike some Spanish colonies, colonial New Mexican structures did not use tiles for roofs. Instead, New Mexican roofs were flat, and with a surface of adobe daub laid damp on top of mats of reeds, brush, and other organic materials, spread over wooden *latillas* which were laid on top of large vigas. The only artifacts related to the roofs that I examined for this study were the fragments of daub.

The samples of roof daub recovered from LA 20,000 resemble the adobe bricks, although the primary difference I noticed was the roofing material was softer, browner, and had large impressions of reedy stalks on the surface (Figure 5.22), but little evidence of sand or plant temper. I used the comparative ethno-botanical collections in the Fiske Center for Archaeological Research to identify the types of plants that made the impressions found in the roofing material by cleaning off the loose dirt to make the structures impressed into the adobe daub samples more visible. Based on the width of these impressions in the fabric of the sample, as well-defined ridges made from the cell structure of the reeds, it seems most likely that the daub was laid against a mat made of cattails (*Typha* sp.) harvested from a nearby water source or marsh.

Figure 5.22. Adobe daub fragments. Left: Roofing daub with reed impressions. Right: Detail of reed impressions.

Mortar

Between all of the adobe bricks documented *in situ* at LA 20,000 is a layer of mortar. Mortar is also adobe based, and would have been applied wet. As it dried it would have bonded the bricks together to stabilize the walls (Figure 5.23). Based on observations of the layers of adobe bricks from the profile and plan drawings from the Fiske Center excavations, the mortar seems to have been applied as much as 6 to 8 cm thick in the residential structure and barn, respectively (Figure 5.21).

To understand how mortar contrasted with the bricks, I examined 3 samples from across the site with a dissecting microscope (10-40X magnification). Under the microscope, the mortar from LA 20,000 is composed of fine, clay-sized particles that make a hard textured surface. Unlike the adobe and daub samples, there are no mineral or organic inclusions present in the fabric. This suggests that the process of making mortar would have been distinct from the process of making adobe or daub, perhaps to create a durable bonding material.

Figure 5.23. Mortar fragment.

Wall Coating

It is unlikely that the walls at LA 20,000 would have been bare brick. Unprotected adobes are susceptible to weathering from the excess moisture in or around adobe bricks. The expansion and contraction from freezing can lead to faster deterioration of the bricks: up to an inch every twenty years (Burgio-Ericson 2018:70). Wall-coating materials such as plaster, whitewash, and paint provide both a protective (Brown and Clifton 1978:143).

Plaster also would have been a decorative element as well for interior spaces through smoothing uneven surfaces of brick walls (Burgio-Ericson 2018:293). While any plaster designs on the walls have not preserved archaeologically at LA 20,000, there is a significant sample of plaster fragments that are diagnostic of the plaster covering the 17th-century structures.

Some 17th-century structures, like the mission at Awatovi, had two different types of plaster for the walls: one for interior spaces that was gypsum-based, and an adobe-based plaster for the exterior walls (Montgomery et al. 1949:164). Another way to make plaster or whitewash made from roasted and ground selenite is a traditional practice among the Pueblo in the Southwest (Solometo 2010:92).

The plaster from LA 20,000 is a white substance with a powdery texture (Figure 5.24). Under the microscope it appears to be fragile and grainy, with other minerals and sand mixed into its fabric. I tested the composition of the plaster using X-Ray Fluorescence (XRF) to determine if the white wall-coated adobes were made using gypsum material.

Figure 5.24. Plaster.

To perform these tests, I used a Tracer IIISD XRF instrument with both a vacuum and a Tungsten filter (blue filter) to amplify readings of the elements calcium and silicon: and the elements most likely to be present in the minerals used to make plaster and whitewash. I took a reading of a sample of selenite as a control for calcium (Ca) and sulfur (S) levels (which are present in gypsum-based plaster). I then tested two samples of plaster-coated adobes with XRF (Blue Filter, 60 seconds, 15kv, Vacuum); this analysis revealed that this substance is most likely not selenite-based, as it contains much less sulfur (the element that is diagnostic for gypsum and selenite) than my control sample of pure selenite. Instead, when tested with XRF, calcium was the most prominent element (see Appendix B). The high calcium, low sulfur base of this plaster indicates that it was likely a material with a high calcium quantity such as caliche rather than gypsum or adobe.

Caliche is found in close proximity to the excavation site, including very small amounts in stratigraphic layers across the structures (Trigg et al. 2019:48). Much like the process of making plaster from limestone, to make plaster from caliche first involves heating up the caliche, grinding it into a powder, and then rehydrating it into a paste before applying it to the surface of the wall (Abundant Edge 2020).

Yeso, or whitewash (Figure 5.25), would have been a finishing layer on walls—sometimes applied directly to the surface of the brick—(Burgio-Ericson 2018:293) to provide a decorative coat of white on the walls that then could be decorated with other paint or tiling. This is evident on a few samples of adobe bricks that were recovered from the northwest portion of the house, and *in situ* in the walls of EU 2015-A (Figure 5.12).

The whitewash on the brick fragments from the residential structure is thin and white. Under the microscope it resembles plaster in terms of its grainy texture, but it is distinguished from plaster as being a much thinner layer of white (>1mm), powdery material spread over the bricks.

There are not enough preserved bricks with whitewash from across the excavation units to determine how many rooms of the residential structure would have had whitewash. It can be assumed, though, that every room would have had some protective coating to even out rough surfaces and to provide an extra-layer of waterproofing.

Figure 5.25. Whitewash and red coating on adobe brick fragments.

Wood

Wood would have been used for roof beams (*vigas*) and roof support posts, and the door and windowsills. Certain species of trees would have been better suited for certain architectural elements based on the properties of the wood. Unfortunately, wood does not preserve well in most archaeological contexts, although it has a greater likelihood of preserving if it has been burned and charred.

Wood samples were recovered from excavation units 2015-A, 2016-E, 2017-C in the house, as well as across the barn. While most were charred, a few samples recovered were uncharred. I examined these under a Nikon dissecting microscope, and made a preliminary identification based on the cellular structures of the cross-sections.

I used the Fiske Center's comparative botanical collections to taxonomically identify samples of the fragments of charred and uncharred wood. With the help of Dr. Heather Trigg I conducted a preliminary hardwood versus softwood identification using a Nikon dissecting microscope (magnifications at 10-40x) to examine fresh cross-sections of the wood samples. This, along with published literature about identifying wood species (Hoadley 1990) allowed for a rough identification of the samples based on known species of trees available in the area.

The samples of uncharred wood recovered from EU 2015A Level 10 Context 25 appear to be a softwood based on the presence of resin canals in the cross section. The most likely identification would be ponderosa pine. These are tall trees that grow at higher altitudes, which would mean that these were not wood used as fuel, but instead may have been structural support (Wennerberg 2004). Furthermore, the excavators interpreted the context from which these samples were removed as part of an original floor surface beneath several layers of wall and roof fall (Trigg et al. 2019:74).

Another wood sample from EU 2016-E (Sample #275, context 176) also is a softwood species, most likely piñon based on the resin canals in the cross section. These fragments were recovered in large chunks that were charred inside of what appeared to be a posthole. Piñon is a smaller tree (5-21m tall) (Nesom 2003) so these might have been vertical roof supports based on the archaeological context.

Even without the presence of wood or charcoal, there are features that suggest there was wood present in that location. The posthole found in the EU 2017-C corner suggests that posts were placed in corners to provide additional roof support. Several post holes on the exterior of the southern wall of the house, suggests that posts were also used to create a *ramada*, or brush-covered shade (Trigg et al. 2019:75).

The stratigraphic context from which the wood samples were extracted also is helpful in determining the likely use of the wood. It is likely that the charred wood remains that were recovered from contexts associated with roof fall artifacts (e.g., daub, brick, etc.) are most likely the remains of the roof supports (*vigas* and *latillas*) that were destroyed during demolition. It is also probable that samples recovered in excavation units near walls and in postholes were used for vertical supports either for the roof, walls, or perhaps benches or cots.

In addition to my botanical identifications with Dr. Trigg, I had access to a previous study of the dendrochronology of samples recovered from the barn that was completed in 1992 and 1996 by the Laboratory of Tree-Ring Research (Jeffrey S. Dean to Dr. David H. Snow, 13 August 1996; Trigg et al. 2019:6). This report showed the richness of species of trees used in the construction of the barn, as well as a rough quantitative assessment of each species. These gave an indication of the variety of species of wood that were used in the barn and likely in the residential structure as well.

Laboratory of Tree-Ring Research identified the charcoal samples from Snow's excavations, which revealed that the majority of the charcoal samples were of ponderosa pine and Douglas fir (Table 5.5) (Jeffrey S. Dean to David H. Snow, 13 August 1996). These are trees with tall, straight trunks (30-50 meters in length for ponderosa pines, and 20-100 meters for Douglas fir) and high tensile strength that would be ideal for *vigas* because longer timbers would maximize roof area (Cameron 1999:206; Nesom 2003; Wennerberg 2004). Since the two structures are relatively similar in size, it is likely that these species would also be present in the residential structure. The smaller trees such as *Populus* (cottonwood) found in the barn were likely used for *latillas* that made up the surface of the roofing. These grew in a forested area near the riverbanks, and as such would likely have been plentiful near the structures and easy to harvest. *Populus* or similarly small diameter trunks would have also been used for the *latillas* in the residential structure (Trigg pers. comm.).

Table 5.5

Species of Charcoal Identified from the Barn*

Species	**Douglas Fir**	**Ponderosa Pine**	**Piñon**	**Juniper**	**Populus**	**Non-Coniferous**
Count (fragments)	32	174	97	63	52	13

*from the 1991-1996 Laboratory of Tree Ring Research study

Stone

Stones were the preferred material for constructing durable structures for Pueblo communities, although the recycling of old stones into new buildings suggest that suitable materials may have been scarce (Cameron 1999:206). Perhaps the builders at LA 20,000 faced similar constraints, as stones are often used in strategic locations such as foundations, and less commonly for cobble stone floors, rather than as the primary material for walls. The foundations of all three major structures at LA 20,000 contain basalt boulders and cobbles along with river cobbles joined with mortar (Table 5.6). In the house, these stones are laid in courses, and appear to be placed 12cm below the 17th-century exterior ground surface level (Figure 5.26) (Trigg et al. 2019:26). According to various unit and profile illustrations, these stones vary in size, but typically they are an average of 20 by 20 by 10cm. Based on similar examples, it would be likely that only some stones would have been worked when they were part of curving structures, otherwise the stones seem to have been selected based on their natural shape and size (Trigg, pers. comm.).

The cobbles and boulders visible in the excavations at LA 20,000 do not appear to have been dressed or modified in a way that suggest masonry techniques were applied, and were laid randomly coursed (Museum of London Archaeology Service 1994:n.p.). Perhaps this was because those in charge of building the foundations did not possess the necessary skills or tools, or maybe for the sake of expediency it was easier to lay uncut stones in the foundations. Instead it seems that the construction workers may have been selective about the stones they used in laying the foundations, so they did not need to make major modifications to the foundation stones.

Stones are used in other locations across the *estancia* as well. Three stone pillar foundations in the barn are made of basalt boulders, and laid with adobe (Figure 5.16) (Trigg et al. 2019:56). Also of note is the cobblestone floor in the barn: one of two finished floors (Figure 5.18). The cobblestones for the floor are about the same size and shape and were laid in a pattern suggesting deliberate selection. Again, these rounded cobbles were likely sourced from around the *estancia*, probably from the nearby Cienega Creek (roughly 0.4 km from the site), rather than acquired at some more distant location. The basalt boulders would have been procured slightly farther away as the nearest flow is across the Cienega Creek about .5 km away.

Figure 5.26. Basalt and cobble foundations in profile EU 2016-B. Note posthole for possible *ramada* post. Photo by Christina Spellman, 2016.

Table 5.6
LA 20,000 Architectural Stone Attributes

Unit-EU	Feature	Stone Types	Size	Laid
B-2016C	Foundation	Basalt, limestone	Cobbles, boulders	With adobe mortar
B-2016EU13	Floor	Basalt	Cobbles	
B-2016EU13	Foundation	Limestone, basalt	Cobbles	
B-2016M	Foundation, pillars	Basalt	Cobbles, boulders	With adobe mortar
C-2017H	Foundation	Basalt	Boulders	With adobe mortar
A-2017C.1-5	Foundation	Basalt, river cobbles	Cobbles	With adobe mortar
A-2015I	Foundation	Basalt, river cobbles	Cobbles, boulders	With adobe mortar
A-2015B	Foundation	River cobbles	Cobbles	With adobe mortar
A-2017L	Foundation	River cobbles	Cobbles	With adobe mortar
A-2016B	Foundation	Basalt, river cobbles	Cobbles	With adobe mortar
A-2016E	Foundation	Basalt, river cobbles	Cobbles	With adobe mortar
A-2017D	Wall	Basalt	Cobble	With adobe mortar
A-2017A	Foundation	Basalt	Cobble, boulder	With adobe mortar
A-2017K	Foundation	Basalt	Cobble, boulder	With adobe mortar

Selenite

Selenite, a translucent mineral form of gypsum, is a prevalent resource across the Southwest (Figure 5.27). It can be used in a variety of 17th-century colonial architectural features, such as the base for plaster or windowpanes since window glass would have been difficult, if not impossible, and expensive to come by in the 17th century (Hanlon 1992:211; Ivey 2005:328; Grizzard 1986:68). Selenite also was used as a wall decoration; it would have been shaped into geometric patterns and placed in mosaics at the mission at Hawikuh (Burgio-Ericson 2018:301).

