EXCAVATIONS AT FOUR ARCHEOLOGICAL SITES ON THE CNM RIO RANCHO CAMPUS, SANDOVAL COUNTY, NEW MEXICO

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Office of Contract Archeology
University of New Mexico

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ABSTRACT

This report documents the results of archeological data recovery and construction monitoring at four archeological sites located on the Central New Mexico (CNM) campus in Rio Rancho, Sandoval County, New Mexico. The work was performed by the Office of Contract Archeology, University of New Mexico (OCA/UNM) as a follow-up project to the Class III OCA survey of the 40-acre parcel of CNM-owned land. That survey documented six archeological sites and 12 Isolated Occurrences. Four of the sites, including LA 158640, and LA 158641, were recommended as eligible for the nomination to the National Register of Historic Places under Criterion “d” of 36 CFR 60.4. The eligibility of LA 158642 and one other site could not be determined from the surface evidence. LA 160886 is one of the 17 additional sites documented by OCA during the survey of the adjacent UNM West Side Campus.

Fieldwork at LA 158640 and LA 158642 was performed between 29 August and 5 September 2008 and between 24 November and 2 December 2008 and at LA 158641 the work was completed between 15 and 18 June, 2009. OCA’s construction monitoring resulted in the discovery of additional cultural resources at LA 158641 and additional work at that site took place on 15 and 16 July 2009. Finally, test excavations were also performed at LA 160886 between 15 and 20 July, 2009.

Of the four sites, LA 160886 appears to be lithic procurement and workshop area while the other three sites encompass a series of discrete short-term occupations dating to the Archaic, Developmental, and Coalition/Classic periods.

ACKNOWLEDGEMENTS

The efforts and cooperation of a number of individuals have contributed to the successful completion of this report. Firstly, we are thankful to Mr. Dan Pearson of CNM Facilities Planning for contracting with the Office of Contract Archeology to perform the archeological data recovery.

OCA field crew consisted of Andrew Carrie, Joanne Gilby, David Holtkamp, Jamie Hilyard, Andrea Kontrath, Lisa Lucero, Adam Lujan, Yuichi Nakazawa, David Plaza, Shannon Porter, and Douglas Rocks-Macqueen. Brian Cribbin served as a Crew Chief during a portion of the excavations as well as during the construction monitoring phase of the project. Scott Worman provided geoarchaeological soil descriptions and Alex Kurota served as the Field Supervisor and Project Director. GIS graphics and feature drawings were produced by Ron Stauber, Adrienne Actis and David Holtkamp.

The various artifact analyses were performed by the following specialists: Matthew O'Brien-lithic analysis, David Holtkamp-ground stone analysis, Connie Constan-ceramic analysis, Robin Cordero-faunal analysis, and Pamela McBride-macrobotanical analysis. Chronometric dates were provided by Beta Analytic, Inc. (radiocarbon dating).

In the office, our Unit Administrator Donna Kay Lasusky provided administrative support and produced the project's final report documents. Finally, the project's Principal Investigator Patrick Hogan offered numerous thoughtful insights and guidance during the fieldwork and also participated on the report write-up and the overall research synthesis.

We are very grateful to all these individuals and institutions for their enthusiasm and hard work which altogether have brought this research into a successful conclusion.

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Chapter 1

INTRODUCTION

by Patrick F. Hogan and Alexander Kurota

This report presents the results of excavations at four archeological sites and construction monitoring by the Office of Contract Archeology, University of New Mexico (OCA) on the Central New Mexico Community College (CNM) campus in Rio Rancho, Sandoval County, New Mexico (Figure 1.1). The campus is a 40-acre parcel of CNM-owned land located in the Rio Rancho City Center (Tracts 1-B and 7 in Section 36, T13N, R2E, Loma Machete, NM 7.5 min quad [35106-C6, 1990]). An intensive cultural resources inventory survey of the parcel completed by OCA/UNM in February 2008, resulted in the discovery of six archeological sites and 12 Isolated Occurrences (Kurota and Chapman 2008; NMCRIS Activity Number 109197). Four of the sites documented during that survey, including LA 158640 and LA 158641, were recommended as eligible for nomination to the National Register of Historic Places under criterion *d* of 36 CFR 60.4. The eligibility of LA 158642 and one other site could not be determined from the surface evidence. LA 160886 is one of 17 additional sites documented by OCA during survey of the adjacent UNM West Campus (Kurota and Hogan 2009; NMCRIS Activity No. 111622).

The excavations were conducted by OCA under contract with CNM to mitigate damage to the sites resulting from Phase 1 construction of the CNM Rio Rancho campus. As originally planned, Phase 1 would involve construction of a classroom building, parking lot, and drainage facilities in the area south of a tributary arroyo of Arroyo de la Baranca that runs northwest to southeast through the campus. Two archaeological sites, LA 158640 and LA 158642, were located within the construction area. Data recovery was proposed at both sites prior to construction, with subsequent monitoring of ground disturbance in the vicinity of the sites during site preparation and utility installation. A data recovery and monitoring plan was prepared and submitted in July 2008 (Hogan and Herhahn 2008).

Fieldwork at LA 158640 and LA 158642 was completed between 29 August and 5 September 2008, and between 24 November and 2 December 2008. The excavations were conducted under New Mexico Cultural Properties Review Committee Project-Specific Permit No. SE-270. Patrick Hogan was Principal Investigator for the project. Alex Kurota was the Project Director and field supervisor for this phase of work. The excavation crew consisted of Joanne Gilby, David Holtkamp, Adam Lujan, Yuichi Nakazawa, Shannon Porter, and Douglas Rocks-Macqueen. Scott Worman was the geoarchaeologist for the project.

A preliminary report of these excavations was submitted to the New Mexico Historic Preservation Division in January 2009 (Hogan and Kurota 2009) to obtain cultural resources clearance for the construction. In May, however, the construction plans were modified to include a temporary overflow parking area on University of New Mexico land adjacent to the CNM campus. Construction of this parking area would directly impact a third site, LA 158641. The data recovery plan was therefore modified and an amendment to our excavation permit was obtained to include data recovery at LA 158641. Excavations at the site were conducted between 15 and 18 June. Patrick Hogan was the field supervisor, with Brian Cribbin serving as Crew Chief. Crew members varied by day but included Andrew Carey, Jaime Hilyard, Andrea Kontrath, Lisa Lucero, Adam Lujan, David Plaza, and Douglas Rocks-MacQueen.

Construction monitoring began on 1 July under the supervision of Brian Cribbin and continued intermittently until 16 July. No additional cultural materials were uncovered at LA 158640 or LA 158642 but possible features were encountered in the immediate vicinity of LA 158641, necessitating additional work at the site on 15 and 16 July. During their initial meeting with the construction crew, the monitors were also informed that the final drainage plan for this part of the campus called for re-contouring of the ridge slope to the south of LA 158641, which would impact one other site on UNM land, LA 160886.

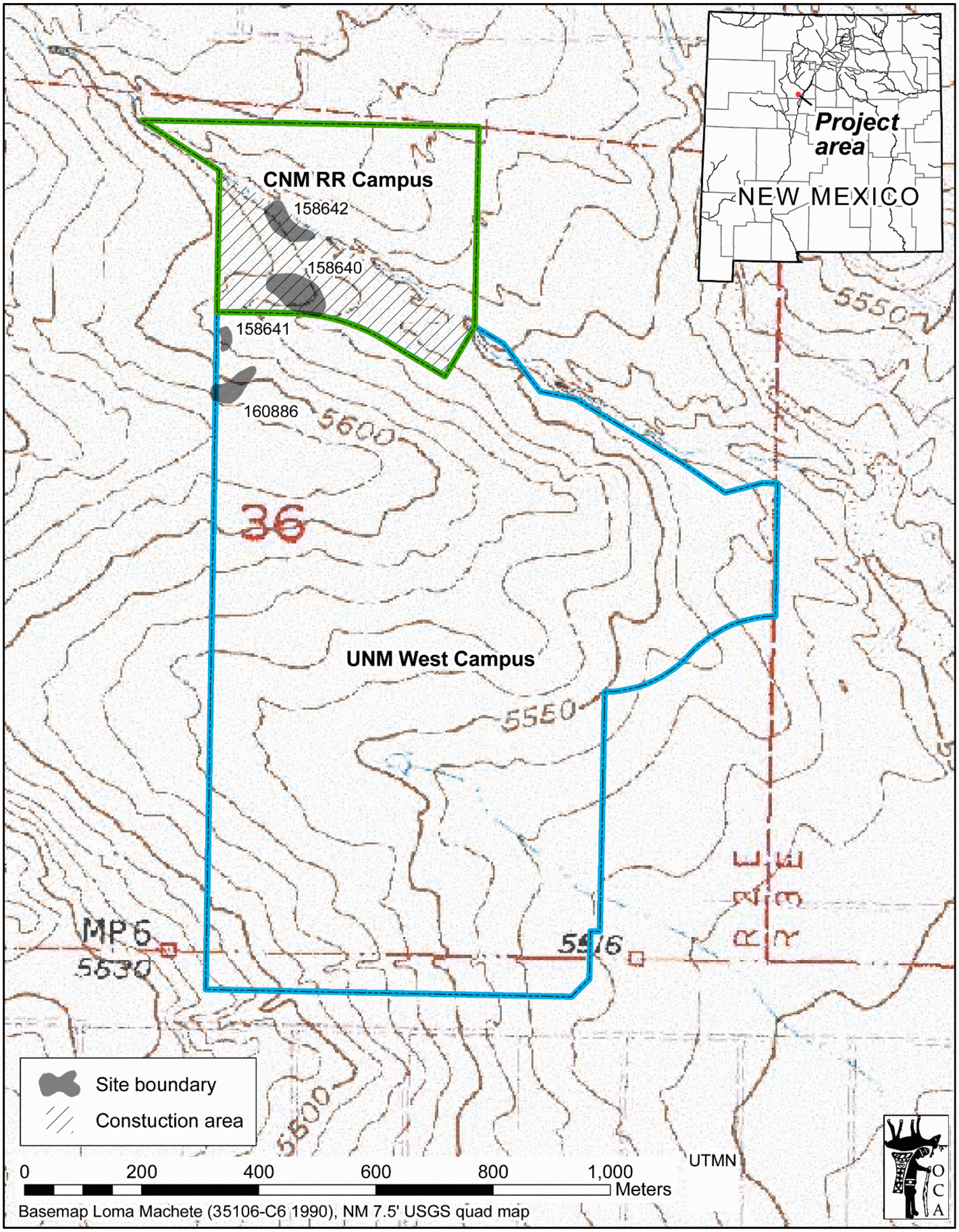

Figure 1.1. Project location map.

Although the lithic scatter at LA 160886 appeared surficial, there was a possibility that features or other cultural materials at the site had been buried by recent aeolian deposits. The survey crew therefore recommended subsurface testing to assess the integrity and information potential of the site before making any recommendation concerning National Register eligibility. The test excavations were conducted under New Mexico Cultural Properties Review Committee General Permit No. NM-09-017-T and in accordance with an approved testing plan. The fieldwork was completed between 15 and 20 July 2009. Brian Cribbin was the field supervisor and the crew consisted of Jaime Hilyard, Andrea Kontrath, Adam Lujan, and David Plaza. As no features or intact cultural deposits were found at the site, the site did not appear to meet the criteria for National Register eligibility. The SHPO concurred with this recommendation, and no further work was conducted at the site.

Of the four sites investigated, LA 160886 appears to be a lithic procurement and workshop area. The other three sites encompass a series of discrete short-term occupations dating to the Archaic, Developmental, and Coalition/Classic periods. As such, the excavations provided important information about pre-contact settlement and subsistence patterns on northern Ceja Mesa.

Chapter 2

ENVIRONMENTAL SETTING

by Patrick F. Hogan and F. Scott Worman

The CNM Rio Rancho campus is located in the northeastern part of the Llano de Albuquerque or Ceja Mesa, a constructional remnant separating the Rio Grande and Rio Puerco valleys. This part of the mesa generally slopes downward to the southeast, toward the Rio Grande valley. It is characterized by a rolling terrain of low hills and ridges incised by intermittent tributaries of the Rio Grande. The nearest named drainage, Arroyo de la Barranca, is situated about 500 m to the east of the project area and an unnamed tributary of that arroyo runs northwest to southeast through the center of the campus. Elevations within the project area range from 1707 to 1695 m. The terrain rises to the north, reaching an elevation of 1847 m at the headwater of Arroyo de la Barranca, and to the west toward Loma Duran (1774 m) on the divide between the Arroyo de la Barranca and Arroyo de los Montoyas drainage basins.

GEOLOGY AND SOILS

Bedrock in the study area consists of the gravel, sand, and mudstone of the Santa Fe Group, locally the Ceja Formation, emplaced from the Miocene to the lower Pleistocene (Personius *et al.* 2000). The uppermost unit of these thick fluvial deposits is sandy gravel, 5–10 m thick, which forms a cap on some hilltops in the vicinity. Rock types present in the unit include vesicular basalt, granite, sandstone, fossiliferous limestone, quartz, chalcedony (Pedernal chert), ironstone, jasper and petrified wood. Outcrops of these gravels were accessed during the pre-Hispanic era as sources of raw materials used to make flaked and ground stone tools. The sites are located at an elevation roughly 120 m above the historical floodplain of the Rio Grande. They are higher than the Lomatas Negras Formation so it is very unlikely that there are any outcrops of the Post-Santa Fe Group gravels in the immediate vicinity.

The soil in the study area is mapped as the Grieta fine sandy loam, a well-drained soil that formed largely in aeolian deposits. The reference description states that the soil is present on linear slopes of 1 to 4 percent, it has moderate available water capacity, the depth to the water table or restrictive features is more than 80 inches, there is no potential for flooding or ponding, it is non-saline, and the maximum calcium carbonate ($CaCO_3$) content is 20%. The reference profile notes fine sandy loam at 0–3 in, fine sandy loam from 3–11 in, sandy clay loam at 11–34 and 34–48 in, and loamy sand from 48–60 in (NRCS 2010). Although it is characterized as unsuitable for agriculture, the presence of a buried sandy clay loam layer suggests that agriculture might have been possible and dense stands of native plants would occur wherever the topography concentrated water. The fine-textured layer would form an aquitard, creating a perched water table below the depth of rapid evaporation but within reach of the roots of many common crops and economically important wild plant resources.

After deposition, roughly two and a half million years of erosion reshaped the surface of the Santa Fe Group deposits. Much of the area subsequently was covered by aeolian sand sheets during the later Pleistocene – Holocene, forming the present-day topography. Surficial sediments are ubiquitous in the area of the sites, suggesting that it is blanketed by Pleistocene – Holocene sand deposits in addition to the thinner layer of recent aeolian sand that covers the vast majority of the Albuquerque basin west of the river. Archaeological deposits clearly are obscured by this thin layer, and additional deposits may be more deeply buried in the vicinity of the sites. The CNM Rio Rancho campus is located several hundred meters to the north of several of the study loci examined along the Paseo del Volcan corridor by Hall (2006, 2008), suggesting that some tentative correlations to his dated depositional units may be possible.