The selenite samples recovered from LA 20,000 vary in terms of their sizes and thicknesses. Most of the samples also showed some evidence of burning such as discoloration or distortion, though it is unclear whether this was done as part of a manufacturing process or as part of the destruction of the structure.

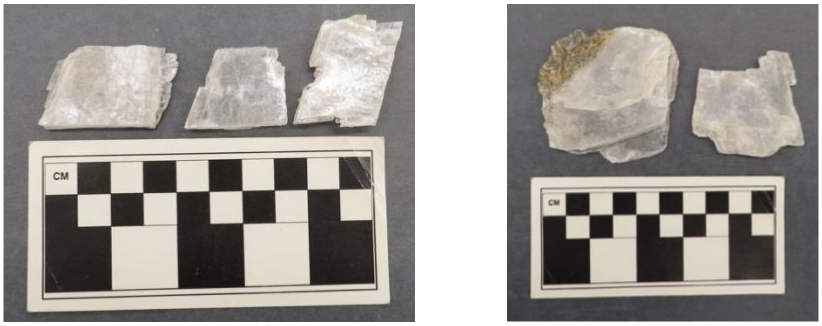


Figure 5.27. Selenite fragments. Left: Fragments with flat edges. Right: Fragments with cortex, and rounded edges, respectively.

It seems likely that if there were windows in any of the structures at LA 20,000, they would have been made of translucent selenite, so I paid particular attention to the way the selenite fragments were shaped, especially the edges. I considered fragments to have evidence of shaping along the edges, such as ground or squared corners, or if there looked to be fragments of plaster attached to the edge, which would have secured the window to the base (D. Snow 1971:28; Thomas 2000:42). No large panes were recovered from LA 20,000, but several of the fragments did have edges that appeared to have been ground and rounded off or flattened, and thus were likely remnants of window panes. It is more likely that these panes would have been relatively small, but large enough to let in some natural light into the spaces.

Additionally, I looked at concentrations of selenite across the excavation units using a density map. To make the density map, I examined the notes and artifact counts of the minerals from the LA 20,000 excavations for the Snow and Stoller excavations, and the 2015 through 2017 seasons. Rather than separate the selenite by context or level (presumably the selenite is from the 17th century, and any movement of selenite into shallower contexts is the result of post-occupational disturbance), I consolidated the selenite counts into a sum total for each excavation unit, and plotted them in relation to architectural foundations using ArcGIS. This revealed concentrations of selenite fragments in certain areas, and a dearth of fragments in other areas that indicates the presence of a selenite feature such as a window, rather than just random distribution (Figure 5.28).

In analyzing the spatial distribution of selenite, I found that the concentration of selenite varies across the site. Besides a large discard area in the midden to the south, there are concentrations along specific areas on both sides of the foundation walls of the house. There are noticeable concentrations on the south and east walls (EUs 2017-A and 2017-K, and EUs 2017-D and 2017-E), and in the interior of the residential structure. Furthermore, there are almost no fragments recovered from the barn or corral. There appears to be a patterning to the distributions of selenite in the house. The concentrations of selenite that occur in areas away from exterior foundations of the house, such along the northern interior, may have been a part of wall decoration. The concentrations along the exterior foundations may be from demolished windows.

While the distribution map was illustrative in showing where selenite was recovered, I was interested in determining the statistical significance of the selenite clusters across the excavation units; this could show where there may have been windows that were broken if there were concentrations on either side of foundations. With the help of Dr. Douglas Bolender, I used Hot-Spot analysis (Getis-Ord. Gi) to test the significance of the concentrations of selenite in each excavation unit in comparison its neighbor. This analysis highlighted excavation units that had statistically significant quantities of selenite, which would indicate deliberate rather than random deposition, most likely from post-occupational destruction of windows.

The initial results of the Hot Spot analysis (Figure 5.29) show the concentrations of selenite in the excavation units where there is a higher probability of statistically significant concentration based on its neighbors. Most obviously, there is a highly significant clustering of selenite in excavation units the midden. This coincides with the other units with high artifact densities in this area. An explanation for the high quantity of selenite fragments is that they may have been part of a demolition layer that spread across the midden that also included larger fragments of ceramics, charcoal, mortar and adobe brick.

Removing the data from the midden provides more nuance to the statistical significance of the concentrations inside the house. There are more units with significant concentrations in localized areas in the structure along the foundations. Their patterning seems to suggest a window on the eastern wall near the *horno*, along the south wall, as well as significantly high concentrations in the center of the structure. These may have been a part of windows along the exterior foundations, windows that opened to an interior courtyard, or evidence of a mineral mosaic on the walls. Further excavations in the interior of the residential structure, with a focus on selenite concentrations should offer more clarity as to the highly significant clustering in the center of the house.

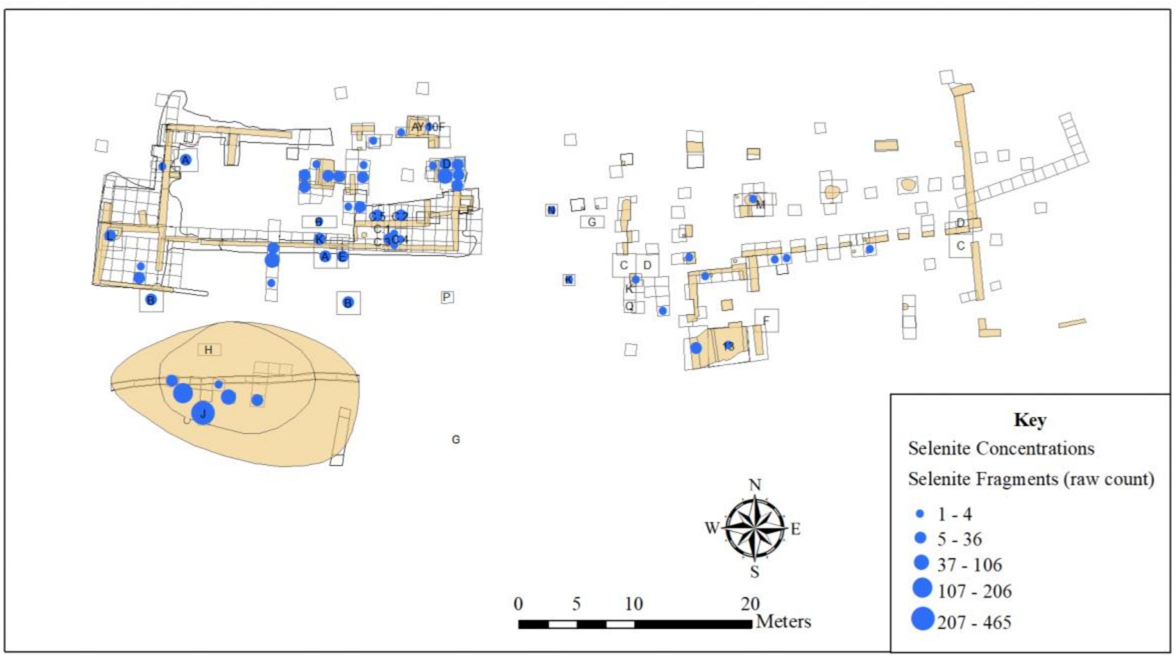


Figure 5.28. Selenite concentrations in LA 20,000 excavation units (raw count).

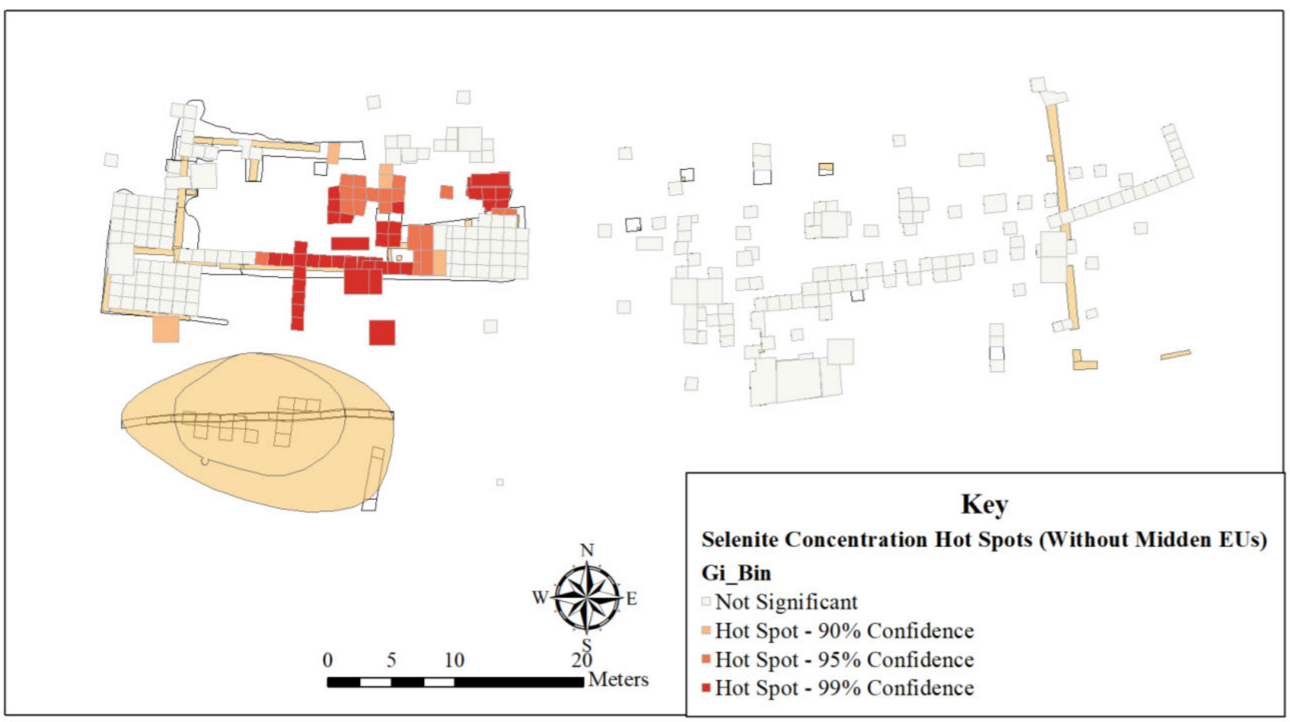


Figure 5.29. Selenite spatial statistics: Getis-Ord Hotspot Analysis. Top: Significant units highlighted in red with data from the midden excavation units). Bottom: Significant units without midden excavation unit data.

Glass

In an attempt to thoroughly examine all artifacts that could be architectural debris, I examined the glass that was recovered from the Fiske Center Excavations. Even though glass was rare among 17th-century colonial structures, I examined the glass artifacts to determine if there was historic window glass among the artifacts.

A total of 48 glass artifacts were recovered from the LA 20,000 excavations. A preliminary analysis of the glass artifacts reveals that over half of the glass is brown and green bottle glass, most likely from the trailer park located on the site and dated to the mid-twentieth century. Other flat glass fragments from shallower contexts (within 20 centimeters below surface) might also be attributed to the twentieth century occupation (e.g., plate glass) of the site rather than the 17th-century architectural use. There were no flat glass recovered that can be definitively dated as 17th-century windowpane fragments.

Metal

Metal artifacts are rare at most 17th-century Spanish New Mexican sites, particularly metal architectural artifacts. I made a preliminary examination of the metal artifacts, though I was not expecting to find many diagnostic metal artifacts that could be classified as architectural. According to historical documents, nails in the 17th century are used for church doors, whereas vernacular structures used wooden pegs to fasten and secure structural components together (Grizzard 1986:72).

Though some of the metal is evidence of modern trash (e.g., bottle caps, washers, bullet casings, wire nails) there are several metal artifacts of personal adornment (button, pins, earring), as well as lead shot, a galloon fragment and barbed wire fragments (Trigg et al. 2019:68). Only 42 nails were recovered from the excavations, and many of the whole nails and nail fragments that are hand-wrought were recovered from the midden. These nails are small, and may be horse hardware, or for securing hinges and straps. There are no large, wrought spikes or nails that can be definitively identified as nails that provide structural support, but as the wooden structural elements were likely pegged together, we would not expect them.

Analysis of Material Extraction

Material Acquisition Reconstruction

Another aspect that I considered in this architecture study was the location of regional sources for each artifact type in order to determine how far the workers needed to travel to acquire materials. For some materials, such as sand and water for adobe, the crew likely had all of the materials that they needed on-site for their production. For other materials, particularly timber and selenite, the distance to the nearest source would have been far greater, assuming that the workers from LA 20,000 harvested these materials themselves rather than traded for them. Illustrating the distances between the site and the locations of raw materials shows how far or close at hand the material needed for the buildings were, which in turn, highlights some of the limitations the builders had when designing the spaces, or the effort needed to construct them.

Using ArcGIS and information from a variety of reports, maps, and other literature about New Mexico's natural resources, I mapped the distance to the sources of these construction materials from LA 20,000 with a resource catchment model. I used land cover data from the New Mexico Resource Geographic Information Systems database, and points of neighboring Spanish and Pueblo sites generated by Stephanie Hallinan for my analysis. This analysis showcases the amount of effort expended to acquire building materials, as well as the wide area around LA 20,000 from which workers extracted resources for construction.

The resource catchment maps show the local and regional scopes that the construction team working on the *estancia* had when acquiring wood, stone, selenite, and water. The regional map shows distances in Spanish leagues (1 league = 4.2 km) (Sheppard nd), as this would have been the unit that the colonists measured distances in the 17th century. While the crew could have acquired many of the materials on site (all within less than 1 league), they would have needed to travel at least three leagues (over half a day's ride, not accounting for terrain) to harvest other necessary materials.

Unsurprisingly, many of the materials would have been locally acquired—even within the grounds of the *estancia*. There are bands of red and white clay along the southeastern edge of the site (Figure 5.30), across the current *arroyo* (by the modern fence line). This would have been the source for the adobe used for the bricks, daub and mortar. There are also deposits of caliche on site (e.g., the layer in the bottom of EU 2015-G) that would have been used for the plaster and whitewash.

The cattails (*Typha sp.)* used for the roofing material also were likely locally acquired. The marshland located close to the *estancia* would have had cattails growing along its banks, as would small ponds just 1.5 to 3 kilometers away from the site. Similarly, the cottonwood found in the barn roofing debris would have grown in the woodlands along the spring and Cienega Creek, and so would also have been relatively easy to acquire. However, the 17th-century had much wetter conditions in New Mexico compared to the present climate (Van West et al. 2009:5-6), which would have possibly allowed for more slow moving rivers or standing water to allow for cattails and trees to flourish even closer to the site.

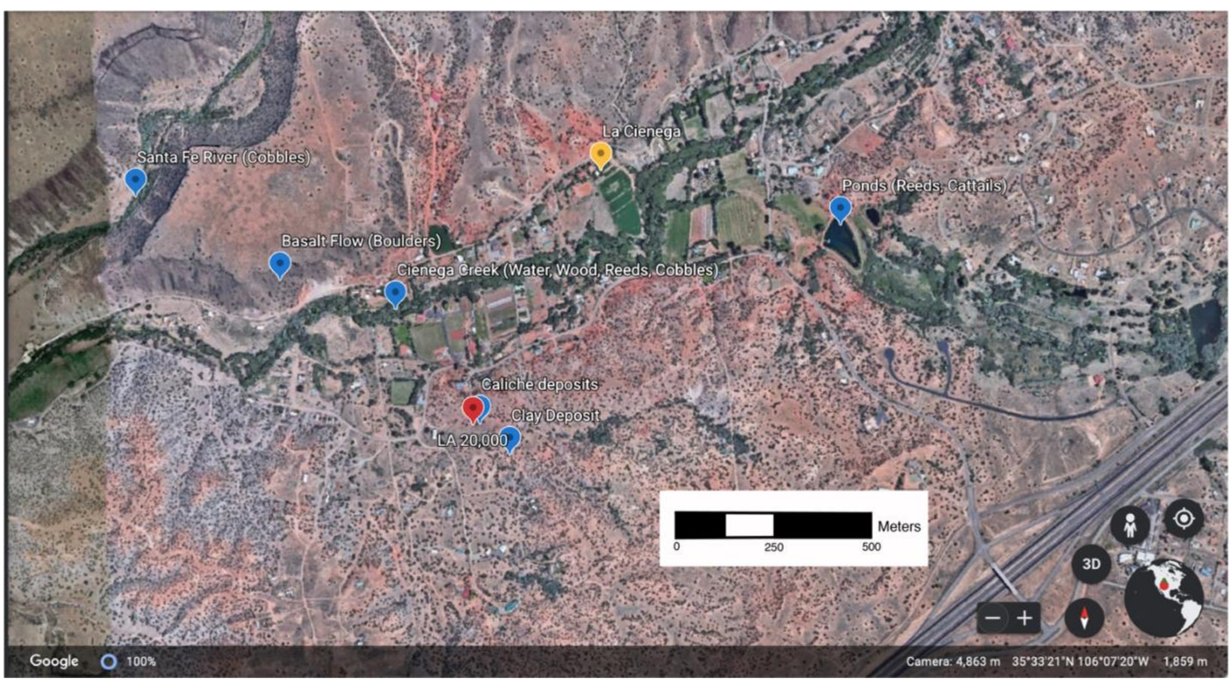


Figure 5.30. LA 20,000 local resource catchment map.

The construction crew would not have needed to travel far to acquire the stone needed for foundations and floors. Most of the river cobbles would have come from the Cienega Creek that flows in close proximity to the site. The basalt cobbles and boulders would also have been harvested close to the site in the basalt flow located nearly 0.5 km from LA 20,000. There are also several boulders incorporated into the footings of the barn, which indicates not only a presence of large stones that were worked into the foundations, but also a sizeable labor force to find and transport these boulders to the location of the *estancia*. Even if these stones and boulders had come from relatively close to the construction site, the crew probably still would have required livestock to move them.

In contrast to the clay, reeds, and stones, the timber for the *vigas* would have been costly to come by in terms of effort to acquire. Prior to construction, either the household would have had to acquire the lumber through trade, or send a crew to log for timber. All of the large timber species present such as ponderosa pine and Douglas fir at LA 20,000 grow at higher, mountainous altitudes than the site of the *estancia*. Although smaller trunks needed for posts and fences would have grown at lower altitudes close to the site (Nesom 2003; Wennerberg 2004), the closest possible environment for these larger trees is at least 3 Spanish leagues (12.6km) away from LA 20,000 to the north in the *Caja del Rio* mesa. Other possible locations for logging would be in the Ortiz Mountains or even the mountains near Santa Fe, but these locations are over 21km away to the south and northeast, respectively.

The process of harvesting the timber would have been arduous and dangerous not only to ascend to the mountaintops, but also to fell the trees and transport them down the mountain back to the site. In order to get all of the logs needed for all of the structures, a multi-person crew would have to spend at least one day traveling to the mountains (for reference Santa Fe was only a day's ride away from LA 20,000, or roughly 19km), select which trees could be used, and then take at least another day transport them back with the help of livestock-driven carts. Perhaps the men assigned the task of bringing lumber for construction would have had the help of Indigenous male laborers as they would have had knowledge of the landscape and possessed skills needed to log the timber. This likely would have made the logging process easier for the crew.

Like timber, the LA 20,000 construction crew would have needed to acquire selenite for the windows off-site. Selenite occurs in caves and deposits in New Mexico, the closest of which is Rosario deposit located just under 3 Spanish leagues (11km) from LA 20,000 (D. Snow 1971:28; Weber and Kottlowski 1952:19-21). While there were extensive trade networks connecting colonial households in the 17th century, no documentary sources have revealed whether selenite was a commodity households traded in exchange for other goods, or whether an *estancia* would send laborers (ones who knew where the deposit was and the qualities of useable selenite) with carts to collect quantities of selenite as needed. If the crew from LA 20,000 had to travel to the deposit directly, it would take them over half of a day just to travel to the deposit, so the harvesting process may have taken multiple days from setting out to returning with the materials.

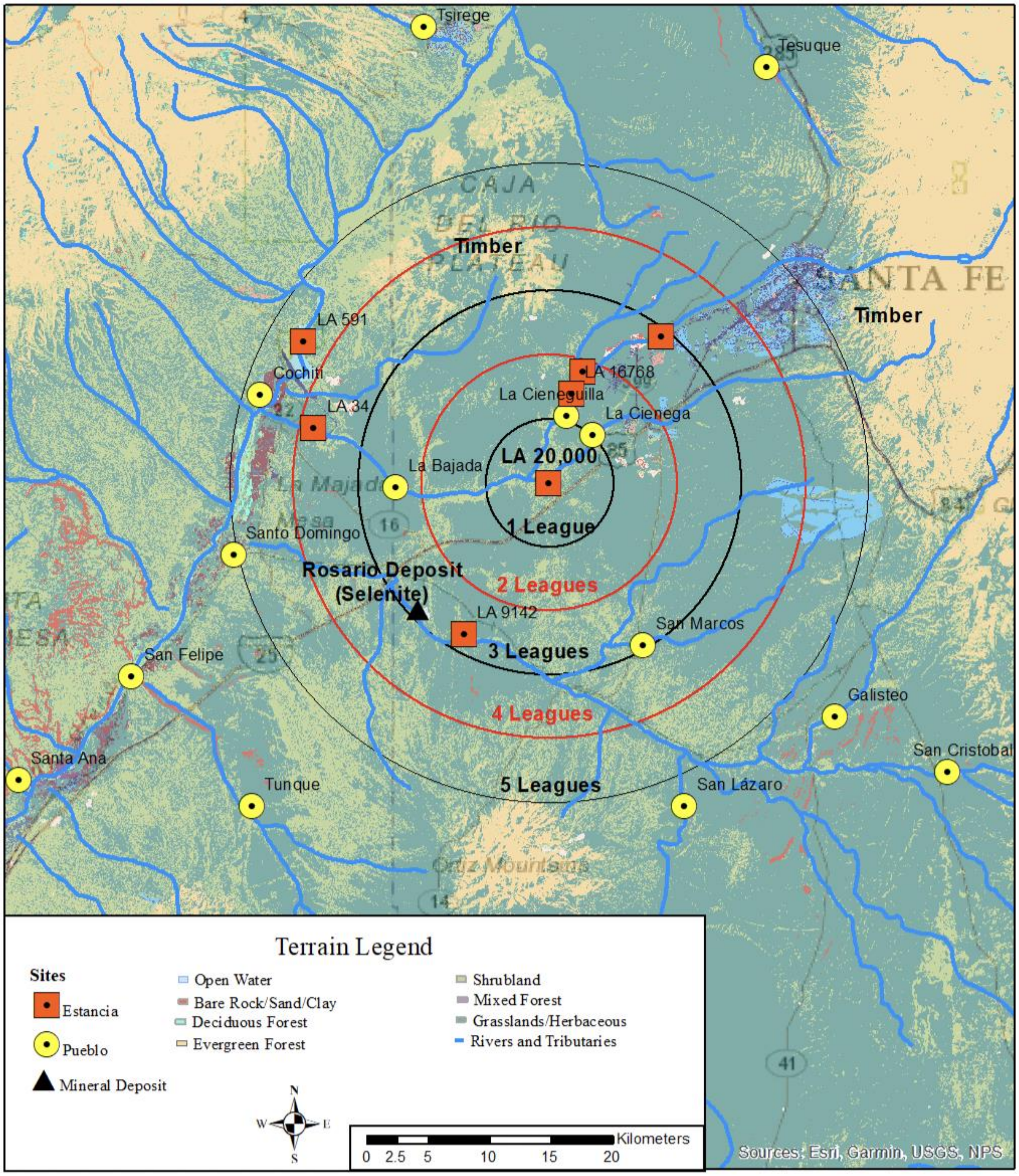


Figure 5.31. Regional LA 20,000 resource catchment map.

To provide a general sense of the quantity of bricks needed to construct these buildings, I used the average and mode lengths of the bricks for the house and the barn, respectively, along with the mode mortar thickness (8 cm in the residential structure, 6 cm in the barn), and divided these by the foundation perimeter length and width of each structure to calculate an estimated number of bricks needed for each layer. The results are presented in Table 5.7. I estimate that the exterior of the house required over 12,000 bricks while the exterior of the barn required over 7,000. Of course, additional bricks would have been needed for the interior walls of both structures, but without a better notion of the number of rooms and interior walls, I am unable to make reasonable estimates.

Table 5.7
LA 20,000 Construction Material Estimates

Structure	**Basalt footing volume (75% rock/25% filler) (m^3)**	**Estimated quantity of basalt (kg)**	**Estimated daub volume (m^3)**	***Latilla* Area (m^2)**	**Estimated number of *vigas***	**Estimated number of adobe bricks (1 layer of perimeter length)**	**Estimated number of layers adobe bricks (estimated height)**	**Estimated number of bricks for structure**
House	28.1	82,426.125	61.341	402.5	80	668	18	12,024
Barn	22.35	67,295.85	36.4236	239	47	570	14	7,014
Corral	14.04	42,274.44	—	—	—	—	—	—

To compare some these estimates to other material estimate calculations from other contemporary sites provides a sense of scale of the quantity of materials for LA 20,000. James Ivey (2005) estimated that approximately 55,000 bricks were required to construct 38,830 cubic feet of walls at the for the mission church at Pecos (314-315). Considering that this structure is significantly larger than any structure at LA 20,000, including a larger floor area and wall height, the nearly 19,000 bricks I estimated to build the *estancia* seems to be reasonable.

Ivey (2005:314) estimates adobe brick production rates at Pecos. He suggests a brick making crew could produce 275 to 300 bricks in a day (around 50 bricks per day per person), with only an about 6 bricks out of every 75 to 80 thrown out due to quality issues. If a seven-person at LA 20,000 crew could keep that pace (requiring roughly 381 person-days of labor), then they would have needed approximately 54 days to complete all 19,038 bricks for the barn and the house. That being said, brick making could not be performed all through the year. Beginning in October the drying time would have increased as the daily high temperatures began to decrease; bricks would be laid at a faster rate than they could be made. Between November and April the frosts would be too cold to allow the adobe to properly dry in the molds (Ivey 2005:314), and during three to four weeks in the summer it would be too rainy to dry the bricks (Trigg, pers. comm.). As such, there was a limited window of opportunity ideal for the production of adobe bricks.

Once enough bricks were completed, they would have been laid with adobe mortar. At the Palace of the Governors in 1710, a crew of 14 Indigenous men working as *repartimiento* laborers laid 100 cubic feet of wall in approximately 6 months (C. Snow 1974:267). A smaller crew of seven laborers at the mission at Pecos could have laid approximately 55,000 bricks for the *convento* over the course of 10 months, breaking down to approximately 40 bricks laid per day per laborer (or 5 bricks an hour) (Ivey 2005:314-315). If that were the crew at LA 20,000 kept up that rate person-days for their construction, it would have taken almost 476 person-days just to lay the 19,038 bricks for the exteriors of house and the barn. With a crew of seven, this could be reduced to 68 person-days of bricklaying, or just over two months.