CLIMATE AND PALEOCLIMATE

The climate in the excavation area is continental and semi-arid. Annual precipitation in Albuquerque averages 22 cm, with July and August being the peak rainfall period. Spring is usually the driest season, while fall and winter are typically periods of moderate precipitation. Average daily maximum and minimum temperatures during January, the coldest month, are 8.2º C and –5.7º C, respectively. During the hottest month, July, average maximum and minimum daily temperatures are 32.2º C and 14.6º C. The average frost-free period is 203 days (Tuan et al. 1973; WRCC 2008). The growing season averages 180 days in the Albuquerque District for frost-sensitive plants such as corn (Cordell 1978:146, Map 5).

Climatic conditions have fluctuated during the Holocene and those changes almost certainly influenced human land use practices in the region. Paleoenvironmental research on the Llano de Albuquerque has focused primarily on investigations of alluvial and aeolian deposits that are somewhat ambiguous indicators of climate owing to the complexity of the geomorphological processes involved (see Chapter 3, this volume). Grissino-Mayer (1995) provides a detailed reconstruction of precipitation for the past two millennia based on the long tree-ring sequence from El Malpais National Monument but Petersen's (1988) La Plata Mountain pollen record remains an important source of paleoclimatic data for the Archaic period.

Apart from its high resolution, Petersen's analysis is particularly useful because he employs three indices to reconstruct different aspects of the paleoclimate. First, pollen ratios from the Twin Lakes core evidence changes in the upper spruce treeline, which provides an indicator of summer temperatures over the past 9600 years. Second, pollen ratios from the Beef Pasture core indicate fluctuations in the lower spruce treeline over the past 5600 years, which correlations most closely with winter precipitation. Third, the influx of piñon pollen in the Beef Pasture core is used as an indicator of summer precipitation.

As summarized by Petersen (1988:110), the pollen record from Twin Lakes (Figure 2.1) indicates that the upper limit of spruce was below the long-term mean at 10,000–8600, 8000–6800, 5600, 4500, 3600, 2800, 1400, and 750–150 radiocarbon years (rcy) BP. Based on analog with the late 1800s, Petersen suggests that a narrow spruce zone result from cooler and possibly drier conditions than at present. High timberlines are evident at 8600–8300, 7600–5900, 4300–4000, and 2200 rcy BP. Petersen suggests that these intervals were characterized by warmer summer temperatures, broadly analogous to those of the 1920s.

Except for the 5600 BP interval, which falls within the later Altithermal drought as defined by Benedict and Olsen (1978), periods of low timberline in the La Plata Mountains are correlated with intervals of glacial activity in the Colorado Front Range (Benedict 1973, 1981). In the southern Sangre de Cristo Mountains, there is evidence for cirque glaciation at 10,000–9800 and 3750–3600 rcy BP, and for periglacial events at 4900, 2750, and 120 rcy BP (Armour et al. 2002). No glacial activity is evident during the cool intervals at 8000–6800 and 5600 rcy BP, however, possibly indicating that the climate in northwestern New Mexico was either somewhat warmer or relatively dry, or both, during those periods.

Dated krummholz fragments from Lake Emma (Cararra et al. 1984), a small cirque lake in the San Juan Mountains, provide corroborative evidence for the two earliest of Petersen's warm periods. The radiocarbon dates for those fragments cluster at 9600, 8900–8300, 8000–7800, and 6600–5500 rcy BP and indicate periods when the upper treeline was at least 70 m above it modern limit. Cararra and colleagues (1984:53) estimate that a rise in July temperatures of 1° C above modern averages would be more than sufficient for effect this timberline advance. Nevertheless, the Twin Lakes pollen ratios suggest that treelines were higher and summer temperatures somewhat warmer during the early and middle Holocene warm intervals than at any other time in the past 10,000 years.

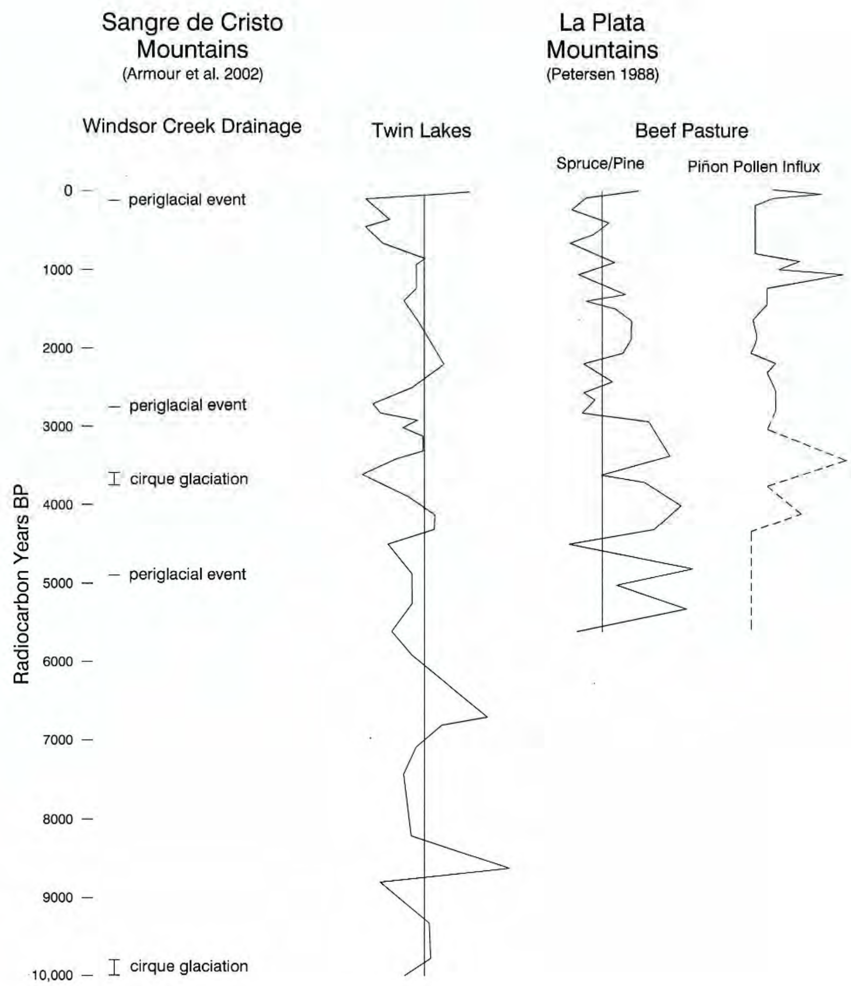

Figure 2.1. Proxy measures showing Holocene climatic fluctuations in northwestern New Mexico. From left to right, glacial activity in the southern Sangre de Cristo Mountains – intervals of cooler temperatures (Armour et al. 2002); conifer to non-arboreal pollen ratios from Twin Lakes showing fluctuations in upper treeline of the La Plata Mountains in southwestern Colorado – shift to right of mean line indicates higher treelines and warmer temperatures (after Petersen 1988, Figures 26 and 29); spruce/pine pollen ratios from Beef Pasture in the La Plata Mountains – shift to right indicates lower spruce boundary and higher winter precipitation (after Petersen 1988, Figures 27 and 29); piñon pollen influx at Beef Pasture – right peaks indicate more piñon and higher summer precipitation (after Petersen 1988, Figures 22 and 51).

The spruce/pine ratios from Beef Pasture (Figure 2.1) indicate that the lower spruce boundary was expanded between 5600 and 2800 rcy BP except for brief intervals at 4500 and 3600 rcy BP. Petersen interprets this evidence as indicating that winter precipitation was higher and snowpack in the La Plata Mountains, heavier than at present. There is a dramatic decline in spruce pollen influx at 2800 rcy BP, marking a retreat of the lower forest boundary and a change from closed to open forests conditions, similar to the present (Petersen 1988:110). Except for a minor peak at about 2400 rcy BP, winter precipitation remains low until about 2200 rcy BP when the lower spruce boundary again expands beyond its present boundary between about 2100-1500 rcy BP. Winter precipitation was moderate but variable at 1400–1200 BP. The Beef Pasture pollen ratios are again below the long term average between 1200 and 150 rcy BP, although there are minor peaks at ca. 950, 750, 550–450, and 350 rcy BP.

Piñon pollen in the Beef Pasture core (Figure 2.1) is used by Petersen as an indicator of summer precipitation. The influx of piñon pollen is low in the early part of the record but increase sharply beginning about 4300 rcy BP and remains high until about 3200 rcy BP. Piñon influx is generally low after 3000 rcy BP except for a peak between 1250 and 750 rcy BP and a brief spike at about 60 rcy BP, which was probably truncated by land clearing for agriculture in the late 19th and early 20th centuries (Petersen 1988:87, 93, 111).

Petersen argues cogently that the early peak in piñon pollen influx in the Beef Pasture core marks the expansion of piñon into southwestern Colorado and southeastern Utah in response a strengthened summer monsoon pattern (1988:88–92), while the later peaks correspond respectively to the period of Anasazi settlement in the Four-Corners region and the expansion of dry farming in southeastern Colorado by American settlers. It is therefore reasonable to expect that periods of increased summer precipitation in southeastern Colorado will also be marked by high summer rainfall in the middle Rio Grande valley. The inverse is not necessarily true, however, since a weakened monsoon system might still bring rain to the middle Rio Grande when summers are dry in southeastern Colorado.

As noted by Petersen, the evidence from packrat middens indicates that piñon was well established in the Chaco Canyon area by about 8000 rcy BP and it is ubiquitous all later middens until about 1200 rcy BP. There is a sharp reduction in piñon between 1200 and 500 rcy BP, but Betancourt (1990:265–266) attributes this reduction more to wood depletion by the inhabitants of Chaco Canyon rather than any climatic shift. Consequently, the Beef Pasture record may not be a reliable indicator for periods of low summer rainfall in the middle Rio Grande Valley.

The Malpais Long Chronology (MLC) provides a very-high resolution reconstruction of annual precipitation over the past 2000 years, and that tree-ring record appears directly applicable to Ceja Mesa and the middle Rio Grande valley (Grissino-Mayer 1995). Although annual data are available, discussion here is limited to the long-term (>100 year) trends identified in the record. As shown in Figure 2.2, Grissino-Mayer (1995:96) identifies interval of above normal precipitation at AD 81–257, AD 521–660, AD 1024–1398, and AD 1791–1992. Intervals of below normal precipitation occur at AD 1–81, AD 258–520, AD 661–1023, and AD 1399–1790.

In discussing this temporal patterns, Grissino-Mayer (1995:132–133) notes that the period of above normal precipitation between AD 1024 and 1398 (AN-3) corresponds very closely with the generally acknowledged dates for the Medieval Warm Period. He cites Petersen's pollen data as indicating that summer and winter precipitation were both high for most of this period, but fails to mention that there is also a minor peak in the Twin Lakes conifer to NAP ratio (Petersen 1988:73), suggesting that summer temperatures were relatively warm during the first half of this period. Similarly, the interval of below average precipitation at AD 1399–1790 (BN-4) corresponds to the Little Ice Age (Grissino-Mayer 1995:133–134) and supports Petersen's conclusion that the climate during this period was not only cold but dry.

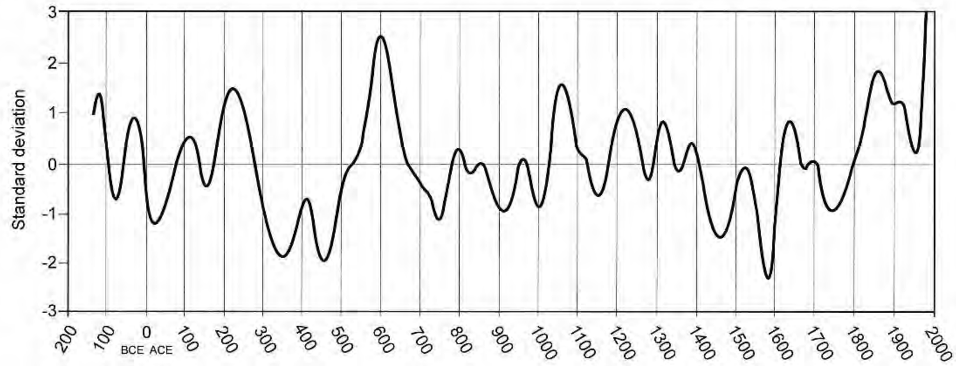

Figure 2.2. Reconstructed long-term, July-July precipitation trends based on 100-year spline of Malpais Long Chronology (MLC) tree-ring data (after Grissino-Mayer 1995, Figure 3.10). Portion of curve above line indicates intervals of above-average precipitation.

VEGETATION

Vegetation in the project area is variously mapped as transitional Great Basin Grassland (Brown 1994) and Plains-Mesa Sand Scrub (Dick-Peddie 1993). It is dominated by grama grass (*Bouteloua* sp.) and galleta grass (*Hilaria jamesii*) with lesser amounts of ricegrass (*Oryzopsis hymenoides*) and dropseed grass (*Sporobolus* spp.). Sand sage (*Artemesia filifolia*) and snakeweed (*Gutierrezia sarothrae*) are the most prominent shrubs and, on some ridge slopes, they are co-dominant with the grasses. Four-wing saltbush (*Atriplex canescens*) and winterfat (*Ceratoides lanata*) are common, as are soapweed yucca (*Yucca angustissima*), prickly pear cactus (*Opuntia* spp.), and cholla (*Opuntia imbricata*). A few scattered junipers (*Juniperus monosperma*) are also present, generally on or at the base of hill slopes.

Working from Tierney's (1979) botanical inventory for Cochiti Reservoir, Dello-Russo (1999:61–67, 222) identified edible wild plants that may have been exploited by pre-contact Native American groups on the Llano de Albuquerque (Table 2.1). He emphasizes that the plants on the list exhibit a strong seasonal dichotomy. That is, most edible greens, buds, bulbs, and berries are available during the spring and early summer (April through June) while most of the edible seeds, fruits, stems, and joints are available during the late summer and fall (mid-August through early October). Some seeds, notably tansy mustard and ricegrass, are available in late spring-early summer, however.

Dello-Russo also ranks a subset of the plant resources in terms of harvest rates and post-encounter return rates using quantitative data provided by Tierney (1979) and Simms (1987). Based on those rankings, he predicts that, in the spring, yucca buds and stipes and tansy mustard seeds would be harvested by foragers before lower-ranked resources like wafer parsnip and ricegrass. In the fall, the rankings suggest that cactus fruits and the seeds from four-wing saltbush and similar shrubs would be targeted first but that lower-ranked seeds such as chenopod and amaranth may have been harvested for winter storage (Dello-Russo 1999:65). Caloric return rate estimates by Hudspeth (1997) suggest a similar ranking for spring and fall resources (Table 2.2).

Table 2.1. Edible Plants and Estimated Seasonal Availability on the Northern Llano de Albuquerque (modified from Dello-Russo 1999:Table C1 and Tierney 1979:Table 2.2).