There were other tasks to complete the construction of the *estancia* that are not as easily represented in ethnographic or experimental data. One such task is plaster manufacturing. Daub would have been used to cover both the exterior and interior of the walls. On some interior walls there would have been whitewash or thicker white plaster over daub. The would have required fires to burn the caliche into a brittle form that could be ground into a powder (Abundant Edge 2020). This would have required not just a worker to gather and grind the caliche, but also a worker to gather firewood. The crew would have applied the daub to the over 238m^2 of wall on the exterior and possibly both daub and whitewash on the 238 m^2 of the house's interior.

It would not have been a small feat to prepare the timbers for the *vigas* for the roof. The tree trunks would have needed to be de-barked, and cut to the right dimensions. If the roofs of the house and barn spanned the length of the foundations—that is to say there were no interior courtyard spaces—approximately 80 timber *vigas* were needed for the house, and 47 for the barn.

Another dimension of labor that is unfortunately lost is the gendering of construction labor at LA 20,000. While similar structures in the Spanish colonial period indicate the use of male Pueblo and Plains servants, this is not the way things were always done in New Mexico. In Pueblo villages prior to the Spanish invasion, women were in charge of plastering the walls (Burgio-Ericson 2018:158-159), and men provided the timber for construction projects by going into the mountains, logging trees and preparing timber, and transporting the wood back to the pueblos (Montgomery et al. 1949:158). It is unknown whether the Spanish would have had Pueblo women participate in the construction of the *estancia,* like they would have in villages. However, it is more likely that the Pueblo women would have been required to do domestic work such as cooking, cleaning, and tending the children, while the men would have been at work on the construction projects, gathering timber and other raw materials. This reorganization of labor using Spanish gender roles would have been another way the colonists established a new order on the landscape.

Another labor aspect to consider is not just construction, but also the maintenance of these spaces. Often times a low maintenance cost comes from having higher cost of materials, and high maintenance is correlated with lower cost or quality of materials (McGuire and Schiffer 1983:282): that is to say that those who can afford more durable materials do not need to spend as much effort repairing them later. The *estancia* was only occupied for just over fifty years, so it is unlikely that major structural repairs were required (and none appear in the archaeological record).

However, due to the nature of the materials used for construction and their susceptibility to the dramatic climate of New Mexico, it is likely that some work would have been needed to ensure the integrity of the structures. Adobe in particularly is sensitive to moisture; rain wears down the surfaces, and water that gets into cracks freezes at it expands and undermines the integrity from within. With the majority of the structures composed of adobe materials, resurfacing the walls and recoating them with plaster would have been an essential job to perform every few years if not every year. The roof also would have required regular maintenance. Not only was it composed of mud, which also would have been exposed to the elements, but also the organic components such as the *vigas* and *latillas* would have needed replacing if there was damage or if the reeds had rotted.

On the whole, it is not likely that maintenance would have been a year-round job for the household at LA 20,000, or even something that would have been performed yearly.

However, the *estancia* would have required workers who would be knowledgeable about what needed repair and who could be directed away from other responsibilities to see to the maintenance of the structures. This, too, adds to the overall cost of the construction of the *estancia*, and would have been indicative of a desire to maintain and uphold a colonial legacy on the site in the buildings on the property.

Table 5.8
Construction Labor Tasks in Person-Days

Task	**Person-Days**	**7 Person Crew-Days**
Clearing/flattening site	Unknown	Unknown
Digging Floors	30	4.3
Transporting and laying foundations	Unknown	Unknown
Laying stones and bricks for floors	Unknown	Unknown
Collecting water, clay, and sand for adobe	Unknown	Unknown
Collecting caliche and preparing for wall coating manufacture	Unknown	Unknown
Gathering reeds for roof	Unknown	Unknown
Producing adobe bricks	381	54.4
Laying bricks	476	68
Travel for logging (to site and back)	2	2
Travel for selenite harvesting (to site and back)	1	1
Logging	Unknown	Unknown
Selenite harvesting	Unknown	Unknown
Preparing wall coating	Unknown	Unknown
Applying wall coating and decorating walls	Unknown	Unknown
Working selenite for window glazing	Unknown	Unknown
Preparing timbers and placing *vigas* and *latillas*	Unknown	Unknown
Digging holes and setting posts	Unknown	Unknown
Laying daub for roofing	Unknown	Unknown
Total	890	129.7

Based on documented rates of construction, the labor required to construct the *estancia* would have totaled 890 person-days to dig out the floors, make and lay bricks, and travel to and from the site, and harvest selenite and timber. This does not include other tasks that I do not have known rates for, like selecting and laying stones for foundations and floors, plaster and whitewash manufacture and application, setting windows and doors, preparing timbers for *vigas* and *latillas*, laying materials for the roof, harvesting stones and reeds, fetching water and clay for the adobe puddling pits, among many other tasks for necessary construction. Even excluding the time needed for these tasks, the total number of person-days is nearly two and a half years of work, but of course much of the work dependent on the seasonal weather like temperature and rainfall. If there were a large multi-person crew, the work could be feasibly completed in a few months, but a smaller workforce would mean that the construction of the *estancia* would be a multi-year project.

Conclusion

In terms of what the structures on the *estancia* of LA 20,000 looked like, it is likely that they would have resembled their smaller contemporary counterparts such as the Signal Site or Las Majadas. Noteworthy architectural differences are the size of the residential structure and the inclusion of a barn complex, with specialized work areas, such as the cobblestone floor in the barn and a large corral, that indicate a commitment to a substantial agricultural enterprise. These show that the household at LA 20,000 was wealthy, of high social standing, could support a large herds of livestock and crop production, or all of the above.

As for the materials the workers used to make the buildings on the *estancia*, the structures were made of many of the same materials as other 17th-century New Mexican ranches. My acquisition analyses have revealed that the builders made use of materials locally available, as well as traveled or traded a great distance to obtain others. This is indicative not only of the uneven distribution of natural resources in the colony of New Mexico, but also the extent to which Spanish colonial power extended in the 17th century; how far one household needed to travel just to erect its structures. Given the scale of the structures on LA 20,000, as well as the territorial scope that required to extract raw materials for the construction of the *estancia*, even if the colonists of the household could perform all of the these tasks of construction on their own, they still would have required Indigenous construction and environmental knowledge to acquire the materials. This is another aspect to consider in the calculation of effort and time required to construct an agricultural complex in colonial New Mexico.

This study has, in essence, not only provided more insights into a style of architecture that has not been studied much archaeologically due to the scarcity of surviving structures in New Mexico of this style and time period, but it also shows that the colonists made use of the materials at hand in the construction of the *estancia,* as well as expended great effort to acquire the right materials to construct the *estancia,* even if it meant traveling long distances for the proper materials. Archaeological evidence and analysis of architectural remains from 17th-century contexts in New Mexico illuminates the not only the form and construction of colonial architectural spaces of the region, but also attests to the significance and implications of these structures on the colonial New Mexican landscape.

As such, the site of the *estancia* at LA 20,000 is both a part of the Spanish colonial history of settling the region of New Mexico, as well as a site of the exploitation of Pueblo or Plains people for the sake of the larger Spanish colonial enterprise. The labor of all involved in the site’s construction would have been represented in the architecture that would have stood.

References Cited

Abundant Edge
2020 Earthen Plasters: the Healthiest and Most Beautiful Way to Finish Your Home. Abundant Edge. <https://abundantedge.com/articles-1-2016-6-17-earthen-plasters-the-healthiest-and-most-beautiful-way-to-finish-your-home>. Accessed 3 February 2021.

Alexander, Robert T.
1971 The Signal Site. In Salvage Archaeology in the Galisteo Dam and Reservoir Area. Ed. David Kayser and George Ewing, pp. 10-33. Museum of New Mexico Laboratory of Anthropology, Santa Fe, New Mexico.

Barrett, Elinore
2015 *The Spanish Colonial Settlement Landscapes of New Mexico, 1598-1680.* University of New Mexico Press, Albuquerque, New Mexico. Accessed April 1, 2021. ProQuest Ebook Central.

Brinkman, Adam C.
2019 *Comales* and Colonialism: An Analysis of Cuisine and Ceramics on a 17th Century New Mexican *Estancia.* Master's thesis, Department of Anthropology, University of Massachusetts Boston, Boston, MA.

Brown, Paul Wencil and James R. Clifton
1978 Adobe. I: The Properties of Adobe. *Studies in Conservation,* 23(4): 139-146.

Burgio-Ericson, Klinton
2018 *Living in the Purísima Concepción: Architectural Form, Cultural Negotiation, and Everyday Practice in a 17th-Century New Mexico Mission Among the Zuni Indians.* Doctoral Dissertation, Department of Art, Duke University, Chapel Hill, SC.

Cameron, Catherine M.
1999 Room Size, Organization of Construction, and Archaeological Interpretation in the Puebloan Southwest. *Journal of Anthropological Archaeology.* 18(2):201-239.

Deagan, Kathleen
2003 Colonial Origins and Colonial Transformations in Spanish America. *Historical Archaeology* 37(4): 3-13.

Dean, Jeffrey S.
1996 Jeffrey S. Dean to Dr. David H. Snow, Santa Fe, NM, 13 August 1996. On file at El Rancho de las Golondrinas.

Douglass, John G. and William H. Graves
2017 New Mexico and the Pimería Alta: A Brief Introduction to the Colonial Period in the American Southwest. In *New Mexico and the Pimería Alta: The Colonial Period in*

the American Southwest, Douglass, John G. and William H. Graves, editors, pp. 3-46. University Press of Colorado, Boulder, CO.

Dozier, Edward P.
1970 *Pueblo Indians of North America.* Holt, Rinehart and Winston, Inc. New York, NY.

Elliot, J. H.
2006 Intrusion and Empire. In *Empires of the Atlantic World: Britain and Spain in America 1492-1830.* pp. 2-28. Yale University Press, New Haven, CT.

Funari, Pedro Paulo A. and Andrés Zarankin
2003 Social Archaeology of Housing from a Latin American Perspective: A Case Study. *Journal of Social Archaeology* 3(1): 23-45.

Geiger, Owen
2012 Latilla Ceilings. Natural Building Blog. <http://www.naturalbuildingblog.com/latilla-ceilings>. Accessed 3 February 2021.

Grizzard, Mary
1986 *Spanish Colonial Art and Architecture of Mexico and the American Southwest.* University Press of America, Lanham, MD.

Gruber, Anya
2018 Palynological Investigations of Agropastoralism and Ecological Change At LA 20,000, New Mexico. Master's thesis, Department of Anthropology, University of Massachusetts Boston, Boston, MA.

Guthrie, Thomas H.
2013 Constructing History at the Palace of the Governors. In *Recognizing Heritage*: *The Politics of Multiculturalism in New Mexico.* Lincoln, NE, University of Nebraska Press, pp. 21-61.

Hammond, George P., and Agapito Rey, editors
1953 *Don Juan de Oñate, Colonizer of New Mexico,* 1595-1628. 2 Vols. University of New Mexico Press, Albuquerque, NM.

Hanlon, Don
1992 The Spanish Mission Church in Central New Mexico: A Study in Architectural Morphology. *Anthropologica* 34(2):203-229.

Hoadley, R Bruce
1990 *Identifying Wood: Accurate Results with Simple Tools.* Taunton Press, Newtown, CT.

Ivey, James E.
2005 *The Spanish Colonial Architecture of Pecos Pueblo, New Mexico: Archaeological Excavations and Architectural History of the Spanish Colonial Churches and Related*

Buildings at Pecos National Historical Park, 1617-1995. History Program, Division of Cultural Resources Management, Intermountain Region, National Park Service, Department of the Interior.

2006 The Estancia: The New Mexican Hacienda. In *Canyon Gardens": Ancient Pueblo Landscapes of the American Southwest*, V.B. Price and Baker H. Morrow, editors, pp. 75-85. University of New Mexico Press, Albuquerque, NM.

Kubler, George
1963 *Religious Architecture of New Mexico*. The Rio Grande Press, Chicago, IL.

Levine, Frances
1992 Hispanic Household Structure In Colonial New Mexico. *Current Research On The Late Prehistory And Early History Of New Mexico*, Vierra, Bradley J., editor, pp.195-206. New Mexico Archaeological Council, Albuquerque, NM.

Liebmann, Matthew
2012 *Revolt: An Archaeological History of Pueblo Resistance and Revitalization in 17th Century New Mexico.* University of Arizona Press, Tucson, AZ.

Liebmann, Matthew, T.J. Ferguson, and Robert Preucel
2005 Pueblo Settlement, Architecture, and Social Change in the Pueblo Revolt Era, A.D. 1680 to 1696. *Journal of Field Archaeology* 30 (1):45-60.

Lightfoot, Kent
2017 The Archaeology of Colonialism in the American Southwest and Alta California: Some Observations and Comments. In *New Mexico and the Pimería Alta: The Colonial Period in the American Southwest*, John G. Douglass and William M. Graves, editors, pp. 355-377. University Press of Colorado, Boulder, CO.

Lycett, Mark T.
1989 Spanish Contact and Pueblo Organization: Long Term Implications of European Colonial Expansion in the Rio Grande Valley, New Mexico. In *Columbian Consequences*, *vol. 1*, David Hurst Thomas, editor, pp.115-125. Smithsonian Institute Press, Washington, DC.

MacCameron, R.
1994 Environmental Change in Colonial New Mexico. *Environmental History Review* 18(2):17-39.

McGuire, Randall H. and Michael B. Schiffer
1983 A Theory of Architectural Design. *Journal of Anthropological Archaeology* 2: 277-303.

Montgomery, Ross Gordon, Watson Smith, and John Otis Brew
1949 *Franciscan Awatovi: The Excavation and Conjectural Reconstruction of a 17th Century Spanish Mission Establishment at a Hopi Indian Town in Northeastern*

Arizona. Peabody Museum Papers, Vol. XXVI. Reports of the Awatovi Expedition, Report No. 3. Peabody Museum, Harvard University. Cambridge, Massachusetts.

Museum of London Archaeology Service
1994 *Archaeological Site Manual*, 3rd Edition. City of London Archaeological Trust, London, UK.

Opishinski, Ana
2019 Eat This In Remembrance: The Zooarchaeology Of Secular And Religious Sites In 17th-Century New Mexico. Master's thesis, Department of Anthropology, University of Massachusetts Boston, Boston, MA.

Pavao-Zuckerman, Barnet and Kelly L. Jenks
2017 Early Colonial Period. In *The Oxford Handbook of Southwest Archaeology*, Barbara Mills and Severin Fowles, editors, pp. 527-548. Oxford University Press, Oxford, UK.

Phillips Jr., W.D. and C.R. Phillips.
2015 *A Concise History of Spain.* Cambridge University Press, Cambridge, UK.

Post, Stephen S.
2002 A Data Recovery Plan For Excavation At The New Mexico Museum Of History Site: 700 Years Of Human Occupation Near The Palace Of The Governors In Santa Fe, New Mexico. Museum of New Mexico Archaeological Studies, Archaeology Notes 311. Santa Fe, NM.

Powell, Eric A.
2017 The First American Revolution. *Archaeology* 70(2): 42-47.

Nesom, Guy
2003 Two-Needle Pinyon. Plant Guide. United States Department of Agriculture. Natural Resources Conversation Service. < https://plants.usda.gov/plantguide/pdf/pg_pipo.pdf?> . Accessed 3 February 2021.

Nierman, Daniel and Ernesto H. Vallejo
2003 *The Hacienda in Mexico.* Trans. Mardith Shuetz-Miller. University of Texas Press, Austin, Texas.

Sheppard, Donald E.
n.d. Conquest League Measure. *FloridaHistory.Com.* <http://floridahistory.com/spanish-navigation.html.> Accessed 18 February 2021.

Snow, Cordelia Thomas
1974 A Brief History of the Palace of the Governors and a Preliminary Report on the 1974 Excavation. *El Palacio.* 80(3): 1-21.

Snow, Cordelia Thomas and Stephen Post
2020 "I Rebuilt the Palace of the Governors at My Own Expense" *El Palacio* Spring 2020. https://www.elpalacio.org/2020/02/i-rebuilt-the-palace-of-the-governors-at-my-own-expense/ Accessed 3/22/2022.

Snow, David H.
1973 Cochiti Dam Salvage Project: Archaeological Excavation and Pottery of the Las Majadas Site, LA 591, Cochiti Dam, New Mexico. *Museum of New Mexico, Laboratory of Anthropology Notes* 75.

1990 Review of Agrarian and Linear Land Measurement of Land from 17th-century Documents in Colonial New Mexico. In *Santa Fe Historic Plaza Study 1,* Linda Tigges, editor, pp. 85-108. City Planning Department, Santa Fe, NM.

1987 Archaeological Field Notes. LA 20,000 Excavations, April-May 1987. Manuscript. Museum of New Mexico's Laboratory of Anthropology, La Cienega, NM.

1992 A Review Of Spanish Colonial Archaeology In Northern New Mexico. *Current Research on the Late Prehistory and Early History of New Mexico,* Bradley J. Vierra, editor, p.185-193. Special Publication 1.

1992 Dr. David Snow to Dr. William J. Robinson, Tucson, AZ 21 July 1992. On file at El Rancho de las Golondrinas.

1994 Field Excavations at LA 20,000 1980-1994. Manuscript on file at El Rancho de las Golondrinas, Santa Fe, New Mexico.

1998 *New Mexico's First Colonists: The 1597-1600 Enlistments for New Mexico Under Juan de Oñate, Adelante and Gobernador*. Hispanic Genealogical Research Center of New Mexico. Albuquerque, NM.

Solometo, Julie
2010 The Context And Process Of Pueblo Mural Painting In The Historic Era. *Kiva* 76:1, 83-116.

Thomas, David Hurst
2000 Excavations at Mission San Marcos, New Mexico, Summer 1999. Manuscript. Mission San Marcos Project. American Museum of Natural History, New York, NY.

Trigg, Heather B.
2003 The Ties that Bind: Economic and Social Interactions in Early-Colonial New Mexico, A.D. 1598-1680. *Historical Archaeology* 37(2): 65-84.

2005 *From Household to Empire: Society and Economy in Early Colonial New Mexico.* University of Arizona Press, Tucson, AZ.

Trigg, Heather B., Ana C. Opishinski, David B. Landon, and David H. Snow
2022 Spanish Use of Plants and Animals in Early Colonial New Mexico. *Kiva 88*(3):269-290.

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

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

Van West, Carla R., Thomas C. Windes, and Frances Levine
2009 The Role of Climate in Early Spanish-Native American Interactions in the U.S. Southwest. Paper presented at the 74th Annual Meeting of the Society for American Archaeologists, Atlanta, GA.

Weber, Robert H. and Frank E. Kottlowski
1959 Gypsum Resources of New Mexico. *Bulletin 68.* State Bureau of Mines and Mineral Resources. New Mexico Institute of Mining and Technology. Campus Station. Socorro, NM.

Wennerberg, Sarah
2004 Ponderosa Pine. Plant Guide. United States Department of Agriculture. Natural Resources Conversation Service. < https://plants.usda.gov/plantguide/pdf/pg_pipo.pdf?> . Accessed 3 February 2021.

White, Courtney
1996 Adobe Typology and Site Chronology: A Case Study from Pecos National Historical Park. *Kiva*, 61(4) 347-363.

Whitehead, Neil L.
2011 Native Americans and Europeans: Early Encounters in the Caribbean and Along the Atlantic Coast. In *The Oxford Handbook of the Atlantic World: 1450-1850.* Nicholas Canny and Philip Morgan, editors, pp. 55-70. Oxford University Press, Oxford, UK.

Windes, Thomas C.
2010 Dendrochronology and Structural Wood Use at Pueblo del Arroyo, Chaco Canyon, New Mexico. *Journal of Field Archaeology* 35 (1):78- 98.

APPENDICES

APPENDIX A: ARTIFACT ATTRIBUTE TABLES

Selenite Attributes

Record/ Bag Number	Unit	Context	Level	Weight (g)	Dimensions of Largest (cm)	Shape	Worked Edges	Burning	Transparency
FS: 71	Unit A/ 2015-A	21	9	36.18	6.7x3.4x.3	Rectangular /triangular	Flat edges	Yes	Translucent/partial opaque
FS: 110	Unit A/ 2015-A	29	Wall clean	4.77	2.4x2x.2	Rectangular	Flat edges and square corners	Yes	Translucent
FS: 66	Unit A/ 2015-A	21	9	0.99	1.7x1.1x.1	Rectangular	No	Yes	Translucent
FS: 28	Unit A/ 2015-A	11	-	1.35	2.2x1.9x.3	Rhomboid	Flat edges and square corners	Yes	Translucent
FS: 92	Unit A/ 2015-A	25	10	0.19	1.1x.6x.3	Rectangular	No	Yes	Translucent
FS: 46	Unit A/ 2015-A	14	Wall clean	0.07	1.3x.6x.1	Rectangular	No	No	Translucent
FS: 23	Unit A/ 2015-B	7	3	35.03	3.5x2.4x.5	Rhomboid	Flat edges and square corners	Yes	Translucent
FS: 37	Unit A/ 2015-B	10	4	7.35	3x2.2x.3	Rectangular /rhomboid	Flat edges and square corners	Yes	Translucent
FS: 195	Unit A/ 2015-J	64	7	86.36	4x3.9x.5	Rectangular /rhomboid	Flat edges and square corners	Yes	Translucent/some opaque
FS: 234	Unit A/ 2015-J	70	10	8.09	3.2x1.9x.4	Rectangular	No	Yes	Translucent/some opaque
FS: 267	Unit A/ 2015-J	81	Wall clean	20.47	3.9x2.8x.5	Rectangular	Flat edges and square corners	Yes	Translucent/partial opaque
FS: 220	Unit A/ 2015-J	66	8	133.41	5.6x 4.7x.7	Rectangular /rhomboid	Flat edges	Yes	Translucent/partial opaque
FS: 273	Unit A/ 2015-J	78	14	0.16	1.6x.8x.1	Irregular	No	No	Translucent
FS: 204	Unit A/ 2015-J	66	8	62.74	3.9x3.7x.5	Rectangular /rhomboid /triangular	Unclear	Yes	Translucent/partial opaque
FS: 227	Unit A/ 2015-J	69	9	40.52	4.4x2.5x.3	Rectangular /rhomboid	Squared edges and rounded corners	Yes	Translucent/partial opaque
FS: 181	Unit A/ 2015-J	57	5	5.51	2.7x2.6x.5	Rectangular /triangular	No	Yes	Translucent
FS: 240	Unit A/ 2015-J	71	11	0.97	2.3x.9x.3	Rectangular /rhomboid	No	Yes	Translucent
FS: 250	Unit A/ 2015-J	74	12	18.35	3.9x2.1x.3	Rectangular , rhomboid, triangular	Flat edges, square corners	Yes	Translucent

FS: 197	Unit A/ 2015-J	62	6	190.44	5.8x5.8x.7	Rectangular /rhomboid/ triangular/ curved with undulations	Undu- -lations	Yes	Translucent
FS: 291	Unit A/ 2015-J	64	7	74.25	8x7.2.6	Rhomboid	Scalloped edges	No	Mostly translucent
FS: 179	Unit A/ 2017-A	332	9W	23.1	4.5x3.4x.8	Mostly oval /rectangular /curved	No	Yes (some fragments)	Mostly translucent
FS: 256	Unit A/ 2017-A	340	11W	4.45	3.4x3x.3	Rhomboid	No	Yes (one side)	Translucent
FS: 480	Unit A/ 2017-C2	407	4	0.13	1.3x.7x.1	Rectangular	No	Yes	Translucent
FS: 464	Unit A/ 2017-C3	405		4	2.3x1.8x.4	Rectangular	Flat edges and square corners	No	Translucent
FS: 382	Unit A/ 2017-C3	395	7	6.01	3.5x2.1x.4	Rectangular /triangular/ irregular	Undu- -lations	No	Translucent
FS: 376	Unit A/ 2017-C3	386		191.5	2.5x1.8x.2	Triangular	No	No	Translucent
FS: 354	Unit A/ 2017-C3	382 (south)		0.68	1.9x.9x.4	Triangular	No	No	Translucent
FS: 344	Unit A/ 2017-C3	370		4.9	2.4x1.8x.3	Rectangular /irregular	No	Yes	Translucent
FS: 371	Unit A/ 2017-C3	381		20.53	5.1x3.2x.7	Rectangular /curved	No	Yes	Translucent
FS: 369	Unit A/ 2017-C5	394	9	4.36	2.9x2.2x.3	Rhomboid /triangular	Flat edges and square corners	Yes	Translucent
FS: 400	Unit A/ 2017-K	398	9	10.52	3.6x2.2.5	Rectangular /rhomboid	Flat edges and square corners	Yes	Translucent
FS: 388	Unit A/ 2017-K	384	6	3.17	2.3x2x.2	Rectangular /rhomboid	No	Yes	Translucent/partial opaque
Flotation Sample	Feature 64	Heavy Fraction	9--11	3.93	3.3x2.2x.3	Rectangular	Flat edges and square corners	No	Translucent
FS: 397	Unit A/ 2017-K	397	8	9.82	4.7x1.9x.9	Rhomboid	No	No	Translucent
FS: 323	Unit A/ 2017-A	wall fall		3.56	1.7x1.6x.3	Trapezoidal	No	No	Opaque
FS: 425	Unit B/ 2016-K	195	13	1.14	1.6x1.4x.4	Rectangular	No	No	Opaque
FS: 322	Unit A/ 2016- E	182	8	27.42	6.2 x 4.5x.7	Trapezoidal	No	No	Translucent/partial opaque
FS: 268	Unit B/ 2016-G	172	15	0.23	.8x.9x.1	Irregular	No	No	Translucent
FS: 249	Unit A/ 2016- E	165	6	12.55	3x2.4x.5	Rectangular /trapezoidal	No	Yes	Opaque
FS: 83	Unit A/ 2015-I	111	6	0.39	1.5x.9x.1	Rectangular	No	No	Translucent
FS: 277	Unit A/ 2016- E	176	7	10.67	3.8x2.6x.5	Rectangular /rhomboid /triangular	No	Yes	Translucent/partial opaque
FS: 103	Unit A/ 2015-I	113	6	3.42	2.7x1.9x.2	Triangular	No	No	Translucent/partial opaque
FS: 110	Unit A/ 2015-I	122	8	0.83	1.9x1x.3	Rectangular	No	No	Translucent/partial opaque
FS: 74	Unit A/ 2016-B	107	5	2.02	2.71.9x.1	Rectangular	No	No	Translucent/partial opaque
FS: 355	Unit A/ 2016-N	198	8	0.55	2.6x1.4x.1	Rectangular	No	No	Translucent
FS: 363	Unit A/ 2016-N	204	9	0.73	1.2x.8x.1	Rectangular	No	Yes	Translucent/partial opaque