Scientific Name	Common Name	Edible Parts	Season
Trees			
Juniperus monosperma	one-seeded juniper	fruit	Sep 21 – winter
Pinus edulis	Colorado piñon	nuts	after Sep 15
Shrubs			
Artemisia filiafolia Torr.	sand sage	seeds	Aug 22 – Sep 22
Atriplex canescen	four-wing saltbush	leaves seeds	after Apr 6 Sep 13 – Oct 12
Dalea scoparia Gray	false indigo bush	seeds?	Oct 12
Lycium pallidum Miers.	wolf berry	fruits	---
Yucca angustissima	soapweed or narrow-leaf yucca	stipe buds fruits	May 5 May 27 after Jun 15
Cacti			
Opuntia clavata Engelm.	club cholla	joints and fruits	Aug 28 – winter
Opuntia imbricata	cholla	joints fruits	Jun 9-24 Aug 15 – Sep 15
Opuntia phaeacantha	Plains prickly pear	joints and fruits	Sep 13
Opuntia polycantha	prickly pear	joints and fruits	Aug 28 – winter
Grasses			
Bouteloua gracilis Lag.	curly grama	seeds	after Sep 22
Oryzopsis hymenoides	ricegrass	seeds	Jun 9
Sporobolus airodes Torr.	alkali sacaton	seeds	Sep 22
Sporobolus cryptantha	sand dropseed	seeds	Aug 22 – Sep 5
Herbs and Forbs			
Allium macropetalum	wild onion	bulb	May 5 – May 27
Amaranthus albus L.	pigweed	greens seeds	--- Sep 13
Artemesia dracunculoides	false tarragon	leaves	Apr 6 – summer
Castilleja integra Gray	paint brush	flowers	Jun 24 – Aug 15
Chenopodium fremontii	Fremont goosefoot	greens and seeds	Aug 25 – Sep 13
Chenopodium graveolens	goosefoot	seeds	Sep 13
Chenopodium leptophyllum	goosefoot	leaves and seeds	Aug 25 – Sep 21
Chenopodium incanum	goosefoot	greens seeds	Apr 26 – May 27 Aug 22 – Sep 21
Circum neomexicana Gray	thistle	roots stems seeds	--- May 27 – Jun 6 Aug 22 – Sep 21
Cleome serrulata Pursh.	Rocky Mountain beeweed	leaves seeds	Apr 26 – May 27 late June – Aug 15
Cymopterus fendlerii	chimaya	roots and leaves	Apr 5 – Jun 9
Cymopterus montanus	wafer parsnip	roots and leaves	Apr 5 – May 5
Descurainia pinnata	tansy mustard	greens seeds	May 17 late June
Eriogonum deflexum	skeleton weed	seeds and stems	August
Eriogonum effusum Nutt.	buckwheat	seeds and stems	Aug 25
Helianthus annuus	sunflower	seeds	Sep 5 – Sep 22
Lesquerella intermedia	bladder pod	greens seeds	May 5 May 27
Metzelia pumila Nutt.	stick leaf	seeds	Jun 24
Mirabilis multiflora	four o'clock	roots	all year
Physalis fendlerii Gray	ground cherry	berries	June 6
Plantago purshii	Indian wheat	seeds	May 27
Polanisia trachysperma Torr.	clammy weed	greens seeds	Jun 9 Sep 21

Table 2.1. Continued

Scientific Name	Common Name	Edible Parts	Season
Portulaca sp.	purslane	greens seeds	Jun 9 – Aug 22 Sep 5-21
Rumex hymenosepalus Torr.	canaigre	greens and stems seeds	Apr 5, Apr 26 Jun 9
Sphaeralcea coccinea	globe mallow	buds	Jun 24
Sphaeralcea sp.	mallow	buds	August 22
Tidestromia lanuginosa	wooly tidestromia	seeds	Sep 13

Table 2.2. Caloric Return Rate Estimates for Selected Edible Plants Available on the Northern Llano de Albuquerque (modified from Hudspeth 1997:Table 23.1).

Scientific Name	Common Name	Plant Part	Return Rate (cal/hr)
Pinus edulis	Colorado piñon	nuts	841–1408[1]
Descurainia pinnata	tansy mustard	seeds	1307[2]
Atriplex canescen	four-wing saltbush	seeds	1200[2]
Opuntia spp.	prickly pear	fruits	1000–2000[3]
Yucca spp.	yucca	fruits	1000–2000[3]
Juniperus scopulorum	Rocky Mountain juniper	fruit	1000–2000[3]
Speralcea coccinea	globemallow	fruits	1000–2000[3]
Physalis fendlerii Gray	ground cherry	fruits	1000–2000[3]
Chenopodium/Amaranthus	cheno-ams	greens	500–1000[3]
Helianthus annuus	sunflower	seeds	467–504[2]
Oryzopsis hymenoides	ricegrass	seeds	301–392[2]
Cleome serrulata Pursh.	Rocky Mountain beeweed	seeds	300–400[3]
Sporobolus spp.	dropseed	seeds	162–294[2]
Chenopodium spp.	goosefoot	seeds	200–300[3]
Amaranthus spp.	pigweed	seeds	200–300[3]
Portulaca oleracea	purslane	seeds	200[3]

1 - caloric return rate calculated for different species within genus, Simms (1987)
2 – caloric return rate calculated by Simms (1987)
3 – caloric return rate estimated by Hudspeth (1997)

FAUNA

Common mammalian fauna on the mesa-top include cottontail rabbit (*Sylvilagus auduboni*), blacktailed jackrabbit (*Lepus californicus*), prairie dog (*Cynomys* sp.), white-throated woodrat (*Neotoma albigula*), rock squirrel (*Spermophilus variegatus*), antelope squirrel (*Ammospermophilus leucurus*), pocket gopher (*Thomomys bottae*), kangaroo rat (*Dipodomys* sp.), mice (*Peromyscus* spp.), coyote (*Canis latrans*), and badger (*Taxidea taxus*). Mule deer (*Odocoileus hemionus*) and pronghorn antelope (*Antilocapra americana*) can be found to the north and west, and their historical ranges encompassed most of the Llano de Albuquerque. Bison and elk may also have been present during the late Archaic period (Schwendler and Railey 2009:20–21). Prairie rattlesnakes (*Crotalus viridis*), coachwhip (*Masticophis flagellum*), and bullsnake (*Pituophis catenifer*) are common reptiles, along with a variety of lizard species. Resident birds include mourning dove (*Zenaida macroura*), scaled quail (*Callipella squamata*), horned lark (*Eremophila alpestris*), road runner (*Geococcyx californianus*), western meadowlark (*Sturnella neglecta*), rock wren (*Salpinctes obsoletus*), canyon towhee (*Pipilo fuscus*), rufus-crowned sparrow (*Aimophila ruficeps*), burrowing owl (*Athene cunicularia*), great horned owl (*Bubo virginianus*), red-tailed hawk (*Buteo jamaicensis*) and northern harrier (*Circus cyaneus*) (Brown 1994; Hacker 1977).

Simms (1987:47) provides caloric return rate estimates for some of these taxa (Table 2.3). In optimal foraging theory, the diet breadth model predicts that food resources are added to the diet in rank order of their net return rate until a maximum return rate per unit of foraging time is achieved (Bettinger 1191:84–87; Kelly 1995:78–90). Based on the estimated return rates in Tables 2.2 and 2.3, it is expected that foragers on the Llano de Albuquerque would have taken large game whenever encountered and that rabbits and the larger rodents would have been part of the diet as their ranking is higher than any of the potential plant resources found in the area.

Table 2.3. Caloric Return Rate Estimates for Selected Animals Available on the Northern Llano de Albuquerque (modified from Simms 1987:Table 4).

Scientific Name	**Common Name**	**Return Rate (cal/hr)**
Odocoileus hemionus	mule deer	31,450–17,971
Antilocapra americana	pronghorn	31,450–15,725
Lepus californicus	black-tailed jackrabbit	15,400–13,475
Thomomys spp.	gophers	10,780–8983
Sylvilagus auduboni	desert cottontail	9088–8983
Spermophilus spp.	large ground squirrels	6341–5390
Spermophilus tridecemlineatus	13-lined ground squirrel (small)	3593–2837

Chapter 3

GEOLOGY AND GEOMORPHOLOGY

by F. Scott Worman

This section provides a brief overview of the geology and geomorphology of the northern Albuquerque basin west of the Rio Grande and adjacent portions of the Rio Puerco drainage. This information may be useful in the context of archaeological investigations in several overlapping ways:

1. Understanding long-term landscape changes in order to characterize the post-depositional processes that may have impacted archaeological sites and materials in various ways.

2. Identifying areas in which sites are likely to be buried or visible at the surface based on the ages of the geomorphic surfaces and the processes that have affected them.

3. Characterizing local resources such as lithic raw materials, water, or arable soil that may have been accessed in the past, and inferring likely site function(s) from those characterizations.

4. Building predictive models or sampling strategies for investigating the archaeological record that account for variable visibility and preservation of archaeological materials.

5. Managing cultural resources threatened by erosion, land use, or other landscape change.

6. Contributing to differentiating among possible causes of landscape and ecological change in the past, including anthropogenic, climate-driven and the complex response of geomorphic systems.

7. Evaluating the proposed ages of different temporally diagnostic artifacts where those ages are based on recovery from particular geological or stratigraphic contexts[1].

The overview includes a description of the geomorphology of the study area, followed by a discussion of the geological context, soils, and landscape changes during the Holocene.

GEOMORPHIC SETTING

The study area considered here includes the northern Albuquerque basin west of the Rio Grande (in particular the northern half of the Calabacillas sub-basin and portions of the Santo Domingo sub-basin to the northeast) and the adjacent segment of the Rio Puerco drainage to the west. It is bordered on the east by the Rio Grande, on the west by the Rio Puerco, on the north by the valley of the Rio Jemez, and on the south to the basalt flows associated with the Albuquerque Volcanoes. It is located at the extreme northern terminus of the Mexican Highlands portion of the Basin and Range physiographic province; adjacent to the easternmost extension of the Colorado Plateaus province, near the border between the Mount Taylor and San Juan Basin portions; and south of the Jemez portion of the southernmost extent of the Southern Rocky Mountains province (Fenneman 1931; Bryan and McCann 1937: Figure 1).

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[1] This is pertinent here in that the proposed ages of many Archaic period projectile point types are based on recovery from various strata exposed in the Rio Puerco drainage basin (e.g. Chapin 2005: Chapter 3; Irwin-Williams 1973).

As summarized recently by Sean Connell and colleagues (Connell 2004, Connell *et al.* 2005, Maldonado *et al.* 1999), the Albuquerque Basin covers 7925 km^2, extending approximately 160 km north–south and narrowing from about 55 km east – west in the north and central portions to 12 km east–west at the southern boundary. It marks the southern limit of the northern contributory section of the Rio Grande, that section in which the river generally increases in size and flow volume from upstream to downstream. Within the basin, topography is characterized by broad mesas and valleys with relatively low relief. Relief is greater in the adjacent portions of the Rio Puerco drainage to the northwest where the steeper valleys are bordered by basalt-capped mesas and punctuated by several dozen volcanic necks and dikes that form dramatic spires and narrow mesas (French *et al.* 2009; Nials 1991, 2003).

At the eastern margin of the study area and adjacent to the modern river channel is the historical floodplain of the Rio Grande. The river incised as much as a few 10's of meters below its current level during the last glacial maximum between 15 and 22 thousand year ago (ka) and has generally been aggrading since that time (Connell and Love 2001). The historical floodplain was a geomorphically active surface until dams, levees, and other measures effectively confined the river to a single, incised channel in the second half of the 20th century. Due to flood control projects, the former floodplain is "now a terrace, because although it is only 1 to 2.5 meters above the active channel, it is no longer subject to active flooding and sedimentation" (Bailey 2004:vii).

Moving westward from the Rio Grande in the vicinity of Rio Rancho, the landscape ascends a long, gentle slope dissected by numerous arroyos formed by ephemeral tributary streams (Kelley 1977). In many places, the slope is interrupted by two and sometimes three river terraces that are variably present west of the Rio Grande between Bernalillo and Belen (Connell 2004; Connell *et al.* 2007; Connell and Love 2001; Kelley 1977; Lambert 1968; Maldonado *et al.* 1999). The terraces were formed as the ancestral Rio Grande episodically incised and then partially filled its valley as many as five times (two additional terraces are tentatively identified east of the river). The earliest aggradation that left recognized deposits began in the early Pleistocene between 1.3–0.7 million years ago (Ma) and the cycles continued until the latest Pleistocene (Connell and Love 2001). The cycles of entrenchment and backfilling most likely were caused by glacial—interglacial climate changes (Connell *et al.* 2005). Apart from ongoing uncertainty concerning the exact ages of the landforms along the Rio Grande, moving away from the river each successively higher terrace is older. Cross-cutting relationships and carbonate morphology observed in soils formed on the youngest terrace constrain its age to between 71–28 thousand years ago (ka) (Connell and Love 2001). Each of the terrace surfaces above the historical floodplain therefore antedates human occupation of the New World.

Above the uppermost terrace, and outside the Rio Grande valley in the strict sense, is the Llano de Albuquerque or Ceja Mesa, a prominent mesa separating the Rio Grande and Rio Puerco valleys that is as much as 19 km wide to the north but narrows to less than 5 km wide at its southern terminus near Bernardo (Love *et al.* 1982). It slopes gently southward, and is 250 to 100 m above the Rio Grande. The landform was initially identified as the Llano de Albuquerque by Kirk Bryan, who interpreted it as a part of a widespread erosional surface, the Ortiz pediment (e.g. Bryan and McCann 1938). In the first comprehensive overview of the geology of the Albuquerque basin, however, Kelley (1977; but see also Bryan 1909 for an earlier overview more specifically of the Albuquerque area) referred to it as Ceja Mesa although he retained Bryan's interpretation of its origin.

More recent studies (Connell 2004; Connell *et al.* 2000; Maldonado *et al.* 1999. 2000) have shown that the Llano de Albuquerque is not an erosional feature. Rather, it is a remnant basin-plain, a constructional surface associated with the ancestral Rio Puerco and Rio San Jose stream systems. Deposition was time-transgressive, and the surface of the northern portion likely is significantly older than the southern parts. As a result, the northern part of the mesa top is somewhat more rugged, being dissected by numerous drainages, while the southern portion is generally flat aside from several fault scarps that trend roughly northward across the entire surface. The plain became a mesa when the depositional surface was abandoned by the river systems as the Rio Grande and its tributaries began to incise in the Albuquerque basin after approximately 2.6 Ma. In the current literature, the landform usually is identified as the Llano de Albuquerque or the Llano de Alburquerque, the latter spelling reflecting the supposed original Spanish spelling of the place-name (e.g. Maldonado *et al.* 1999).