FS: 278	Unit A/ 2017-K	261	2S	0.13	1.2x.6x.1	Rectangular	No	No	Translucent
FS: 269	Unit A/ 2015-J	81	cleanup	0.03	.8x.6x.1	Rectangular /curved	No	No	Translucent/partial opaque
FS: 56	Unit A/ 2017-B	274	1	0.14	1.2x1x.1	Irregular	No	No	Translucent
FS: 431	Unit A/ 2017-C5	403	11	0.63	1.5x1.4x.2	Rhomboid	No	No	Translucent
FS: 414	Unit A/ 2017-A	332	heavy fraction	0.11	1x.5x.1	Rhomboid	No	No	Translucent
FS: 85	Unit A/ 2017-A	295	4	0.09	1x.5x.1	Rectangular	No	No	Translucent
FS: 146	Unit A/ 2017-C4	313	1	0.16	1.9x1x.1	Irregular	No	No	Translucent/some opaque
FS: 174	Unit A/ 2017-A	327	8W	1.39	1.8x1.4x.2	Triangular	No	Yes	Translucent/some opaque
FS: 495	Unit A/ 2017- A	306	6W	1.7	2.5x1.9x.3	Irregular	No	No	Translucent/some opaque
FS: 259	Unit A/ 2017-A	355	Photo clean	1.51	2.4x1.5x.3	Rhomboid	No	Yes	Translucent/partial opaque
FS: 156	Unit A/ 2017-C4	325	2	0.36	1.3x.7x.1cm	Rectangular	No	No	Translucent/partial opaque
FS: 39	Unit A/ 2015-J	267	heavy fraction	0.07	.8x.5x.1	Rectangular /triangular	No	No	Translucent
FS: 261	Unit A/ 2017-A	338	10W	3.03	2.8x1x.1	Rectangular /rhomboid	No	Yes	Translucent/partial opaque
FS: 34	Unit A/ 2015-J	269	heavy fraction	0.25	1.5x.9x.1	Rectangular	No	Yes	Opaque
FS: 344	Unit A/ 2016-K	195	13	2.83	3.6x2.6x.3	Triangular	No	Yes	Opaque
FS: ?	Unit A/ 2017-K	397	8	0.7	1.6x1.2x.2	Rectangular /triangular	No	Yes	Translucent/partial opaque
FS: 36	Unit A/ 2015-J	268	heavy fraction	0.7	1.5x1.3x.3	Rectangular /rhomboid	No	Yes	Translucent/partial opaque
FS: 37	Unit A/ 2015-J	271	heavy fraction	3.4	3.6x1.7x.3	Rectangular	No	Yes	Translucent/some opaque
FS: 392	Unit A/ 2017-K	392	7	7.43	4x2.4x.3	Triangular	Yes	Yes	Translucent, partial opaque
FS: 22	Unit A/ 2015-J	260	cleanup	7.36	2.2x1.8x.7	Triangular	No	Yes	Translucent, some opaque
FS: 438	Unit A/ 2017-C5	404	12	0.69	1.8x1.4x.2	Triangular	No	Yes	opaque
	N Interior Extension / W Side	In situ	51-179	0.08	1.1x.9x.1	Irregular	No	No	Translucent, some opaque

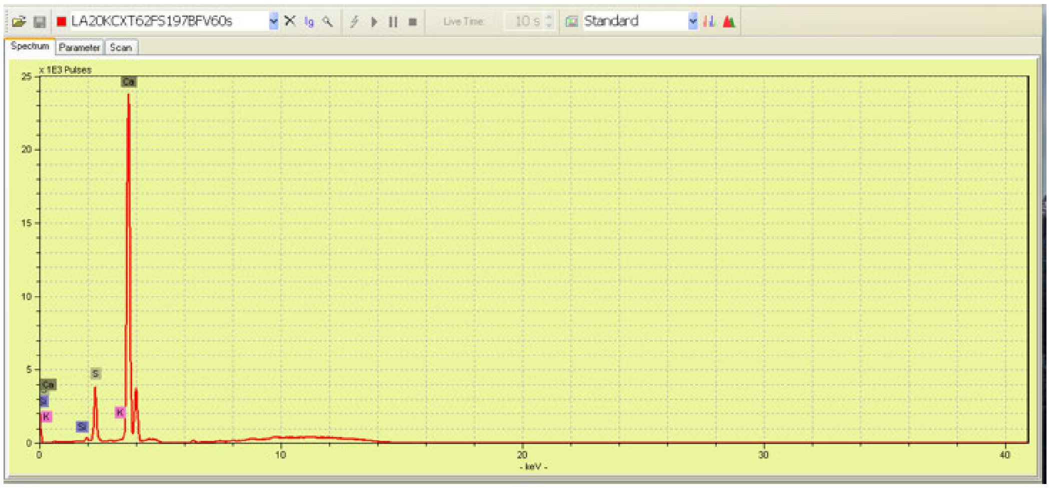
Adobe Attributes

Record # /Bag #	Location	Context	Inventory Count	Dimensions of largest	Munsell	Texture	Composition	Burning
FS: 124	Unit A/2017-B	304	2	5.8x 3x2.9 cm	10R 6/2 pale red	Hard, grainy	Gravel, red staining beneath white covering, large white patch	No
FS: 108	Unit-A/2017-B	6	6	2.2x2.1x1.1cm	2.5YR 6/3 (light reddish brown)	Hard, grainy	Gravel (some), red staining (paint?)	No
FS: 189	Unit A/2015-J	62	2	3x2.4x2.1cm	5YR 6/3 (light reddish brown	Friable, grainy	Gravel, white flecks ,grassy plant fibers	No
FS: 190	Unit A/2015-J	62	2	3.2x2.7x1.8cm	5YR 6/6 (reddish yell0w)	hard, grainy	Gravel, grass fibers, red staining (paint?)	No
FS: 247	Unit A/2016-E	165	23 + fragments	11.5 x 6.5 x 4.5 cm	10R 7/6 (light red)	Hard, finer texture	Gravel, grass/plant fibers	Yes
Fea 4	Unit A/ Grid P		1	4.8 x 3.7 x 2.3 cm	2.5 YR 7/4 light reddish brown)	Hard	Gravel, plant fibers	Yes
FS: 128	Unit A/2017-C4	313	15	5 x4.3 x 2.7cm	2.5YR 6/3 (light reddish brown)	Friable, grainy	Gravel, grass fibers, red staining	No
Quad AY Grid QA	La Cienega/Sanchez		4	16 x6.5x 6.2 cm	5YR 7/3 (pink)	Hard, grainy	Gravel, charcoal ,grassy plant fibers	No
FS: 446	Unit A/2017-C2	396	12	2.9 x 2.7 x 1.6 cm	10YR 3/1 (very dark brown); 5YR 7/4 (pink)	Hard	Gravel, grassy plant fibers	No
FS: 372	Unit A/2017-C3	381	10 + fragments	3.1 x2.4 x 1.2 cm	2.5 YR 7/6 (light red)	Friable, finer texture	Gravel, charcoal	Yes
FS: 68	Unit A/2016-B	107	16 + fragments	7.6 x 6 x 3.2 cm	2.5YR 6/3 (light reddish brown)	Hard, finer texture	Gravel, grass/plant fibers	Yes
Fea 52:	Sanchez		1	9x5.5x4.3cm	5YR 6/3 (light reddish brown)	Hard, grainy	Gravel, plant fibers	No
FS: 59	Unit A/2015-A	18	6	3.2x2.2x1cm	2.5 YR 6/4 (light reddish brown)	Hard, grainy	Gravel, grass fibers, charcoal, red staining (paint?)	No
FS: 128	Unit A/2017-C4	313	12	3 x 1.9 x1.9 cm	2.5YR 4/2 (weak red)	Hard, grainy	Gravel (some)	Yes

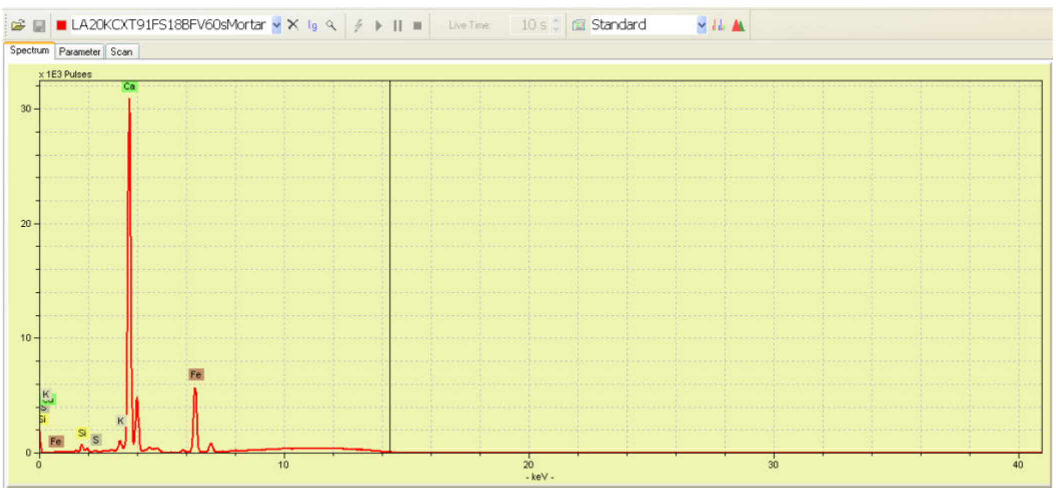
FS: 48	Unit A2015-A	15	12	5.5x2.7x2.2cm	2.5YR 7/3 (light reddish brown)	Hard, grainy	Gravel, grass fibers, red staining (paint?)	No
FS: 341	Unit A/2017-C5	358	34	9.4x7.5x4.7cm	2.5 YR 7/2 (pale red)	Friable, grainy	Gravel (multicolored), charcoal, white flecks (plaster?), red staining	No
FS: 341	Unit A/2017-C5	358	11	3.8x3.3x2.4 cm	2.5 YR 7/4 (light reddish brown)	Friable, grainy	Gravel, charcoal, reedy plant fibers	No
FS: 55	Unit A/2015-A	15	28 + fragments	6.7x4.4x3cm	5YR 6/2 pinkish grey	Hard, grainy	Gravel (some)	No
FS: 117	Unit A/2015-I	127	3	4.6 x 4.2 x 3.2 cm	5YR 6/3 (light reddish brown	Hard, grainy	Gravel, white flecks (plaster?), grassy (?)	No
Bag 114	Unit A/2015-I	122	2	4.3 x 4.2 x 2 cm	5YR 6/4 (light reddish brown)	Hard, grainy	Gravel, white flecks (plaster?), burned reeds	No

APPENDIX B: XRF RESULTS

Selenite Control Sample:
2015-J FS: 197



Calcium-Based Plaster:
2016-B FS: 18



2016-B FS: 67

mortar2016BFs67BF60sV15v
Live Time
10 s
Standard
Spectrum
Parameter
Scan
x 1E3 Pulses
Ca
K
S
Si
Ca
Fe
Si
S
K
Fe
40
30
20
10
0
0
10
20
30
40
- keV -

Chapter 6
Conclusions

By Heather B. Trigg, Katherine A. Albert, Anya Gruber, Clint Lindsay, and Ana Opishinski

Introduction

LA 20,000 has proven to be a rich source of information about the 17th-century Spanish occupation of New Mexico. This initial period of Spanish settlement represents a time of learning for the colonists as they adapted to the novel social and physical environments. The colonists brought their own expectations for what New Mexico had to offer and the sorts of activities and occupations they would undertake in their pursuit of making a living. They also brought existing notions of how these occupations would be performed. For the most part, Spanish households were agrarian. While there were some specialized occupations (e.g., the baker or blacksmith), most colonists were primarily occupied in subsistence production. Many of these activities also engaged Indigenous people. The Spanish Crown had laws that regulated the treatment of Indigenous people. Some of these regulations were design to protect Indigenous people from exploitation by colonists, but other laws entangled Indigenous people in colonists' productive activities thereby exploiting them for their time and labor. *Encomienda*, tribute payments, and *repartimiento*, labor obligation, compelled Pueblo peoples to provide subsistence items such as food and textiles and labor for colonists' construction and agricultural projects. Documents also recount that Plains people and Pueblo children were enslaved in colonists' households or Indigenous people provided labor for wages that were rarely paid.

As an agrarian society, the colony relied primarily on agricultural production, not only for colonists' subsistence needs but also for economic transactions. Basic subsistence items such as textiles and livestock were used in lieu of money since coins did not circulate. These subsistence items were also used for fulfilling social obligations such as tithing and dowries. Many of the same subsistence items, livestock, cloth, and hides, were exported to mining towns in northern Mexico. This long distance trade with cities in Mexico afforded Spanish New Mexicans essential goods such as iron and luxury goods such as fine cloth, jewelry and foodstuffs, and trade relationships provided social and cultural links to the more populated parts of New Spain. Thus agricultural production was the foundation of the colony and its connection to more central regions of the empire.

New Mexico was a difficult environment for agriculture, in general, and especially risky for 17th-century colonists, who had little experience in the region (Dawson and Trigg 2022). Environmental conditions were challenging as surface water for agriculture was highly localized and structured the placement of colonists' settlements. The location of the colony hundreds of miles north of the colonists' homeland in Mexico challenged their understanding of growing conditions – day length, temperature, freeze free periods, and precipitation. Colonists' lack of environmental knowledge taxed their abilities to produce sufficient food, and during the early years of the colony, the unfamiliarity with the location of resources such as timber and fuelwood hampered daily life. Colonists had some technological mechanisms for buffering risk, particularly *acequias* to compensate for the restricted distribution of water (Dawson and Trigg 2022). However, social obligations that required the movement of subsistence goods between households (e.g., dowries, tithing), also spread risk among colonists (Trigg 2003). Other social mechanisms, such as *encomienda*, shifted risk onto Pueblo peoples (Dawson and Trigg 2022). At their expense, and no doubt unwillingly, the Pueblos supported colonists' households, shouldering the burden of subsistence efforts in this challenging environment.

Colonists relied on Indigenous people for both agricultural labor and domestic services. Pueblo people could not be enslaved outright, but could effectively be enslaved as punishment for crimes, and Pueblo children were declared orphans and placed in colonists' households. While the various Pueblo communities had given obedience to the Crown and could not be legally enslaved, other Indigenous peoples such as the Comanche, Apache, and Navajos did not. These unconquered tribes were not subject to *encomienda*, but they could be enslaved as captives of war. New Mexico's governors and their allies were accused of leading raids onto the Plains, and it is possible that there was a market for enslaved people in Santa Fe.

The activities at rural ranches such as LA 20,000 brought together Spanish colonists and Indigenous peoples of varying tribal communities. From the building of the ranch's structures to the production of crops and the raising of livestock, colonists and Indigenous peoples' lives were intertwined. In the previous chapters, the authors explored aspects of the colonists' activities and the cross-cultural interactions involved in making a living and ultimately establishing a colonial presence in the region.

Another major impact of colonization was the introduction of livestock, crops, and technologies that underlay the productive activities, which in addition to engaging Indigenous people, impacted the environment. Construction of the ranch's buildings disturbed habitats, altering the plant and animal communities that dwelled there. Even though we lack physical evidence for *acequias* at LA 20,000, recent phytolith research by Dawson (personal communication) revealed that the wheat found at the site was grown under irrigation. That data, combined with Gruber's palynological analysis (Chapter 2) indicating that Old World cereals were grown nearby, shows that *acequias* were built, which in turn modified microenvironments around the site and its agricultural fields. The ranch's livestock would also have altered environments as they grazed on nearby grass and shrublands. These sorts of activities have been implicated in environmental degradation in Mexico, but research by Edwards (2015) at the Leonora Curtin Wetlands a few miles from LA 20,000 suggests that the small scale of Spanish farming in New Mexico during the 17th century did not significantly change the region's vegetation.

Gruber's analysis of pollen at LA 20,000 (Chapter 2) sheds light on productive activities, local environmental impacts, and interactions with Pueblo peoples at the ranch. Gruber's samples came from a sediment column at the edge of the site and from cultural deposits on the site. She found that the edge-of-site sediments were significantly different from the cultural deposits. The pollen assemblage in the sediment column paints a picture of the local environment: the wetlands associated with the perennial stream that borders the ranch's structures, the bosque vegetation of willow and cottonwood, and the pine woodlands and upland forests which dominate the arboreal vegetation and which likely represent major vegetation zones around the site as well as from farther away in the mountains. The shrublands and grasslands in which the site currently sits contributes little to pollen assemblage. However, the occupation of the site is marked in the palynological record by an increase in weedy plants, a decline in shrubs such as saltbush and local trees such as cottonwood and juniper. The subsequent increase in montane trees such as fir and ponderosa pine is interesting and perhaps suggests changing environmental conditions or localized deforestation that allowed for the long distance transport of upland pollen. Also notable is the absence of domesticate pollen such as maize, wheat or barley. This is consistent with what Edwards (2015) found at the nearby Leonora Curtin wetland site, which was also nearly lacking in domesticates. The paucity of domesticate pollen is most likely the result of these taxa's pollination strategies. Maize pollen is heavy and rarely travels far from the parent plant, and the Eurasian domesticates tend to pollinate while the flowers are closed. Thus pollen is typically found only in the immediate area of fields and where the grains are processed.

The pollen in on-site samples are different despite being in some cases less than 20 meters from the sediment column, and these samples provide evidence of food and specific productive activities at the site. Gruber analyzed cultural layers in the house, barn, corrals, and an area between the barn and house. Samples from the house contain small quantities of both maize and Old World cereal (wheat or barley) pollen indicating these foods were being eaten by the inhabitants, which supports the macrobotanical evidence. Cucurbit pollen, which could be pumpkin, squash or a wild taxon was also identified. However, other plant foods that we know were consumed based on the macrobotanical evidence are lacking. The relatively high proportion of maize pollen in samples from the area between the house and barn may indicate a processing area for shucking maize.

The samples in and around the barn and corral likely contained manure from the animals housed there. The pollen assemblages in these samples provide evidence of the plants the animals fed on and by extension the herding and animal husbandry practices of the farm. The palynology indicates the animals consumed grass, as the proportions of grass pollen here are far higher than the grass pollen in the sediment samples. Although the presence of arboreal pollen in these samples likely represents the natural pollen rain, the presence of domesticate pollen in the manure pollen also is notable. Wild grasses were more common than domesticates, which is to be expected from grazing animals, but the presence of domesticates in all cultural samples points to several conclusions. First, a variety of cereals were being cultivated at LA 20,000. Both Indigenous domesticates (maize) and introduced domesticates (wheat and/or barley) were recovered and were likely grown at the farm. The availability of wheat to the colonists is something that is debated, but the presence of wheat pollen at the site supports the macrobotanical evidence that wheat was being grown there. The maize may have come from Indigenous fields if the livestock encroached on their fields, something that is recorded in the documents, but these fields would have had to be nearby as animals' manure was deposited on the site. More likely, it came from the farm's maize fields. The palynology indicates that the animals grazed on or were foddered with wild grasses, but they also stubbled grazed on the farm's fields of wheat and maize. Thus livestock were at least partially free ranging, perhaps under the care of herders or shepherds.

Opishinski's chapter (Chapter 3) on the faunal remains from LA 20,000 dovetails with the palynological evidence. Her analysis of the available faunal remains found that the vast majority of identifiable bones came from introduced, domesticated animals: cattle, horse, sheep, goats, pigs, and chickens. By NISP, domestic animals far outnumber wild animals, with sheep/goats the most numerous category by NISP and by MNI. By biomass, however, cattle provide the most meat, followed by horse, and then sheep/goat. While Spanish New Mexican cuisine is often described as being based on mutton and sheep were a mainstay of animal husbandry, the data from LA 20,000 suggests cattle were also important. By MNI cattle were less numerous than sheep, but the large amount of meat on a cow meant that beef was a significant component of the diet.

The faunal analysis indicates that a large proportion of the meat consumed at LA 20,000 came from domestic animals. There are few specimens of the types of animals that comprise Pueblo diets, such as rabbits and deer.

While most of the meat consumed on the farm was likely produced there, fish and game birds were also eaten. Both of these types of animals would have been available in the nearby Cienega Creek, marshlands, and the grasslands to the south of the site. The fish procured here may indicate a broad cuisine, but it may also relate to Catholic practices of abstinence from meat at certain times. The small numbers of deer and rabbits may indicate food stress given the strong preference for domestic meat. Although, if the farm was that of an *encomendero*, the deer and rabbits may have been acquired as part of *encomienda* payments made by Pueblo people. Similarly, the butchered horse suggests at least frugality if not outright food insecurity.

The faunal assemblage primarily reveals the inhabitants' diet, but secondary products from the animals were important for the colonial economy. Wool from the sheep were used for the textiles and fat was used for candles, both of which were exported to the mining communities in Mexico. Horses were used as transportation, and horses and cattle for pulling plows and carrying loads. The limited quantity of appropriate faunal remains made determining the animal husbandry patterns difficult to assess with any certainty. However, the data hint at a generalized strategy for increasing herd size and for a the production of both food and secondary products. LA 20,000's assemblage is similar to those from other 17th-century sites in Santa Fe and rural farms (Trigg et al. 2022).

Tools for these productive endeavors as well as other activities were likely made of wood, stone, and to a smaller degree of iron. A small quantity of metal including small nails, a possible knife blade, and lead shot, was recovered from the site, primarily from the midden. But little has been recovered from the primary deposits. While iron was largely imported because the Crown limited and licensed its production, there is some evidence for metal working in the form of extracting and refining metals in the colony (Vaughan 2006). Slag has been reported at several sites. Smelting has been identified at Paako, and metal working at San Marcos Pueblo and Comanche Springs. Lead and copper were the ores worked at Paako and San Marcos. Iron does not seem to be among the ores reduced, and colonists complained that iron for tools was scarce, so production of iron was probably limited. Any iron that was available in the 17th century was probably extensively re-used and re-formed into smaller and smaller items. While wood for tools would have been plentiful, lithics likely filled the gap when more durable tools were needed, and stone was the only material for certain items such as gunflints and strike-a-lights.

Lindsay's chapter (Chapter 4) describes his extensive analysis of the chipped stone tool assemblage at LA 20,000. This assemblage comprises formal and expedient tool technologies and both local and Spanish traditions. The vast majority of the chipped stone assemblage consisted of debitage or shatter, followed by informal tools, and a few formal tools. Lindsay identified a variety of lithic materials including obsidian from the nearby Jemez Mountains, a variety of cherts and crypto-crystalline silicates, and a small amount of petrified wood. The informal, expedient tools were predominantly made of materials that were easily available on or near the site, whereas the high quality lithic materials found on the site were frequently brought as complete tools.

Lindsay also analyzed the use wear on the informal tools. These tools were used on a variety of materials. The most common materials were soft and medium hardness such as plants, soft wood, and leather. Less common was use on harder material such as bone, hardwood, antler and soft stone. Not surprisingly, several tools showed evidence of being used in different ways and on different materials.

Formal tools, including projectile points, bifacially worked scrapers, and drills, were quite rare comprising only 17% of flaked tools. Many of these tools were well made, and were typically of high quality materials such as obsidians and cherts, available in the region but at distances greater than 15 km from the site. The number of projectile points was small (n=4), but comprised a variety morphologies and materials (obsidian, Pedernal chert, and non-local chert). The morphology and material of one was unusual and may indicate the presence of, or trade with, Athabascan peoples. The diversity of forms and material types point to a variety of makers. While determining the ethnicity of tool makers is difficult, the type and high quality of workmanship and the tool making traditions suggests Indigenous makers. Lindsay suggests that the points and drills were likely made by Puebloan and possibly Plains workers who brought them to the farm. Debitage analysis indicates the high quality tool materials, obsidian and Pedernal cherts, appear to have arrived at LA 20,000 as finished tools or nearly finished pre-forms, which were finished or re-touched on the site.

Colonists arrived in New Mexico with a stone tool technology for creating gunflints and strike-a-lights, and these tools were found at LA 20,000. Based on the type of materials, it is clear that the gunflints were made in the colony (not imported) and strike-a-lights were made from high quality materials such as Pedernal chert and other cryptocrystalline silicates. A small number of gunflints were recovered. These were made from materials that were present in the region, with the majority made from materials within 15 km of the site. The gunflints are notable in that they are made from several silicious materials and there appears to be several flaking techniques, which suggest that the gunflints were made by different knappers. Like the projectile points and drills, these tools were likely not produced exclusively on the site or necessarily by a specialist flint knapper.

A elemental analysis of obsidian found at the site (Lindsay 2021) illustrates not only the source of some of the tool making materials, but also possible relationships with nearby Pueblos, including the presence of Pueblo people at the ranch. Using pXRF, Lindsay identified the source of the obsidian found on site. These correlate to four known obsidian sources in the Valle Caldera in the Jemez Mountains. Obsidian nodules from three of those four sources can be found in eroded/secondary deposits outside the Caldera. One type of can be found within 15 km of the site in the gravels of the Rio Grande, the Cerro Toledo Rhyolite (CRT). The majority of obsidian at LA 20,000 comes from the CRT source likely obtained from the Rio Grande gravels. The rarest type of obsidian comes from the Valles Rhyolite source which can only be acquired within the Valle Grande. This suggests the obsidian was selected from the nearest available location, and that there was little access to the Valle Caldera directly. What is more interesting is that the proportion of the different types of obsidian at LA 20,000 is nearly identical to the assemblage at the nearby Pueblo village of San Marcos (Lindsay 2021; Ramenofsky et al. 2017). The similarity in both the nature of the assemblages and the source materials suggests a connection between LA 20,000 and San Marcos. Lindsay offers several possibilities. One is that Pueblo people from San Marcos worked at LA 20,000 bringing obsidian or tools with them; an alternative is that the village supplied LA 20,000 with obsidian tools.

This in-depth look at the lithic assemblage shows that the inhabitants at LA 20,000 relied on both Indigenous and Spanish tool technologies. The presence of Spanish-style gunflints and strike-a-lights is not surprising. The large proportion of Indigenous-type manufacturing of both formal and expedient tools, however, is striking. Whether those formal tools were brought by Pueblo peoples who performed labor at the site, or indicates the presence of captive and enslaved Plains and Pueblo peoples, or the Spanish inhabitants bartered for them at nearby San Marcos Pueblo, or even Spanish residents learning the technology from the Pueblos, the lithics at LA

20,000 attest to the importance of Plains and Pueblo peoples to the everyday life at early colonial ranches.

In addition to the being the location of shelter and productive activities, the farm's buildings provided the physical context for social reproduction and cultural interaction. In this colonial setting, the form and layout of structures contributed to the expression and exercise of power. At a basic level, the architecture also reflects economic decision making of colonists, but because of practices such as *repartimiento*, Indigenous peoples likely assisted with the construction and procurement of raw materials. Albert's chapter (Chapter 5) presents the architectural evidence for this complex farm. She provides a reconstruction of the layout of the buildings, detailing the construction methods and raw materials used. She also identifies the likely sources of these materials, and the amount of labor that must have been required for some aspects of the physical features of the ranch.