West of the Llano de Albuquerque, the landscape descends to the Rio Puerco. South of the study area, there is a series of two and often three terraces, originally identified by Bryan, which may correlate with those along the Rio Grande (Bryan and McCann 1937, 1938; Connell *et al.* 2007; Kelley 1977; Love *et al.* 1982; Nials 1991, 2003; Wright 1946). In the northern Albuquerque basin, though, the landscape slopes gently downward to the west of the Llano de Albuquerque. Based on its position, the high, gently-sloping surface – Bryan's Ceja del Rio Puerco (Bryan and McCann 1937, 1938) – is probably an erosional landform that was shaped as the Rio Puerco began to incise. This erosional geomorphic surface continues past the fault zone where the alluvium filling the Albuquerque basin meets the older bedrock exposed outside the basin to the northwest. In the northwest portion of the study area, beyond that intersection, the erosional surface is overlain by the basalt flows that cap Mesa Prieta, flows related to the Mount Taylor volcanics (Nials 1991, 2003). West of Mesa Prieta, the landscape falls steeply to the Rio Puerco, with the locations and elevations of intervening surfaces largely determined by geological structure (i.e., the presence of faults and bedrock units resistant to weathering).

The terrace surfaces, the Llano de Albuquerque, and Mesa Prieta are all older than accepted dates for the earliest human presence in the Americas. The ages of the landforms imply that archaeological deposits from all time periods should be present at and near the surface. The long-term stability of the surfaces also suggests that archaeological materials are likely to have been impacted by post-depositional processes such as bioturbation that are most significant in the "biomantle", that near-surface zone in which the vast majority of burrowing animals and insects are most active (Johnson *et al.* 1987). Locally, archaeological materials on these stable surfaces may be buried by or present in or on more recent aeolian deposits, as discussed in greater detail below in the consideration of landscape changes during the Holocene.

GEOLOGICAL CONTEXT

As a bedrock feature, the Albuquerque basin is a wide, deep, and well-defined graben, an extensional basin that formed as part of the Oligocene-age, intracontinental Rio Grande rift system (Connell 2004). It is the second largest structural basin of the Rio Grande rift after the San Luis Valley of southern Colorado (Connell *et al.* 2005). It is surrounded on all sides by significant faults and fault systems and is bordered on the east by the Ortiz, Sandia, Manzanita, Manzano, and Los Pinos mountains and on the west by the higher-elevation San Juan Basin, the Colorado Plateau, and the Ladron Mountains and Sierra Lucero. The Albuquerque basin is filled in most locations by hundreds of meters of alluvium; the geologic studies most relevant to archaeological questions are the descriptions of the lithology of the different depositional units exposed at the surface. These provide an initial indication of the areas that might have been accessed as sources of raw materials for manufacturing stone tools.

In the northwest portion of the study area, outside of the Albuquerque Basin, the Rio Puerco valley follows the Rio Puerco Fault Zone, one of the fault zones bordering the Rio Grande Rift. The Rio Puerco Fault Zone may be of some relevance to archaeology (for example, in predictive modeling) in that bedrock structure and faulting largely control the locations of valleys and springs in the portions of the Rio Puerco valley considered here (Nials 1991, 2003). In that area, the river and its tributaries cut through upper Jurassic–Cretaceous shales and sandstones that locally are capped by Plio-Pleistocene basalts (Wright 1946). In some locations the basalts are particularly fine-grained or vesicular, providing potential sources of raw materials for manufacturing flaked or ground stone tools, respectively. Some of the underlying sedimentary units, notably the Dakota Formation, yield clays suitable for pottery manufacture, but they generally are lacking in materials useable for flaked stone tools. The Jemez Lineament also crosses that northwest portion of the study area, trending to the northeast. It is a basement rock structural feature that penetrates the lithosphere, and it gave rise to the volcanism at Mount Taylor and in the Jemez Mountains. Both loci, outside the study area, are sources of high-quality obsidian used to manufacture flaked stone tools. The most likely source of fine-grained siliceous stones in the northwest portion of the study area is the alluvium deposited in the valleys of rivers and streams that drain adjacent areas in the Sierra Nacimiento, Jemez Mountains, the uplands around Mount Taylor, and the San Juan Basin.

In the early 20th century, Kirk Bryan (1909) was among the first scholars to divide the sediments filling the Albuquerque basin into the older Rio Grande beds and the younger inset Rio Grande gravels, now the upper Santa Fe Group and the Post Santa Fe Group deposits, respectively. In the Albuquerque basin, the Santa Fe Group is most broadly divided into the eastern basin-margin facies, central basin facies and western basin-margin facies (Maldonado *et al.* 1999). The eastern basin-margin facies are derived primarily from the uplifts flanking the Albuquerque basin to the east of the study area, such as the Sandia and Manzano mountains.

The central basin facies occur, as the name implies, in the central portion of the basin and they were deposited by the ancestral Rio Grande. For approximately the past 2.6 Ma, since it became a through-flowing stream, the position of the river generally has moved westward in the Albuquerque basin because of deposition of sediments derived from the Sandia, Manzanita, and Manzano mountains along the mountain front and on the adjacent piedmont. The central basin facies, then, are present at the surface mostly to the east of the current river channel and the study area; the Sierra Ladrones Formation is one of the westernmost of the central basin facies and it forms the discontinuous bluffs east of the historical floodplain of the river in the Albuquerque area (Connell 2004, Connell *et al.* 2007). The Ceja Formation, which locally forms bluffs along the western margin of the historical floodplain, includes clasts carried both by the ancestral Rio Grande and by its tributaries that entered from the west; it represents a transition to the western basin-margin facies. The central basin facies include clasts transported from the Sangre de Cristo Mountains and other areas to the north. They are not notably rich in high quality lithic raw materials, but include cobbles of quartzite and well-rounded chert that could be used as raw materials for stone tool manufacture.

The western basin-margin facies were deposited primarily by the ancestral Rio Puerco and other tributary streams draining the Colorado Plateau. Typically, these facies (including the Ceja Formation) yield a wider variety of higher-quality toolstones than the eastern basin-margin and central basin facies. The western facies contain pebbles and cobbles of Pedernal (or Pedernales) chert, other multicolored, well-rounded chert and chalcedony, silicified (petrified) wood, and occasional fine-grained quartzites and basalts. Outcrops of the gravelly and cobble-rich facies would have been attractive locations for past inhabitants of the Rio Grande valley to collect raw materials for flaked stone tool manufacture. The combination of a more dissected landscape and its position closer to the surrounding uplands suggests that the western basin-margin facies in the northern portion of the Albuquerque basin are both better exposed and more likely to yield large clasts of lithic raw material than analogous facies farther to the south.

Inset against the Santa Fe Group are the younger constructional terraces and modern floodplain deposits emplaced by the Rio Grande each time it partially backfilled the valley it excavated after it became a through-flowing stream. From youngest to oldest (also lowest to highest), the geologic units comprising the terraces are the Los Padillas, Arenal, Menaul, Los Duranes, Edith, and Lomatas Negras Formations (Connell *et al.* 2007; Connell and Love 2001). The oldest of the Post Santa Fe Group deposits, the Lomatas Negras Formation, was emplaced after approximately 1.3 Ma. All of the terrace gravels therefore were deposited after the beginning of the eruptions in the Jemez Volcanic Field that produced the Cerro Toledo Rhyolites between approximately 1.59 and 1.22 Ma (Spell *et al.* 1996). The obsidian from the Cerro del Medio source is the highest-quality obsidian from the Jemez Mountains and it occurs as the largest nodules, but it is not transported beyond the caldera except by human agency. The natural availability of El

Rechuelos obsidian is also restricted to the immediate vicinity of its source – a number of small rhyolite domes near Polvadera Peak. The Rabbit Mountain and Bandelier obsidians, however, occur in outcrops of the Cerro Toledo Rhyolites along the eastern side of the Jemez Mountains and they enter the Rio Grande fluvial system as gravels and small cobbles (Steffen 2005:13–21). All of the Post Santa Fe Group terrace gravels therefore contain small quantities of this obsidian as pebbles and rare small cobbles that would have been highly valued as raw material for manufacturing flaked stone tools.

As noted above, the Los Padillas Formation underlies the historical floodplain of the Rio Grande. Because it has not been exposed to any significant degree by river incision following deposition, it is the least well-described of the Post Santa Fe Group formations. Drillhole data show that it is approximately 15–29 m thick and tends to fine upward from a gravelly base. It interfingers with and is overlain by late Pleistocene to Holocene alluvial deposits emplaced by tributary drainages, showing that it was deposited after the last glacial maximum ~15–22 ka and predominantly before the mid-Holocene. It typically is dominated by sand and locally contains both finer clayey beds and coarser gravelly to cobbly beds that include clasts of Pedernal chert, basalt, siliceous-volcanic and metamorphic stones. Observations recorded during excavations at the Alameda Pueblo (LA 421) indicate that the coarser-grained facies of the Los Padillas Formation include sub-rounded to well rounded cobbles of a wide range of material types. They are dominated by coarse-grained quartzite and basalt, with minor occurrences of granite, tuff, pumice, and sandstone, and there are rare occurrences of fine-grained quartzite, chalcedony, chert, fine-grained basalt, and small clasts of obsidian that were used for manufacturing flaked stone tools at the site. Because there are no extensive vertical exposures of this unit, collection of lithic raw materials by past residents of the valley likely was focused on river channels and chutes where erosion created large horizontal exposures of the coarse-grained facies. Presumably, opportunistic collecting also occurred that was tangential to activities such as farming that would occasionally have involved excavation of individual clasts or small exposures of the coarser-grained facies.

The Arenal Formation comprises the lowest preserved terrace above the historical floodplain of the Rio Grande. Where present, it is 3 – 6 m thick and consists of sandy gravels. Cross-cutting relationships and Stage I–II+ soil carbonate morphology (Machette *et al.* 1987; Machette 1985) suggest late Pleistocene deposition between 71–28 ka. The upper surface, 15–21 m above the Rio Grande, was identified by Lambert (1968) as the Primero Alto surface, which he suggested was correlative with Bryan's Primero Alto (Bryan and McCann 1938), the lowest terrace along the Rio Puerco. The most common cobbles in the Arenal Formation include rounded quartzite and subrounded welded tuff with smaller quantities of granite. While high quality toolstone is not common, the quartzite and rare smaller clasts of obsidian, chalcedony, and chert could have been quarried in the past as raw materials for manufacturing flaked stone tools.

The Menaul Formation, as identified by Lambert (1968), is generally less than 3 m thick and is present mostly to the east of the river at elevations 26–36 m above the historical floodplain. It is pebbly sand with generally small clasts dominated by rounded quartzite with some volcanics; it would not have been a particularly good source of lithic raw materials. Its age is not well established and clear stratigraphic relationships have not been recorded, largely due to urban development. Connell and colleagues (2007; see also Connell and Love 2001) suggests that it is a member of the Los Duranes Formation, not a separate formation, and that it was deposited during the late-middle Pleistocene.

The Los Duranes Formation is a prominent fill terrace up to 52 m thick that outcrops extensively along the inner valley, particularly to the west of the modern river channel. On the eastern side of the valley it is inset against, and therefore younger than, the Edith Formation, and its age is further constrained by stratigraphic relationships with two dated basaltic flows and by included mammalian fossils; deposition ended between 160 and 128 ka. Where it is exposed between Rio Rancho and Bernalillo, the cobbly base of the unit is resistant to erosion and forms a strath terrace approximately 6 m above the river. The upper surface of the formation, 42–48 m above the river, was designated the Segundo Alto surface by Lambert (1968), suggesting that it correlates with Bryan's Segundo Alto (Bryan and McCann 1938), the second terrace above the Rio Puerco. Although it is sand-dominated, coarse-grained intervals within the formation include rounded orthoquartzite and volcanic pebbles and cobbles, with rarer clasts of quartz, sandstone, granite, and metamorphic stones up to 8 cm in diameter. Aside from rare obsidian clasts, there are few high quality lithic raw materials in this unit.

The Edith Formation, as formally described by Connell *et al.* (2007) is present variably and occurs only along the eastern side of the valley, outside the study area. It is approximately 3–12 m thick and the basal strath is at an elevation 12–24 m above the historical floodplain. It is an upward-fining unit, with the base defined as quartzite-rich cobble gravel containing rounded orthoquartzite and volcanic rocks with rarer granite, metamorphic, and sandstone clasts. As with the Menaul Formation, the authors suggest that future data may indicate that it should be considered a member of the Los Duranes formation.

The Lomatas Negras Formation is the highest and oldest of the identified and formally described inset Rio Grande terraces. It is discontinuously present along the western margin of the Rio Grande valley at an elevation of 65–75 m above the historical floodplain. It typically is less than 5 m thick, but in some locations the thickness exceeds 20 m. Included mammalian fossils indicate deposition during the middle Pleistocene, and dated volcanic deposits and stratigraphic relationships bracket its age between 156 +/-20 ka and 1.3 Ma. The formation is characterized as pebble- to cobble-sized sandy gravel, with clasts of quartzite, volcanic rocks, granite, Pedernal chert, and sparse basalt; roughly 30% of the gravel is present as cobbles as large as 22 cm. Interestingly, the Lomatas Negras Formation is the only one of the Post Santa Fe Group terrace gravels in which the geological descriptions specifically note the presence of obsidian, in this case "Rabbit Mountain obsidian from the Jemez volcanic field" (Connell *et al.* 2007:19). The specific mention of obsidian and the relatively large size of the cobbles imply that the Lomatas Negras Formation would have been a particularly good source of raw materials for manufacturing flaked stone tools.

In summary, the Santa Fe Group and Post Santa Fe Group deposits exposed at the surface west of the current channel of the Rio Grande provide several potential sources of high-quality lithic raw material. In general, there are higher proportions of high-quality stone, and they are present as larger nodules, in those facies of the Santa Fe Group located farther to the west and northwest. Geomorphic processes no doubt have concentrated clasts of these highly resistant materials, and transported some of them eastward toward the river, in the ephemeral stream channels that drain the Llano de Albuquerque. Nearer the river, localized outcrops of the Post Santa Fe Group deposits provide spatially restricted sources of high quality lithic materials, including obsidian, that very likely were revisited during much of the prehispanic period as quarry sites. Similar high-quality lithic materials are rare east of the river, suggesting that populations residing in the valley very likely traveled westward to gather materials to manufacture stone tools.

Farther to the west, the bedrock units exposed outside the Albuquerque basin and along the valley of the Rio Puerco generally lack materials suitable for manufacturing flaked stone tools. Plio-Pleistocene basalts related to the Mount Taylor volcanics cap those units at the tops of mesas both east and west of the Rio Puerco. Localized facies of those basalts are particularly fine-grained or vesicular, and they may have been used as raw materials for manufacturing flaked or ground stone tools. The most likely source of high-quality siliceous stones for tool manufacture is the alluvium of the Rio Puerco and its major tributaries that drain the adjacent highlands.