Surface indications of this farm are limited to a rock alignments of the buildings' foundations, stubs of corral walls eroding out of an arroyo, and an artifact scatter. Nineteen field seasons of archaeological excavation revealed the physical remains of the house, barn, a series of corrals, an *horno,* and a *torreon*. The farm's buildings back up to a steep, south facing slope rising nearly 20 meters above the site. Four hundred years of slope wash has covered the back of the house, where excavations have revealed the most extensive intact adobe walls on the farm. Elsewhere, 20th-century land modifications have removed most of the buildings' superstructures so the foundations are the primary indications of the their locations and layout.

The house was a large, single story structure constructed with boulder and cobble foundations and adobe brick walls. The foundation cobbles are primarily basalt from a nearby basalt flow, limestone and rounded river cobbles. For the most part, the adobe brick walls that remain are limited to a few courses of bricks laid in a pattern alternating perpendicularly. The limited extant brickwork hinders our understanding of the construction of the building, particularly its height, but the brickwork appears straightforward rather than decorative like the herring-bone pattern found at San Marcos. Most walls have cobble footings but a few internal walls have the adobe bricks laid on the floor. Walls in some rooms were whitewashed or covered with red and white plaster. A possible kitchen with a raised hearth was identified in the southeast portion of the house. Most floors were informal layered surfaces, but one ornamental adobe brick floor near the center of the house was identified. It is possible that the floors were hard packed sediment, or covered with sedges, grasses or reeds, or even woven textiles. The presence of selenite around the house foundation attests the small windows in this structure. Posts were placed in corners of rooms and by doorways to help support the roof.

There is little architectural evidence for the roof. No roofing tiles were recovered, so it is likely that the roof was the traditional flat construction with large vigas supporting layers of *latillas*, brush, and capped with mud. Some of the fill layers of rooms contained daub with impressions of reeds, lending support to the notion of flat, mud-covered roofs. Post holes associated with the exterior of the structure suggests that ramadas were attached to the southern wall of the house. While the house is large for 17th-century homes, its form and construction were typical of domestic structures at other sites such as at Las Majadas. However, there were several unusual features: an *horno* adjacent to the side of the house, the *torreon*, and a room with a curved wall on the back of the house. The latter structure was constructed after the main wall of the house on 30 cm of fill, without cobble footings, and may have had small posts supporting the roof. Its function is not known, but could have been for storage or surveillance. In essence, this reconstruction is strikingly similar to the reconstructions of 18th-century adobe homes. Thus, the style of Spanish New Mexican domestic architecture was developed early in the colonial endeavor.

The architecture emphasizes not only the domestic aspects of the farm, but also the economic activities. The large barn and series of large and small corrals attest to the importance of agricultural production in general and livestock production, specifically. Barns are unusual structures for the 17th century, and the barn at LA 20,000 was large and architecturally complex. Some of the walls were substantial with large boulder and cobble footings. Some of those walls were adobe topped such as the main wall running east-west through the center of the barn. Others, such as the north-south running walls in the western half may have had a wooden superstructure. The stone columns in the back of the barn would have provided an open expanse for storage or individual wooden pens. A cobble surface at the southwestern edge of the building provided one entryway into the barn. Wooden pens may have also been placed on the western side of the main structure. The main corral was integrated into the barn with the eastern wall of the barn providing at least a portion of the western wall of the corral. While it is clear that the barn is expansive and complex, we do not know the full extent of this structure because the southern end of the barn was damaged by the erosion caused by an arroyo and the modern impoundment.

The large barn and series of corrals attests the size of the farm's herds. The faunal analysis suggests that different animals were kept – sheep, horses, cattle and pigs. The high status accorded horses may have meant that they were kept close by in the barn or corral while sheep and cattle may have been allowed to graze in fields. The smaller corrals at the eastern edge of the site might have been for different livestock or special purposes such as lambing, shearing, breaking horses, or branding.

Constructing these structures required a variety of raw materials. Some of those were close to the site. Clay beds for adobe, mortar and plaster were within 50 meters of the house, probably within the core of the farm, and cobbles and boulders were available less than a 500 meters away. While the materials for the foundations were nearby, the size of the boulders likely required the use of draft animals to haul them to the building site. Wetlands near the site were the source of reeds and cattails for matting or roofing. Selenite for windows and white wash probably came from at least 15 km away. The large timbers for the *vigas* were made of ponderosa pine and Douglas fir, which grow in the uplands and mountainous areas of the region at least 30 km from the site.

The range and quantity of materials highlights the needs of the farm and its broad reach. The colonists at LA 20,000 clearly had access to materials and the ability to obtain heavy, bulky, and distant resources. One such resource were the *vigas* for the structures. Albert estimates more than 125 timbers were used in the construction of the roof of the house and the open expanse in the barn. This does not include large timbers for any possible wooden walls in the barn. Obtaining those 125 timbers required a 30 km trip to upland and mountainous areas, felling, stripping, and then transporting these timbers back to the farm. The walls for the structures required more than 20,000 bricks. Albert estimates that 381 person-days to needed to create the bricks just for the structures' perimeter walls and 476 person-days were needed to lay them. The time needed to construct the buildings depended on the amount of labor the colonists were able mobilize, likely Indigenous Pueblo laborers or enslaved Plains people. These figures clearly underestimate the effort involved. Due to gaps in the archaeological record, Albert was not able to estimate the number of bricks for interior walls of the structures; she also did not attempt to estimate the amount of time needed to raise and create the roof, erect ramadas, fences, and gates, plaster the exterior and interior of the walls, prepare and set windows, doors, or matting on floors. She also did not address the *torreon* structure, the adobe platform or the *horno*. Moreover, missing from the record are the *acequias* that the pollen and phytolith records show must have existed. All of the structures and the *acequias* required upkeep and repair, and there is evidence of remodeling over the 60 years the farm was occupied. A small room at the southwest corner of the house predates the main structure and may have been the primary dwelling as the other structures were built, and it appears that the an extensive addition was added to the house's southern wall. So the need for labor was not limited to the creation of the structures, but likely consisted on an ongoing demand for labor that was in addition to the daily activities of the farm – crop, livestock, and textile production, and domestic activities such as cooking and child raising.

The architecture and layout of the farm was not only a physical space for housing colonizers, their families and servants and for producing a livelihood, but it was also a social space that brought colonizers and Indigenous people together for the intimate, day-to-day negotiation of power and knowledge. The farm buildings were likely built with Indigenous, probably Pueblo labor, perhaps as *repartimiento*. This physical backdrop to those interactions likely had aspects that were familiar to the Pueblos, but challenging and oppressive. To other colonists, the size and complexity of the architecture at LA 20,000 likely signaled wealth. Differing ways those buildings were constructed and used, no doubt challenged Pueblo gender roles. While the Pueblos would not have been familiar with a barn containing large livestock, the house at LA 20,000 may have looked superficially like a pueblo, with the plastered walls, flat roofs, and ramadas. However, the sheer size of the house constructed for a single family would have been novel and may have signaled to Indigenous people an environmental engagement and acquisitiveness that may have been foreign to their cultural values.

Conclusions

LA 20,000 is probably the most intensively investigated 17th-century Spanish farm in New Mexico. The years of archaeological investigation, archival research and material culture and sample analyses provide a picture of 17th-century life at rural farms, which likely comprised the majority of colonists' households. LA 20,000 was home to a wealthy family with connections to the long-distance trade with Mexico and various Indigenous communities. Other archaeologically known farms, such as Las Majadas and the Signal site, are less complex and probably housed less affluent colonists, but they are nonetheless similar in form and in their emphasis on agricultural production and European-introduced livestock.

The technical analyses along with material culture indicate the colonists' activities were tightly focused on the farm. The identification of economic activities at this site indicate a broad range of productive activities – a range of livestock, crops, and textiles – rather than a specialized commodities. This production was integrative in nature: European-introduced crops were planted, livestock grazed on the farm's crop fields, and they provided meat, milk, wool, and hides, which were exchanged in the regional barter economy (Trigg 2003) and perhaps sent to Mexico. The identification of a bread oven and the large quantity of selenite for window panes, whitening wool, and perhaps whitewash may signal the household's ability to produce not only basic foodstuffs but items that enhanced their quality of life –for example, wheat bread and the means to decorate their home. The activities speak to a broad economy rather than a specific focus on livestock as might be expected on a specialized ranch. Despite the breadth of productive activities at LA 20,000, the household was not self-sufficient. At the very least, it relied on Indigenous labor, but the artifact assemblage demonstrates exchange with Pueblo people for ceramics for cooking, serving, and storage, and it shows a desire for goods produced in Mexico and farther abroad, such as metals, majolica, and porcelain.

The investment in the built environment, especially the architecture associated with agricultural production, points to the success of this farm. To a large extent, the productive activities were the way colonists created landscape out of land (Trigg et al. 2022). The construction of the large house, herds of livestock, and irrigated agricultural fields transformed the environment. While the area around LA 20,000 had been managed by Pueblo peoples for centuries, colonists created new environments, both deliberately and inadvertently, with their activities. Underpinning this new way of engaging the land were colonists' moral ecologies–people's internal systems of right and wrong that guide behavior (Trigg and Mrozowski 2023).

Spanish authorities knew the importance of Indigenous people to the colonial project, allowing colonists to force Indigenous people to assist with agricultural and domestic activities. The archaeology at LA 20,000 and elsewhere illustrates that there was an intense amount of engagement with Indigenous people for many aspects of colonial life. Archaeological research at Spanish sites across the colony has shown that a large proportion of the ceramic assemblage was created by the Pueblos, which attests to the importance of Indigenous people to colonists' daily lives. At LA 20,000, the similarity in lithic tools to those of San Marcos pueblo suggest the presence of San Marcoseños at the farm. The hybrid nature of the lithic assemblage, with both gunflints and expedient tools, suggests the frequent interaction between colonists and Indigenous people working on the farm. That sustained, likely daily, interaction with Indigenous people and their material culture at colonists' households left a distinctive mark on colonial society.

Future Directions

Despite the large amount of research done on LA 20,000, the site still has much to offer inquiries into 17th-century Spanish colonialism in New Mexico. Questions about the construction and use of space, particularly the domestic space, remain. The house has only partially been excavated. Much of the excavations done by Snow and Stoller in the 1980s and 1990s focused on identifying the outlines of the house by exposing the foundations, but they often did not excavate to the floors, wanting to preserve these contexts. Likewise, our 2015-2017 excavations attempted to limit excavation of the house to specific areas. While our excavations uncovered floors and associated features in some locations, many areas of the structure still remain to be examined. Internal divisions within the house, especially toward the northern (back) part of the house, are also poorly understood, in part because of the deep deposits of slope wash covering the structure. As a consequence the size, number, layout of rooms is unknown. This critical gap in our knowledge of the architecture has important implications for understanding the practices related to domestic production and consumption, and the social life of the farm. The division of space facilitated the exercise of power colonists exerted over Indigenous servants, as well as the exchange of information and practices among peoples.

The barn is better understood because units were often excavated to the floor. However, there are areas that warrant additional investigation. The area to the west of the main structure has deep deposits of manure, which may indicate the presence of wooden pens. Two ash and charcoal layers in the deposits east of the house are intriguing as they may either relate to repeated attempts to burn layers of animal waste or may reflect a catastrophic fire prior to the Pueblo Revolt. Additional work in the area between the house and barn, therefore, could yield important information about extra mural activities and less durable architecture.

Understanding the colonists' economic connections with Pueblo villages would provide an important view of the nature of cross-cultural relationships. As the lithic analysis at LA 20,000 demonstrated, specific artifacts are useful for tracing those connections. Ceramics are one of the most visible items exchanged between the Pueblos and colonists' households; therefore, identifying the source of Pueblo ceramics would provide information about the nature, intensity, and breadth of interactions. The ceramic assemblage comprises a wide variety of Puebloan types, Zuni, Hopi, Tewa painted wares, as well as micaceous and plain wares, but the predominant decorated wares are glazewares. An analysis of the glazewares is already being undertaken but the source of other ware types is not as well understood.

Some of this research and others can be accomplished on collections and samples that have already been recovered. But other research directions require additional excavation. The potential for this additional information to address issues of colonialism and ethnogenesis must be balanced by the disturbance to this unique and precious resource.

References Cited

Dawson, Emily, and Heather Trigg, Heather
2022 Archival Insights into Vulnerability and Risk Management during the Early Spanish Colonial Period (1598–1680 AD) in New Mexico. *The Holocene 32*(12):1518-1529.

Edwards, Kyle
2015 *Environmental Dimensions of Colonial Settlement: A palynological investigation of La Cienega, New Mexico*. Unpublished MA thesis (Historical Archaeology) University of Massachusetts Boston.

Lindsay, Clint
2021 pXRF Analysis of Obsidian Artifacts from a Rural Spanish Household: Investigating Spanish-Pueblo Interactions in Seventeenth-Century New Mexico. *Kiva* 87(4):486-508.

Ramenofsky, Ann F., Anastasia Steffen, Jeffrey R. Ferguson, Philippe D. Letourneau, and Adam Okun
2017 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.

Trigg, Heather
2003 The Ties that Bind: Regional Interactions in Early Colonial New Mexico, AD 1598-1680. *Historical Archaeolo*gy 37:65-84.

Trigg, Heather and Stephen Mrozowski
2023 "An Exploration of the Moral Ecologies of Spanish and English Colonization of North America." Paper presented at the 56th Annual Conference on Historical and Underwater Archaeology. Lisbon Portugal. January 4-7, 2023.

Trigg, Heather, Ana Opishinski, David Landon, and David Snow

2022 Spanish Use of Plants and Animals in Early Colonial New Mexico. *Kiva* 88(3):269-290.

Vaughan, C. David
2006 *Taking the measure of New Mexico's colonial miners, mining, and metallurgy*. Ph.D. dissertation (Anthropology). The University of New Mexico.