SOILS

As discussed at some length by Vance Holliday (2004:8–19), there are several different approaches to studying soils that reflect the varied reasons people conduct the studies. Each type of research is relevant to archaeological investigations to differing degrees and in different ways. The Soil Survey Division of the Natural Resources Conservation Service (NRCS), part of the United States Department of Agriculture

(USDA), has developed detailed protocols for describing and classifying soils (Schoeneberger *et al.* 2002, Soil Survey Division Staff 1993, 1999). They have completed descriptions and maps of the soils across large parts of the United States and made the majority of their data available on line in several formats (Soil Survey Staff 2010; NRCS 2010). Their approach emphasizes the agricultural potential of soils in different areas. Geologists, particularly those focused on the Quaternary, also frequently provide descriptions of soils in the areas in which they conduct research. Typically, they use soil data to discern the approximate ages of different geomorphic surfaces and the timing, processes, or historical trajectory of landscape change. Civil engineers characterize soils in different ways in order to evaluate their stability, compaction characteristics, and suitability for various types of construction. Aside from their identifications of regions prone to episodic landslides that might have buried archaeological sites or areas with vertisols (clayey soils that swell or shrink significantly depending on moisture) where argilloturbation is likely to affect cultural deposits, their studies generally are not useful in archaeological research. As both large scale landslides and vertisols are extremely uncommon or entirely absent in the study area, civil engineering approaches to soil studies will not be considered in greater detail here.

The NRCS soil descriptions and maps are useful in archaeological research in several ways. Clearly, at a broad scale they can help to identify locations that would have been less or more agriculturally productive. At a finer scale, the formal descriptions of each soil map unit include information concerning climate, growing season length, specific impediments to agriculture, and extant plant communities, although not all mapped units are consistently described at that level of detail. These detailed data may help to identify areas with particular resources that would have been of interest to foragers as well as farmers.

Although potentially useful, two important caveats must be considered in using the NRCS data. First, the purpose of the soil mapping effort is to support modern industrial agriculture and other commercial uses of the land. The scale at which soils are mapped therefore overlooks much micro- and meso-scale variability, instead identifying large tracts of land suitable for different types of production. Unlike modern industrial agriculture, traditional agriculture in the American Southwest has often relied on a diversified strategy that took advantage of multiple crop varieties and geomorphic settings as well as highly localized edaphic conditions (e.g., Bradfield 1971; Hack 1942; Homburg *et al.* 2005; Sandor *et al.* 2007; Woosley 1980; Worman and Mattson 2010). Specifically, farmers used (and in some cases still use) a sophisticated knowledge of the landscape to identify, augment, and exploit concentrations of water and nutrients, particularly in areas with beneficial soil characteristics (see Cordero 2008 for an example from Albuquerque's West Mesa). Similarly, foragers identified and often returned to loci with particularly abundant resources; they did not build their subsistence strategies around a generalized sense of the productivity of a large area or region. Typical soil maps are not detailed enough to show all of the small areas that were or could have been used for agriculture or that might have attracted game or supported dense occurrences of edible plant resources in the past. Many areas in which the soils are shown as marginal or unsuitable for agriculture may have supported small-scale production in the past, and some areas considered useable for agriculture today might have been impractical to farm with traditional technologies. For archaeological purposes, soil maps should not replace detailed, empirical study of the soils near sites or in areas of interest.

The second important consideration is that the soil maps are, of necessity, based on extant conditions and the NRCS approach to pedology (soil science) emphasizes classification over genesis. Data directly relevant to inferring past conditions rarely are presented. For example, each soil's susceptibility to erosion is usually classified and reported, but evidence of actual recent or past erosion is not generally described. Plant communities recorded by the soil scientists provide some clues concerning what might have grown in an area in the past, but those communities may have changed radically due to climate change, colonization by invasive exotics, altered fire regimes, grazing and/ or erosion, or for other reasons. The data presented in soil maps must be combined with paleoenvironmental reconstructions and empirical observations in order to infer past climate conditions, biotic communities, and landscape change.

At the eastern margin of the study area, soils on the historical Rio Grande floodplain are mapped as a series of loams that range in texture from fine sandy loam to clay loam, including the Trail, Gilco, Aga, and Peralta loams (all soil data from NRCS 2010). In general, these are moderately well-drained to well-drained bottomland soils with low to moderate erosion potential, low salinity (i.e., none to slight salinity in the NRCS classification system) and a relatively high water table. In small areas, high clay content and increased salinity can create somewhat poorer conditions for plant growth. The typical frost-free period of 140 to 160 days is within the tolerances of traditional varieties of maize and other crops. With irrigation, the soils are classified as excellent for agriculture and they have historically been among the most productive farmlands in the region; they certainly were farmed productively in the prehispanic era. In addition, the high water table and dense mosaic of different soil types on the floodplain indicate that it would have been a varied and productive natural environment for hunting and foraging in the more remote past.

West of the historical floodplain, the soils transition to the Sheppard and Grieta series, loamy fine sands and fine sandy loams, respectively. These are well-drained to excessively well-drained soils with moderate to high erosion potential (depending on slope), low salinity, a deep water table, and low to moderate available water capacity. They are classified as unsuitable for modern agriculture, primarily due to lack of water. However, this is an area in which localized conditions would have allowed for successful cultivation; for example, at the base of slopes that generated runoff or along ephemeral streams. Similarly, the landscape would have offered localized seasonal resources for foraging populations, including the edible seeds of various grasses and other plants as well as game animals.

The Sheppard and Grieta series soils continue westward onto the Llano de Albuquerque, where the Clovis and Zia series soils also are present. The Clovis and Zia soils are fine sandy loams and sandy loams, respectively. They are well drained with low erosion potential, low salinity, a deep water table and moderate available water capacity. They are classified as unsuitable for agriculture due to lack of water, but because of common buried clay loam horizons they tend to have somewhat better hydrologic characteristics for plant growth than many of the Sheppard and Grieta series soils. At the highest elevations along the Llano de Albuquerque and into the Rio Puerco valley the frost free season is somewhat shorter, 120 to 140 days, and approaches the limits of tolerance of traditional varieties of maize. Again, this would have been an area in which some locations could have supported agriculture or comparatively dense natural resources due to localized conditions.

The Clovis and Zia series soils continue onto relatively level areas on the western flank of the Llano de Albuquerque. Topographic and geomorphic variability increase as the landscape descends to the Rio Puerco, and that variability is reflected in the soils. Rocky soils such as the Rock outcrop – Zia complex and the Zia-Skyvillage-Rock outcrop complex become more common because the topography is steeper than it is to the east of the Llano de Albuquerque. Some of the related soil map units, such as the Zia San Mateo Association and the Querencia – Zia complex, include increasingly loamy and clayey soils with high water holding capacities, located in swales and along drainages. They are typically well drained with low erosion potential, a deep water table and high water holding capacity. Some are classified as suitable for agriculture, although a few of the San Mateo soils are moderately saline. The Pinavetes loamy sand is present on sand dunes west of the llano; as one might expect, it is excessively drained with a deep water table, moderate erosion potential, low salinity and very low available water capacity. The mosaic landscape and soils would have created varied opportunities for foraging or farming populations. Soils with high water holding capacities at the base of rocky slopes, in swales, and along drainages would have been suitable for traditional agriculture, and they likely would have supported seasonally abundant wild resources. In addition, Indian Ricegrass (*Achnatherum hymenoides* alt. *Oryzopsis hymenoides*) is among the large-seeded grasses known to have been commonly used by foraging populations that frequently grows on sand dunes.

Soils in the valley of the Rio Puerco are somewhat different in character due to the influence of the Jurassic–Cretaceous shales and sandstones that are the parent material. In general, they tend to be finer in texture with higher salinity than the soils of the Albuquerque basin. On the steeper slopes towards the edges of the valley, the Sandoval fine sandy loam is thin and well drained with a deep water table, low available water capacity and slight salinity. The San Mateo loam and Zia–San Mateo association are widespread on the lower slopes above the abandoned floodplain of the Rio Puerco. They are well drained with moderate erosion potential, a deep water table, high available water capacity, and salinity varies from very low to moderate. Along the river, the Sparank clay loam covers much of the abandoned floodplain. It is well drained with a deep water table (reflecting the historical incision of the Rio Puerco and the consequent fall in local water table), high available water capacity, and slight to moderate salinity. Slightly and moderately saline soils are characterized as unsuitable for agriculture, but the portions of the San Mateo, Zia–San Mateo, and Sparank soils with low salinity could have supported agriculture or dense stands of edible plants in the past, particularly with simple irrigation.

The relationship between soil salinity and agriculture has been a matter of some interest (but remarkably little investigation) in the archaeology of the American Southwest since several researchers asserted that salinity would have made farming impossible in Chaco Canyon (Bradfield 1971:58–59; Judd 1954:60; Schelberg 1992:62). In general, maize is a moderately salt-sensitive plant. Modern hybrid varieties show little to no reduction in yield in soils classified as very slightly saline by the NRCS (Brady and Weil 1999). Yields are reduced by approximately 35% at the midpoint of the slightly saline classification, and maize typically fails to mature in moderately or strongly saline soils. Research has shown that soil texture is a complicating factor; crop tolerance of saline irrigation water is reduced in clayey soils (Katerji *et al.* 1996), very likely because the smaller particle size leads to exponentially-increased soil particle surface area and, therefore, increased chemical interaction and rapid accumulation of salts in the soil. Recent investigations, however, have demonstrated a high variability in salt tolerance among hybrid maize cultivars (Maiti *et al.* 2010). Surprisingly, investigations of the characteristics and tolerances of the landraces of maize grown by traditional farmers in the American Southwest has begun only recently (Adams *et al.* 2006), and it remains an open question whether slightly saline soils might have been farmed productively in the past. In any case, the variability in the landscape and soils along the Rio Puerco very likely afforded the prehispanic occupants at least localized areas in which farming would have been productive. Similarly, there would have been a patchwork of resources available to foraging groups.

The soil information provided by geologists working in the study area is less extensive and systematic than that presented by the NRCS. Their data are useful, however, because soils form slowly on stable surfaces and follow a more-or-less predictable trajectory of development. The degree of soil development therefore can be used to differentiate the depositional units exposed at the surface and to identify geomorphic surfaces of different ages. In particular pedogenic clays and, in semiarid or arid environments, calcium carbonate ($CaCO_3$) and other chemical salts accumulate through time in subsurface B horizons. These accumulations cause measurable alterations of color, texture, reactivity to dilute hydrochloric acid (10% HCl), and other characteristics that can be evaluated in the field or in the laboratory, and the degree of accumulation can be used as an approximate measure of the age of the soil (Birkeland 1999; Machette 1985).

Soils are very well developed in Santa Fe Formation deposits on the uplands of the Llano de Albuquerque, which has been a geomorphically stable surface for approximately 2.6 Ma. The soils exhibit stage III+ to IV carbonate morphology (stage designations after Machette 1985; soil data from: Connell *et al.* 2007; Connell and Love 2001; Maldonado *et al.* 1999). Topographically below the Llano de Albuquerque, soils developed in the Santa Fe Formation typically exhibit stage III or III+ carbonate morphology. Soils developed at the surface of the terrace formed by the Lomatas Negras Formation are identified as having stage III eroded carbonate morphology. No soil data are available for the upper surface of the Edith Formation, but it is capped by alluvial deposits in which a soil has formed that exhibits stage III+ carbonate morphology and moderately developed Bt and Btk horizons. Soils at the surfaces of the Menaul member and the Los Duranes Formation show stage II+ carbonate morphology. On the surface of the Arenal

Formation, soil development is weaker, with stage I to II+ pedogenic carbonate morphology. The surface of the Los Padillas formation has not been stable long enough to develop measurable accumulations of pedogenic clay or carbonates.

Younger aeolian deposits in the study area are not consistently described in the geological literature. Geoarchaeological studies on Albuquerque's West Mesa report soils with stage II carbonate morphology and argillic horizons developed in sand dunes that stabilized in the late Pleistocene, roughly 26–21 ka (Holliday *et al.* 2006). Soils in sediments deposited during the terminal Pleistocene, roughly 16–10 ka, exhibit a reddened argillic horizon and stage I carbonate morphology (Hall 2006, 2008). Soils typically are weakly developed in Holocene deposits; mid-Holocene and older deposits may exhibit cambic or incipient argillic horizons. Virtually the entire Albuquerque basin west of the river also is blanketed by a thin layer of recently deposited sandy sediments, 2–20 cm thick, which exhibit no measurable pedogenic alteration.

HOLOCENE LANDSCAPE CHANGE

At a large scale, geomorphic surfaces across the majority of the study area have been stable since prior to the human colonization of the new world, but there have been landscape changes during the Holocene that are significant at the scale of archaeological investigations. The floodplains of the major rivers and tributaries have been affected by aggradation and erosion, processes that have moved extensive bodies of sediment 10's of meters thick. More localized area, such as the small drainages in which arroyos have episodically formed and alluvial fans at valley margins, have also been subject to aggradation or erosion. In addition, aeolian processes have been active in the uplands, mobilizing and depositing sediments across large areas in the northern Albuquerque basin. Finally, the past presence of small playas (shallow, seasonal, rain-fed lakes) has been documented in several locations on Albuquerque's west mesa. These would have supported game and edible plants in the past and may have provided localized opportunities for cultivation.

River Floodplains

The Albuquerque reach of the Rio Grande incised its floodplain as much as a few 10's of meters below the current level during the last glacial maximum between 15 and 22 ka and it has generally been aggrading since that time (Connell and Love 2001). The aggradation is driven in part by a high sediment load; in the Albuquerque area, the "Rio Grande has one of the highest sediment loads of any river in the world, with measured sediment concentrations as high as 200,000 ppm [parts per million]" (Mussetter 2002: 82). Before the recent historical period, the river occupied multiple wide, braided channels in several locations in the Albuquerque reach and was subject to avulsion (rapid changes in channel position) during large flood events (Martinez 1985; Mussetter 2002; Ortiz 2004; Richard 2000; Treadwell 1997). By the late 19th century, reduced flows due to removals for irrigation caused the river largely to be confined to a single channel during normal years. Prior to the construction of artificial levees in the mid-20th Century and closing of the Cochiti Dam in 1975, however, the broad floodplain in the Albuquerque reach was frequently inundated by overbank flows, particularly during the spring months.

The former presence of a braided to meandering stream system carrying a high suspended sediment load is consistent with a geomorphically active floodplain with high rates of aggradation. Lambert (1968) reports average aggradation rates of 1.04 cm yr during the 20th century for the Rio Grande floodplain before the closing of Cochiti Dam. These rates are exceptionally high and are almost certainly not typical of the Rio Grande floodplain throughout the Holocene; they imply > 100 m of sedimentation since the river valley began filling after the last glacial maximum, more than three times the measured thickness of the sediments deposited during that time (the Los Padillas Formation; Connell and Love 2001). Lambert's calculations were based on measurements recorded in one location over a span of 25 years and therefore evidently do not take into account the episodic scouring (localized erosion of deposits from the surface, for example caused by the creation of a chute) that takes place during large flood events; scouring would significantly reduce the net rate of aggradation across the floodplain over longer time periods.

Regardless of the exact rates of sediment accumulation, the Rio Grande floodplain was geomorphically active prior to recent human interventions. It was characterized by frequent and significant movement of sediments, including widespread deposition and localized erosion during episodic floods, within a long-term trajectory of overall aggradation. Due to the rapid deposition of sediments, often associated with relatively gentle overbank flows covering large areas, river floodplains frequently provide excellent conditions for preservation of cultural materials (Huckleberry 2001). The historical floodplain of the Rio Grande was no exception. Severe localized erosion is likely to have displaced cultural materials on many portions of the floodplain, however. The result is that a patchwork of sediment bodies of different ages (albeit all Holocene) are present at and near the surface, and archaeological materials in any given sediment body may have been redeposited by fluvial action. Across large areas, prehispanic materials are likely to be buried by a few to several 10's of cm of sediment deposited by flooding during the early 20th century. Many sites are therefore invisible during any pedestrian survey that does not incorporate subsurface testing. While older archaeological materials are likely to be more deeply buried than more recent artifacts in general, it is not possible to predict accurately the age of the surface or subsurface strata in any specific location or to evaluate the degree to which spatial patterning in archaeological materials may have been altered by redeposition without empirical in-field observations.

Beginning in the 1880's, the Rio Puerco began to incise rapidly, creating a steep-walled channel tens of meters deep along most of its length within the span of a few decades. Channel formation essentially destroyed the potential for irrigation on the floodplain, deposited vast quantities of sediment at the confluence with the Rio Grande, and it severely disrupted the agrarian communities that then existed along the river eventually causing most to be abandoned. The dramatic geomorphic change and obvious impacts on nearby communities attracted the attention of geologists and geomorphologists and sparked nearly a century of debate over the causes of arroyo formation and the "natural" state of the fluvial system (e.g. Bierman *et al.* 2005; Bryan 1928; Gellis *et al.* 2004; Love 1986; Love *et al.* 1982). The Rio Puerco case came to figure prominently in studies of arroyo formation across the American Southwest (e.g. Aby *et al.* 2004; Bryan 1925, 1942; Bull 1991, 1997; Cooke and Reeves 1976).

Geological investigations have not been able to determine with certainty whether the most recent cycle of arroyo formation on the Rio Puerco can be attributed to human activity, climatic variation, natural cycling of the fluvial system, or some combination of these factors. The research has, however, elucidated many aspects of the fluvial system and its past behavior. Only the Yellow River in China is known to carry a higher suspended sediment load than the Rio Puerco (Milliman and Meade 1983). Measured sediment concentrations in the Rio Puerco are as high as 600,000 mg/l (Gellis *et al.* 2001) (approximately equivalent to 600,685 ppm), defined as hypersaturated flow because the river system transports more sediment than water by weight. Studies have demonstrated a moderate increase in valley floor erosion related to historical land use, but they also indicate that the overall rate of erosion in the river basin has remained comparable for hundreds of millennia (*ibid.*; see also Gellis *et al.* 2004).

The high rates of erosion and sediment transport reflect the erodibility of the bedrock exposed in much of the Rio Puerco watershed, the generally low vegetative cover, and significant sediment storage on the floodplain in between episodes of channel formation. Weathering generates large quantities of sediment throughout the watershed and erosion transports it to the river valleys where it accumulates on aggrading floodplains. Very likely, a relatively shallow and discontinuously incised channel has almost always been present on the Rio Puerco floodplain (Love *et al.* 1982), transporting water and small bodies of sediment downstream as described by process-based models (e.g., Bull 1997). Episodically, a through-flowing channel forms and widens, rapidly removing far larger quantities of sediment to the Rio Grande as occurred in the late 19th century. Eventually sediment begins to accumulate in the widened channel, creating an inset aggrading floodplain, and the cycle repeats (Aby *et al.* 2004).

Continuously incised channels may form in response to climate change, lowering of base level (i.e. downcutting of the Rio Grande), changes in water or sediment supply (anthropogenic or otherwise), or because the system crosses an internal threshold related to slope, discharge and erodibility (Bull 1991). Moreover, multiple episodes of incision or aggradation may follow from a single change in any of these external or internal conditions (Schumm 1977). The fluvial system is therefore a complex system in the narrow sense: its state at any given time (i.e. aggrading or incising) is determined not only by mechanistic processes and external conditions, but also by the state of the system at previous times and by changing linkages between interacting components. Its behavior on short time scales is largely predictable, but it is not possible at longer time scales to predict the timing of a shift in the state of the system or to infer the system's state based solely on knowledge of external conditions.

Channel formation along the Rio Puerco is important to archaeology for two reasons: it dramatically alters the local environment, and it has significant implications for interpreting the archaeological record. An aggrading floodplain generally is associated with relatively high water tables, localized wetlands (cienegas), an extensive riparian ecosystem, and fertile soil that regularly is replenished. Plant and animal resources are likely to be abundant and extensive irrigation is possible using simple technologies. A through-flowing, deeply incised channel, however, rapidly removes water and sediment to the trunk stream. It is marked by a lowered water table, severely restricted wetlands and riparian vegetation, and little to no sedimentation on the floodplain. The historical collapse of the agrarian communities along the Rio Puerco amply demonstrates that channel formation can be disastrous for farming populations. Logically, channel incision also would dramatically reduce the resources available to foraging populations. Knowing when the channel was incised or aggrading would be significant for interpreting the human past in the area.

The history of episodic channel formation also has implications for the geological and archaeological records. As along the Rio Grande, the Rio Puerco's high sediment load and history of channel formation indicate a geomorphically active floodplain. Although an oversimplification, it is heuristically useful to contrast the long-term development of the two floodplains before human interventions altered the nature of the Rio Grande system. Along the Rio Grande, episodic flooding deposited sediments over large areas and channel avulsion caused localized erosion; deposition and erosion occurred at the same time and were separated in space. Along the Rio Puerco, however, the fluvial system is marked by widespread aggradation for long periods of time, punctuated by relatively short episodes of channel incision and widening and rapid sediment removal; deposition and erosion are separated in time. The implication is that, while on the Rio Grande floodplain the surface at any given time is made up of a mosaic of sediment bodies of different ages, the floodplain of the Rio Puerco should be comprised of a series of stratigraphically superimposed sediment bodies that are laterally continuous over long distances along the river. Each unit is the remnant of a previous floodplain, and each one was deposited during a single period of aggradation. In addition, when the river is incised as is currently the case, these sediment bodies should be identifiable in profile in the banks of the arroyo.

Archaeologists have taken advantage of this situation to propose that identifiable strata – and the included materials – can be correlated over long distances along the Rio Puerco and its major tributaries. Early observers noted similar series of alternating fine- and coarse-grained strata in many fluvial systems across the American Southwest and suggested, optimistically as it turns out, that they might be correlated regionally (Bryan 1925). Along the middle Rio Puerco and its tributaries, Nials (1991, 2003) differentiates six depositional units in his study profiles, and French and colleagues (2009) note six to eight in their overlapping study area. Although the relevant information simply are not provided in the brief summary and synthesis of Cynthia Irwin-Williams' work in which she outlined the Oshara Tradition (Irwin-Williams

1973)[2], the location of the excavated middle and some of the late Archaic sites in the valley bottoms in the Arroyo Cuervo area (Chapin 2005: chapter 3) implies that she might have used fluvial stratigraphic correlations as the basis of her proposed date ranges for some Archaic projectile point types. Similarly, French and colleagues present pollen evidence indicating "very early maize within these cumulic soils that date ca. 2400 BC, especially in the Arroyo Tapia [a major tributary to the Rio Puerco], which would make this the earliest maize found in the Southwest" (2009: 671). Unfortunately, due to the confusing and somewhat unorthodox layout of pollen diagrams and the presentation of only schematic stratigraphic sections, the precise relationship of the single sediment sample containing maize (*Zea mays*) pollen to the unidentified radiocarbon dated materials recovered from the same stratum remains unclear. Hopefully follow-up publications that clarify these issues are in preparation.

The logic of using laterally-continuous floodplain strata to constrain the age of included materials is generally sound, and its use in archaeology extends back over two centuries to the early identification of hominid fossils in the same strata as extinct megafauna in the gravels of the Seine, initial proof of the deep antiquity of the human presence in Europe (e.g., Trigger 1989:87–102). There are, however, several issues with using strata to date included materials that should be addressed. Leaving aside the question of whether the materials might be intrusive in a stratum, the first is the question of whether the strata are, in fact, laterally continuous and correlative. Second, because of the nature of deposition and erosion in discontinuously incised ephemeral stream systems, an individual stratum is only approximately contemporaneous at different points in the system.

A superficially similar sequence of alternating strata may or may not represent exactly the same strata in spatially separated study loci for several reasons. Because arroyos tend to form in nearly the same locations as previous arroyos in the same valleys (Force *et al.* 2002), erosion and deposition may obscure or erase evidence of previous cycles, and the same processes can create remnants of inset terraces low in the exposure that might be mistaken for extensive, discontinuously exposed former floodplain surfaces. In addition, strata thought to be chronological markers generally are differentiated by sediment texture and degree of soil formation. Because the source of the sediments (the drainage basin) does not change significantly, the texture of the sediments is determined by the competence of the fluvial system (i.e. its ability to move clasts and sediment, related to discharge, slope, sinuosity, etc.). The competence of the stream system, in turn, will vary through time and is highly likely to return to similar levels repeatedly during each of the cycles of channel incision and floodplain deposition, implying that many strata will exhibit similar textures.

Soil characteristics are useful for differentiating the ages of surfaces at a coarse scale, but pedogenesis is a complex phenomenon influenced by numerous variables (minimally climate, biota, relief, parent material and time, Jenny 1941) and soil characteristics can vary significantly on a surface of a single age. Soil development simply is not useful for distinguishing among deposits separated in age by less than a millennium at the very least, particularly in arid and semiarid climates where pedogenesis proceeds comparatively slowly. Because the Rio Puerco is thought to go through cycles of incision and aggradation on a roughly millennial time scale (Love 1986), it certainly is plausible that a stratum exposed in one location does not represent the same floodplain surface as a similar stratum exposed at the same level in another location. It could be the remnant of a floodplain from a cycle of deposition a millennium or more earlier or later in time. The problem is exacerbated where different tributaries are included in a study because the inclusion of multiple drainage basins (or sub-basins) introduces another level of complexity. For example, French *et al.* (2009) note that strata exposed in the walls of Arroyo Salado, one of the large tributaries to the Rio Puerco, could not be correlated with the strata in other nearby tributaries or along the trunk stream.

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[2] Unfortunately, Irwin-Williams died before she was able to publish the results of her long-term Anasazi Origins Project in greater detail.

Even where strata can be shown to be laterally continuous, for example where a researcher takes the time to trace them across several km of exposures as s/he walks from one study locus to another, each individual stratum is only approximately contemporaneous at different exposures. Under normal conditions, arroyo formation usually propagates upstream through a fluvial system by headcutting. Similarly, widening and eventual filling of the arroyo proceed upstream, probably at roughly the same rate as headcutting, and often while the upstream portion of the channel is still incising (Bull 1997). Estimates of the rate of upstream movement of headcuts in different fluvial systems on the Colorado plateau range from 25 meters/ year (Force 2004) to as much as 257 meters/ year (Worman and Mattson 2010), and the range of rates observed historically across the American Southwest is even greater (Bahre 1991). Moreover, the period of filling between episodes of channel incision typically is longer than the time during which a channel is present; French and colleagues (2009) estimate that approximately 90% of the time represented in the exposures along the Rio Puerco is in the strata that reflect deposition due to overbank flooding on a relatively stable floodplain. Therefore, an individual stratum that was the floodplain surface likely was quasi-stable and aggrading for centuries or millennia at a given location, and the timing of initial deposition, abandonment, and burial of that surface could be separated by decades for each kilometer at different points along the channel. Clearly, a dated inclusion at one location can only give a rough estimate of the age of inclusions at another location.

Perhaps because of these complexities, and the apparently irresistible urge to generalize beyond patterns documented in a particular study area, different investigators have suggested that the Rio Puerco has incised and aggraded at different times in the past. Their conclusions are sometimes overlapping, sometimes contradictory as shown in Table 3.1. Interestingly, only Nials (1991, 2003) describes a depositional unit antedating 6000 BC, his late Pleistocene Cuervo Horizon. The lack of early Holocene units implies that the floodplain was stable for many millennia prior to the mid-Holocene at the level of Nials' Cuervo Horizon, that extensive erosion during the mid-Holocene removed earlier Holocene floodplain sediments from all but the valley margins where they remain buried, or that the age of the Cuervo Horizon is overestimated and current incision has not reached sufficient depth to expose early Holocene and older sediments. Whichever scenario is correct, the lack of early Holocene units may explain why Irwin-Williams concluded that early Archaic occupations were limited to the uplands; evidence of floodplain occupations has been removed by erosion or deeply buried by later deposition. In any case, it is clear that inferred ages for projectile points or other potentially important items recovered from different fluvial strata should be based on clear and close associations of the items with dated materials, and multiple dates from multiple contexts are highly desirable. Nials' introductory words of warning remain pertinent: "Despite the seemingly uniform and widespread nature of alluvial deposition recognized in the Middle Rio Puerco, individual horizons are poorly dated, and correlations with alluvial strata elsewhere remain tenuous until further dating is accomplished." (1991:48).

Aeolian Deposits

As discussed above, the major geomorphic surfaces above the historical river floodplains in the study area have been stable since well before the accepted dates for a human presence in the New World, implying that archaeological materials from all time periods should be present at and near the surface. However, aeolian processes have impacted the landscape considerably in upland areas in several locations. To the south of the study area, sandy aeolian deposits form five large bands of sand sheets visible on aerial photographs and geological maps; they cover extensive areas from west of the Albuquerque volcanoes to west of Belen (Kelley 1977). Sand dunes also are common in the southern portion of the Albuquerque basin, particularly near the Rio Salado and in specific geomorphic positions including the tops of valley margin escarpments, down-wind from playas, inset on the terraces of the ancestral Rio Grande descending to the east from the Llano de Albuquerque, and on the windward (west) side of the Llano de Albuquerque (*ibid.* see also Maldonado *et al.* 1999). These aeolian features are inferred to be Pleistocene-Holocene in age.

Table 3.1. Timing of Channel Formation and Filling on the Rio Puerco as Inferred by Different Investigators. Dates converted to calendar years for purposes of comparison.

Reference	Study Area	Inferred Channel Formation	Inferred Filling	Comments
Love *et al.* 1982	Lower Rio Puerco	~ 150 BC	before AD 1000	One episode of channel incision and filling documented between 150 BC and AD 1000, they suggest many more are probable. Floodplain aggraded to within 1 m of the present surface by 2000–3000 BP.
Love and Young 1983	Rio Puerco	before AD 90 AD 1250–1325 after AD 1450	AD 90–1250 AD 1325–1450 before 1800's	Suggest that at least a shallow channel usually has been present; it deepens significantly during periods identified as "channel formation".
Nials 1991, 2003	Middle Rio Puerco	900–600 BC AD 800 AD 1030 AD 1175–1200	Late Pleistocene before 900–600 BC before AD 800 AD 1030–1800's	Study area overlaps with current study. Notes poorly dated cycle of filling, channel formation, filling between 600 BC and AD 800. Includes a somewhat simplistic assumption that channels form during dry periods, filling occurs in wet periods.
French *et al.* 2009	Middle Rio Puerco	4100–3700 BC 2900–2400 BC 2200 BC–AD 400 before AD 900 after AD 1300	3700–2900 BC 2400–2200 BC after AD 400 AD 900–1300 before 1800's	Study area overlaps with current study. Notes significant problems with temporal correlations of units deposited before 2500 BC. Suggests that the Rio Puerco was out of sync with proposed regional cycles of arroyo formation before 2500 BP.
Aby *et al.* 2004	American Southwest	5400–4500 BC 3400–2400 BC 700 BC–AD 100 AD 1200–1600	between periods of channel formation	Argue for "crude synchroneity" of channel formation across the American Southwest, reflecting climate change playing out differently in different fluvial systems, depending on the prior state of the system.

Sand sheets and low dunes are common and widespread in the study area, but not extensive enough to obscure underlying units such that they would be mapped and formally described in the geological literature. As often is the case, the Holocene deposits and geomorphic features like playas that may be archaeologically significant are simply noted and then disregarded as they are not particularly useful for addressing questions related to structure, tectonism, basin development, or others typically of interest to the majority of geologists. The recent aeolian deposits are important to archaeologists because they frequently cover archaeological materials or are the matrix from which they are recovered, and correlations or associations can provide some degree of chronological control.

As is the case in the southern portion of the Albuquerque Basin, sand dunes and sand sheets are most common in specific geomorphic positions. Holliday *et al.* (2006) report that surficial sand sheets are thicker to the east of the Albuquerque volcanoes, on the slopes and terraces below the Llano de Albuquerque, than they are to the west. Logically this reflects the accumulation of sediments in the relatively more sheltered locations below and downwind from that high, flat, exposed surface, as is the case with the aeolian sediments inset on the terraces further to the south. In several locations, including near the Rio Rancho City Center, dunes have formed and stabilized downwind from the larger arroyo systems that drain towards the Rio Grande, creating ridges of low hills parallel to the arroyos. Like other geologically-recent aeolian features, these ridges are not large or extensive enough to appear on many standard-scale geologic maps. They are not discussed in the pertinent literature and their ages are not known, but it is likely that at least some portions are Holocene in age and they may bury archaeological deposits. No sand dunes or sheets are shown west of the Llano de Albuquerque and Mesa Prieta on geologic maps, but soil maps clearly indicate that they are present.

As with fluvial deposits, archaeologists have suggested that aeolian deposits may be age-correlative over relatively large areas. Specifically, Irwin-Williams appears to have based much of her proposed chronology of the Oshara Tradition (Irwin-Williams 1973), particularly for the early Archaic, on suspected correlations between soil horizons exposed in sand dunes at different sites (Chapin 2005: chapters 3, 5 and 6). In particular the Jay, Bajada, and early San Jose phases seem to have been most intensively investigated at three sites located on sand dunes: Dunas Altas, Collier Dune, and Ojito. Moreover, "[t]he same stratigraphic level designations were used at all three of the dune sites" (Chapin 2005:78). Early Archaic deposits were recovered primarily from a unit designated the "red dune".

As noted above, Irwin-Williams was unable to adequately publish the work of the Anasazi Origins Project. Chapin's (2005) reanalysis of field notes, photographs and other materials includes a concerted, although possibly somewhat misguided, effort to synthesize the information from the dune sites into a single, formal soil-stratigraphic description. His work clearly was hampered by the excavators' mistaken belief that soil horizons were isomorphic with depositional units, their lack of training in geology and pedology, and their assumption that the same strata were present at each site. In any case, he correctly identifies a minimum of three depositional units. The degree of pedogenic alteration of the "red dune" deposits, which contained the early Archaic materials, in general appears to indicate early to mid-Holocene deposition. The high variability in carbonate content, however, as well as the broad range of radiocarbon dates he presents for different loci within the unit (2210±120 BP to 6780±250 BP), are consistent with a more complex scenario. Although all three dune sites are located on cliff tops at the heads of the canyon of Arroyo Cuervo, a tributary of Rio Puerco, it does not seem likely from the extant data that the soil-stratigraphic units are exactly the same at each. In particular, the more calcareous "red dune" deposits are almost certainly many millennia older than those exhibiting only weak to moderate reaction to dilute HCl. Very likely, the dunes in the area were remobilized several times during the early–mid Holocene. Different depositional units probably are present within the "red dune" deposits at some sites, with the differences obscured by subsequent soil welding.

In a handful of studies, mostly geoarchaeological, researchers have begun to date the ages of aeolian deposits across the study area and in adjacent areas. At sites near the Albuquerque volcanoes, Holliday and colleagues (2006) report "older" sand sheets and sand dunes dated by Optically Stimulated Luminescence (OSL) to 23.8–26.4 ka and approximately 21 ka, and three identifiable "later" sand sheets deposited after 6100 BP. They also note episodic aeolian deposition in the playa at the Boca Negra Wash site (LA 124474) after 2800 radiocarbon years BP. Similarly, Hall (2006, 2008) worked from a series of 12 OSL dates to create a geochronology for the Paseo del Volcan corridor through the eastern portion of the study area near the Rio Rancho City Center. He inferred major periods of aeolian activity and deposition of sand sheets >100 ka and 10–15 ka, and localized dune deposition 2500–1000 BP. Regionally, there also was widespread mobilization of sand sheets and dunes that began during the mid-Holocene warm period (or "altithermal", ~5000–7000 BP) and lasted as late as 4000–3000 BP in the dune fields of the San Juan Basin (McFadden *et al.* 1983, Wells *et al.* 1990). Research at the County Dump Fault on the Llano de Albuquerque near Interstate 40 indicates three episodes of aeolian deposition, dated by thermoluminescence to 41–38 ka, ~28 ka, and 4 ka (McCalpin *et al.* 2006). Finally, a layer of sandy surface deposits 2–20 cm thick is ubiquitous on Albuquerque's west mesa. It generally is thought to be related to soil erosion and mobilization of surface sediments caused by grazing and then urban development during the 19th and through the 20th century (Hall 2006; Holliday *et al.* 2007; see also Worman 2008a, 2008b, 2006a, 2006b).

Taken together, the data reflect multiple episodes of aeolian activity and deposition in the study area. Dated sand sheet and dune deposits were emplaced from the Pleistocene through the Holocene. The studies enumerated above included dated deposits from > 100 ka, 41–38 ka, ~28 ka, 23.8–26.4 ka, 21 ka, 15–10 ka, 9–3 ka, 4 ka, and 2.5–1 ka, as well as three more loosely dated sand sheets deposited after 6.1 ka, "episodic" aeolian activity after 2.8 ka, and recent mobilization of surface deposits. These are the dates and age estimates obtained from no more than two dozen radiometric determinations of various kinds; it seems as though every investigation that yields a date for dune or sand sheet formation documents a separate episode of aeolian activity. Any proposed regional correlations of depositional units based on the extant data would be tenuous to the point of absurdity. The clear implication is that dunes and sand sheets of different ages may cover archaeological remains of different ages in different locations, and correlations based on pedological data can provide only a very rough estimate of the ages of different deposits. At present, independent data are necessary for determining the ages of different depositional units at any given site in aeolian deposits in the uplands of the study area.

Playas

Playas have been documented in several locations on Albuquerque's West Mesa, several in conjunction with Folsom sites (Holliday *et al.* 2006). Detailed study of sediments at the Boca Negra Wash site indicates that the playa "probably held water more often, at least seasonally, and was likely characterized by relatively lush vegetation when dry (compared to modern times) during the latest Pleistocene and earliest Holocene, including the time of the Folsom occupation" (Holliday *et al.* 2006: 788). Moreover, the playa returned to relatively moist conditions several times through the Holocene, in response to climatic fluctuations. Renewed use of the area by farming populations is attested in the Classic period (AD 1325–1600) (Cordero 2008; Kurota 2006). Clearly playas were significant, especially during relatively moist periods, in that they provided seasonal sources of water, attracted game animals, supported particular plant communities, and could have been used for some types of farming. As they commonly are not represented on geologic maps, these features must be identified by archaeologists in the field.

SUMMARY AND IMPLICATIONS

The geomorphic context and geology of the northern Albuquerque basin and adjacent areas of the Rio Puerco drainage have several implications for conducting archaeological investigations. Geomorphic studies indicate that the major upland surfaces in the study area have been stable since millennia before the accepted dates for the presence of humans in the New World. First, archaeological materials should be present at and near the surface in most areas, and they may have been impacted by post-depositional processes such as bioturbation that are most significant at and near the surface. Second, geological research indicates that high-quality lithic raw materials are most abundant and widespread in the northwest portions of the Albuquerque basin. Localized outcrops of high-quality tool stone also are present in the terraces composed of the Post-Santa Fe Group gravels that primarily outcrop above the western margins of the historical Rio Grande floodplain. In the Rio Puerco drainage, outcrops of particularly fine-grained basalt provide the only significant source of raw material for manufacturing flaked stone tools other than the alluvium present along the channels of the rivers draining adjacent uplands.

At a somewhat finer scale, soil data indicate that agriculture would have been highly productive and on the historical floodplain of the Rio Grande, particularly with simple irrigation. Similarly, plant and animal resources would have been abundant and varied on the floodplain. Along the Rio Puerco, floodplain farming likely would have been productive and natural resources abundant during those time periods when a deeply-incised channel was not present. In upland areas, micro- and meso-scale variability in soils and topography would have provided localized resources for foraging and farming populations.

Finally, Holocene landscape change has been most significant in the valleys of the major rivers and their tributaries. Aggradation and erosion have proceeded simultaneously on the floodplain of the Rio Grande, creating a complicated patchwork of sediment bodies of different ages, many of which contain redeposited cultural materials. On the Rio Puerco, alternating phases of channel formation and floodplain aggradation have created stratified floodplain deposits. While individual units may be continuous over relatively large distances, a critical examination of the literature suggests that initial attempts to correlate strata throughout the fluvial system probably were overly optimistic as each investigation has come to different conclusions regarding the timing of channel formation and aggradation and the ages of the fluvial deposits. In general, proposed correlations over any significant distance should be treated as supported hypotheses in need of further testing. In upland areas, despite the large-scale stability of the geomorphic surfaces there has been significant aeolian activity during the Quaternary. As along the Rio Puerco, every investigation yields new age estimates for the depositional units, implying that temporal correlations across the study area are unsupportable, at least at present. In any given location, archaeological materials may be present beneath, within, or on top of aeolian deposits of varying ages. Detailed, empirical examination of the soils and sediments associated with cultural materials remains the best way to determine the relative ages of strata, to illuminate the local history of landscape change, and to understand the nature of the post-depositional processes that may have affected the archaeological record.

Chapter 4

CULTURE HISTORY

by Alexander Kurota and Patrick F. Hogan

The prehistory of the Southwestern United States is commonly discussed in three basic chronological periods: Paleoindian, Archaic and Puebloan. Each of these represents a different cultural adaptation established during a different time period. Numerous scholars have offered overviews on the prehistory of the region. General discussions of human adaptive strategies in the project area are presented in Cordell (1978), Stuart and Gauthier (1981) and Tainter and Levine (1987). More focused summaries have also been produced for the Paleoindian period by Judge (1973) and for the Archaic period by Irwin-Williams (1973). These syntheses provided the basis for the following discussion.

PALEOINDIAN PERIOD

The climatic conditions and human occupation of this region are known only from sparse records, largely because, until recently, little research attempting to reconstruct the paleoenvironment has been done in or near the project area. The Paleoindian period began during the Late Pleistocene when the local climate was cooler and wetter. Such conditions supported grassland environment with many species of now extinct megafauna (Raymond et al. 2004). The presence of Pleistocene megafauna attracted small bands of nomadic hunters and gatherers to the area. Intended to kill and butcher these large mammals, the Paleoindian stone tool technology was typified by finely made spear points, knives, and hide scrapers. The locations of Paleoindian sites, therefore, would have depended on the location and numbers of such animals (Gerow 1994:23). Such sites are often found along major drainages or near the edges of Pleistocene lakes (Irwin-Williams 1979).

In the Southwest, the Paleoindian period is divided into Clovis (10,000–9000 BC), Folsom (9000–8000 BC) and Plano (8000–5500 BC) complexes (Irwin-Williams 1979). Each complex is distinguished by specific projectile point styles and associated artifact assemblages. Although rare in the Middle Rio Grande Valley, Clovis sites are commonly interpreted as kill and butchering loci associated with mammoth and other extinct Pleistocene megafauna. Similarly, Folsom sites were also probable kill and butchering sites associated with these megafauna; however, they are also associated with extinct bison. Sites belonging into the Plano Complex can be further subdivided into the following subgroups based on their artifact assemblages and projectile point styles: Plainview, Firstview, Agate Basin, Hell Gap, Alberta, Cody, and Frederick.

Judge's (1973) survey of the Middle Rio Grande Valley documented 59 Paleoindian sites representing the human occupation of the area throughout the entire span of the Paleoindian period. Another major work was done on Paleoindian adaptive strategies at the Rio Rancho Folsom site by Dawson and Judge (1969). Folsom was the first excavated Paleoindian locus in the Middle Rio Grande Valley region.

In recent years, significant knowledge of the Paleoindian adaptive strategies has been gained through new research projects in the region. Currently, several Folsom sites are known to exist on the West Mesa of Albuquerque (Brandi 1993, Huckell 2002a, 2002b). The best known of these is the Boca Negra Wash site (LA 124474) excavated by the University of New Mexico (Huckell 2002b). Aside from the Paleoindian stone tools, excavations also revealed a small number of bison tooth enamel fragments. Following the Boca Negra Wash site excavations, Huckell (2002a) performed a survey of 1129 acres of New Mexico State Trust Land in the vicinity of the volcanoes west of Albuquerque. This survey resulted in the discovery of two Paleoindian sites and two isolated occurrences with Paleoindian projectile points. The locations of the newly discovered sites near playas correspond well with Judge's (1973) assumption that playas were closely associated with the occupation of the Paleoindian sites. Perhaps the Paleoindian artifacts found nearest the current project area come from the OCA Venada Airport survey area located about 1 mile to the east. Here two fragmentary Cody points (IO 95 and IO 165; Hogan 1986:34) were found on ridge slopes that provide overviews of potential hunting areas. Hogan suggests the points probably mark locations where a hunter repaired his weapon while waiting for game (Hogan 1986:33).

ARCHAIC PERIOD

The Archaic period is marked by the shift from a primary reliance on hunting to an economy in which a wide variety of plant and animal resources were procured. This transition is usually attributed to large-scale climatic changes and the extinction of Pleistocene megafauna. The changes in subsistence strategies are reflected in tool assemblages associated with a gradual decrease in the size of projectile points and in the introduction of ground stone tools. Archaic sites are characterized by more diverse artifact assemblages that reflect utilization of a greater variety of floral and faunal resources across the landscape. Archaic settlements, therefore, can be expected in areas where the distribution and diversity of key plant resources can be predicted seasonally (Hogan 1986:9). Archaic subsistence strategies reveal a dependence on plant foods, a seasonally mobile settlement pattern, and a flexible social structure that depends on the available economic/natural resources (Hogan 1986:10).

There is a long history of research relating to the Archaic period occupation of the northern Llano de Albuquerque. During the early 1950s, Campbell and Ellis (1952) described the Atrisco Focus, a lithic assemblage from surface sites within the Atrisco Land Grant and along the eastern scarp of the Rio Puerco. They argued that the majority of these artifacts most closely resembled materials recovered from San Pedro Cochise sites in southeastern Arizona, and concluded that the Atrisco Focus was a local manifestation of the late Cochise Culture.

In their description of the Atrisco Focus, Campbell and Ellis (1952:217) identified two major point types. The first type consisted of large points with slight shoulders and a long stem with straight or concave base. Their photographs of these points indicate that they are clearly what Irwin-Williams (1973) later termed Bajada points. Their second point type, Atrisco points, includes both corner-notched dart points with expanding stems and straight to convex bases, and side-notched forms also with expanding stems. The illustrated examples of both these styles closely resemble points within the En Medio assemblage illustrated by Irwin-Williams (1973:Figure 6). Campbell and Ellis also illustrated a number of unclassified projectile points, one of which they recognized as a San Jose point. The Atrisco assemblage therefore includes what is now recognized as a mixture of early, middle and late Archaic projectile point forms.

In the late 1960s, Reinhart (1967; 1968) completed a survey and excavation program centered in the Rio Rancho area, north of the Atrisco Grant. Based on this research, he suggested a tentative chronology of the northern Llano de Albuquerque. The Atrisco Focus was redefined as an Archaic phase predating 1000 BC. It was followed by the Rio Rancho phase (1000 BC–AD 1), which Reinhart considered to be a local Basketmaker II manifestation. Although Reinhart seems to view the Rio Rancho phase as a basically upland occupation, test excavations at the Taylor Ranch site (LA 33223) on the west bank of Rio Grande near Montaño Road uncovered a pitstructure dating to 2040±110 rcy BP (O'Leary and Biella 1985:133), indicating that the settlement system also included habitations in the Rio Grande Valley.

Reinhart designated the succeeding Basketmaker III occupation as the Alameda Phase, which he dated between AD 1 and 550 based on a single tenuous radiocarbon date (Reinhart 1968:113–114). Cordell (1978:41–42) argued that the date range for the Alameda Phase was probably later than Reinhart had suggested due to the presence of Lino Gray and Kana'a Gray pottery at all Alameda Phase sites. More recent excavations (Hammack et al. 1983; Schmader 1990b; Walth 1999:71–130) support Cordell's position and indicate that Alameda phase sites date after AD 450–500.

Based on the work in the Arroyo Cuervo district (located between Rio Puerco and Jemez River), Irwin-Williams (1973:4–12) defined a temporal framework for the Archaic period in northwestern New Mexico that has supplanted Reinhart's sequence. Her Oshara Tradition consists of six phases: Jay (5500–4800 BC); Bajada (4800–3200 BC); San Jose (3200–1800 BC); Armijo (1800–800 BC); and En Medio (800 BC–AD 400); and Trujillo (AD 400–600). Irwin-Williams interprets these phases as reflecting successive adaptations by hunter-gatherer populations to fluctuating climatic conditions, a gradually increasing regional population and, in the later periods, to an increasing reliance on cultigens. Although the Oshara phases are commonly used as a local sequence for the Archaic period, the date ranges attributed to those phase dates are not well-supported by radiocarbon dates (Berry and Berry 1986; Chapin 2005). For that reason, researchers have increasingly adopted a three-part division that divides the Archaic into early, middle, and late periods**.**

Early Archaic

The Early Archaic is associated with two of Irwin-Williams' phases: Jay (5500–4800 BC) and Bajada (4800–3200 BC). Irwin-Williams (1979:36) argues that the Jay phase represents the origins of the Oshara Tradition during which Archaic people from California moved to the region after the departure of the Paleoindian groups. Based on the tool kits, scarce faunal materials, and suspected repeated occupations of preferred localities, it is suggested that these sites reflect various subsistence strategies with year round exploitation of resources available in the area (Irwin-Williams 1973:5).

In the Arroyo Cuervo district, the most common Jay phase sites are base camps and small specialized activity sites. The base camp sites are usually small, cover areas of about 50 square meters, and are commonly found in canyon heads. The location of Jay phase specialized activity sites would have depended largely on the type of food procurement. For example, hunting loci could be expected near ponds or in the mountains, while foraging sites are mostly found along low mesas. Typical Jay phase artifacts include large, slightly shouldered projectile points, well-made bifacial knives, and side-struck side scrapers (Irwin-Williams 1979:36).

The Bajada phase is dated by Irwin-Williams to 4800–3200 BC. Diagnostic projectile points are basally thinned with indented bases and increasingly well-defined shoulders. The Bajada phase sites are often defined by small cobble-filled hearths and earth ovens associated with an increased number of chopping tools and well-made side scrapers. In general, the Bajada phase reflects continuity from the preceding Jay phase (Irwin-Williams 1979:36–37).

A small number of Early Archaic sites have been documented in the vicinity of the project area. Hogan (1986:38) reports of a possible Early Archaic hunting overlook (OCA:304:4) about 1 mile east of the survey parcel. Kennedy et al. (1998:98–104) excavated a small hearth at LA 80877, about 5 miles east of the CNM RRC that was radiocarbon dated to the Early Archaic. An Early Archaic projectile point was also found at LA 99706 during a survey of lands south of Highway 550 in what is now part of Rio Rancho (Brandi 1993:176).

Middle Archaic

The Middle Archaic in the Middle Rio Grande region roughly corresponds to Irwin-Williams' San Jose phase (3200–1800 BC). This period is characterized by the initial emergence of shallow basin grinding slabs and cobble manos, and increasing numbers of large, heavy chopping tools and crude side scrapers. The large cobble-filled ovens first documented during the Early Archaic become more common during this period. Diagnostic projectile points are similar to those from Bajada phase except that the points have short widely expanding stems and the point blades often have serrated edges (Irwin-Williams 1973:8–9, 11). San Jose phase sites in the Arroyo Cuervo area are more frequent and larger than those from the preceding Early Archaic, and several have posthole patterns indicating the remains of simple temporary structures (Hogan 1986:11). In the vicinity of the project area, Brandi (1993:74) reports of finding a reworked San Jose point at LA 99671, a suspected Late Archaic locus just south of Highway 550.

Late Archaic

The Late Archaic encompasses the period during which cultigens were introduced in the Southwest and agriculture gradually became an important subsistence strategy for the native cultures. In the Middle Rio Grande region, the Late Archaic is described by Irwin-Williams' Armijo and En Medio phases. Both phases are represented by a large number of sites on the Llano de Albuquerque.

Irwin-Williams argues that Armijo phase (1800–800 BC) sites reflect a continuation of the Middle Archaic hunting and gathering focal economy. Armijo sites are commonly associated with dense structural remains. The small amounts of maize recovered from such deposits indicate that maize represented only a small portion of the diet but may have provided a reliable seasonal surplus (Irwin-Williams 1973:9–10).

The En Medio Phase (800 BC–AD 400) encompasses both the Late Archaic occupation of northwestern New Mexico and the earliest Ancestral Pueblo occupation, the Basketmaker II period. According to Irwin-Williams, the transition from the Archaic to the Puebloan lifestyle took place without a significant break (1973:11). Within the Arroyo Cuervo district, the cliff tops and the canyon-head rockshelters continue to be the main types of settlements, although the number of these sites increases sharply. These sites are believed to reflect seasonally repeated occupations. These sites also evidence the first appearance of well-made storage pits (Irwin-Williams 1973:12).

Late Archaic sites are the most common Archaic sites on the Llano de Albuquerque. Unfortunately, these sites are often found in eroded contexts on low sand dunes with few of the original features preserved. Such was the case with the Late Archaic component at the Volcano Vista High School Site (LA 134636). Positioned about 8 miles south/southwest from the proposed CNM Rio Rancho campus location, this Archaic locus yielded over 500 lithics and an En Medio projectile point, all in an eroded sand dune (Kurota 2006a).

Numerous sites tested and excavated about 3 miles east/southeast of the current project area were radiocarbon dated to the Late Archaic. One of these sites, called Lru-Kish Kachreu (LA 107577), yielded a small pit structure and 13 thermal features (Seymour et al. 1997). Similar sites were also investigated during an excavation project conducted by TRC Mariah and Associates on the Town of Alameda Grant land. Four partially eroded Late Archaic features were uncovered at LA 103035 that were interpreted as probable fire pits, although the two of the features (Feature 2 was 2 m by 0.6 m and Feature 3 was 1.2 m in diameter) were also identified as possible temporary structures (Turnbow et al. 1997:50–54). Charcoal recovered from LA 103035 produced radiocarbon dates of cal 810–515 BC; the three dates overlapped within a range of AD 390–450. This suggests the site was probably occupied during the early Late Archaic and the transitional Late Archaic or very Early Developmental period (Turnbow et al. 1997:60).

PUEBLOAN PERIOD

Two temporal classification schemes have been developed to characterize southwestern prehistoric cultural developments following the Archaic period. The earliest one is the Pecos Classification (Kidder 1927), which has been widely used throughout the Southwestern United States. The sequence consists of a series of periods termed Basketmaker II, Basketmaker III, and Pueblo I through Pueblo IV. Each of these periods is defined both temporally and in terms of the associated technology and architecture believed to characterize the time period. The second classification scheme was developed by Wendorf (1954) and Wendorf and Reed (1955) to better reflect the sequence of cultural developments in the Rio Grande Valley. This scheme identifies Developmental, Coalition, and Classic periods that roughly correspond with the Pecos Classification time span.

Basketmaker III–Pueblo I (Early Developmental) Period

The Basketmaker III–Pueblo I period (AD 450–900) is defined by new innovations, such as the use of ceramics, bow-and-arrow hunting, a significant reliance of agricultural production, and construction of year-round habitations (pithouses) and associated storage facilities. The prevalence of cists, pits, and ceramic containers to store surpluses of wild plants and cultigens indicates that agriculture began to play an increasingly more important role between the Late Archaic (or Basketmaker II) and Basketmaker III periods. This change is reflected in more permanent occupation sites typified by pithouse structures (Cordell 1978). In the Rio Grande Valley, this period is generally referred to as the Early Developmental.

Pueblo II (Late Developmental) Period

The Pueblo II or Late Developmental period (AD 900–1200) is characterized by an increased diversity in architecture and an elaboration of styles of ceramic vessel manufacture. In addition to the common pithouses with formal floor features, above-ground unit pueblos began to be used as residential units. The ever-growing reliance on agriculture resulted in the movement of settlements closer to the fertile floodplains or near the confluences of major drainages. West of the Rio Grande Valley, aggregation of populations into large settlements emerged at Chaco Canyon and the surrounding area of San Juan Basin. In the Rio Grande region the community size remained relatively small (Cordell 1978).

Pueblo III (Coalition) Period

A demographic shift to increasingly aggregated settlement took place during Pueblo III (AD 1200–1300) in the regions west of the Rio Grande. This shift seems to have involved restructuring of economic networks. Near the end of the period there is overt evidence of conflict and abandonment of some communities. In the Middle Rio Grande Valley, there is an increased use of adobe roomblock architecture, which began to replace the traditional pit structure residences. Some evidence indicates that population from the western regions began to occupy the Pajarito Plateau region as early as the late 1100s (Biella and Chapman 1977). In other areas, large pueblos were established on the first terraces above the Rio Grande. The presence of tradeware ceramics at Pueblo III sites indicates an increase in trade relations with neighboring or distant regions (Cordell 1978). However, changes in climatic conditions have been documented after AD 1200 throughout the region, e.g., in the Rio Puerco area, and abandonment of the Puebloan settlements is under way by mid-1200s (Baker 2003:195).

Pueblo IV (Classic) Period

The most dramatic changes of the Anasazi cultural sequence took place during Pueblo IV (AD 1300–1600). At this time, settlements in the San Juan Basin and the Mesa Verde region experienced a significant decrease in population, followed by the abandonment of the territory and resettlement of those populations in the Rio Grande Valley and other areas such as the Hopi and Zuni. The Classic period in the Rio Grande Valley is marked by new and even larger communities and an elaboration of material culture. The most prominent of these include glaze-paint pottery, stone effigies, and kiva murals. Most of the petroglyphs along the escarpment of Albuquerque's West Mesa are also believed to have been made during this period. Schaafsma and Schaafsma (1975) contend that these petroglyphs relate to the introduction of the Katchina cult. Large aggregated settlements were formed in the Ojo Caliente and Chama valleys, the Pajarito Plateau, the La Bajada scarp (Los Aguajes, La Cienega, La Cieneguilla, and La Bajada Pueblo), the Sangre de Cristo Mountains (Arroyo Hondo Pueblo), the Galisteo Basin (San Marcos, Pueblo Blanco, Galisteo Pueblo, Pueblo She, Paa-Ko, San Cristobal and others), in the Sandia and Manzano mountains (Sandia, Tijeras, Abo, Gran Quivira) as well as in the Middle Rio Grande Valley (Kuaua, Corrales, Santiago, Puaray, Alameda, and Calabacillas Pueblo).

HISTORICAL PERIOD

The beginning of the historic period in the Rio Grande Valley is marked by the arrival of the Coronado expedition to the region in AD 1540. At this time, the Pueblo populations were largely aggregated into a few very large settlements. Spanish contact with the native cultures resulted in a large-scale movement of indigenous people and the destruction of many pueblos. European diseases were introduced and contributed to the decimation of the native population. In 1598, almost a half a century later, a large contingent of Spanish military and administrative settlers established a capital near San Juan pueblo (relocated to Santa Fe in 1602) and began to construct missions to Christianize the local populations. *Encomiendas* granting rights to native labor and products were given to Spanish colonists, who constructed haciendas nearby existing Pueblo villages. With the increased number of Spanish *encomiendas* in the region, unrest among the native cultures grew stronger and culminated in 1680 with the Pueblo Indian Revolt, which resulted in expulsion of all Spanish settlers from the region by the Pueblo people and their allies. The Spanish regained control of the region in 1692 through an expedition led by Don Diego de Vargas (Fugate and Fugate 1989).

The earliest Albuquerque settlements were established in 1706, shortly after the Reconquest. The Spanish administrative policy replaced the *encomiendas* with a system of land grants given both to Pueblo Indians and Spanish settlers. Consequently, numerous small towns were settled by the colonists along the banks of the Rio Grande in Albuquerque's North Valley between what is today Old Albuquerque to the south and Alameda Boulevard to the north. Villages such as Alameda, Los Ranchos, Los Poblanos, Los Griegos, Los Gallegos, Los Garcias, and Los Candelarias were formed and occupied from the early eighteenth through the early twentieth century. The farming advantages led to settlement of the valley by Hispanic people in or near the former locations of the native pueblos (Sargeant 1987:45) ,while the uplands of the Llano de Albuquerque appear to have had less intensive use. Common historic period sites on top of the mesa are isolated trash dumps or masonry corrals associated with sheep herding (Rodgers 1978; 1980; Rodgers and Neal 1981).

Goods manufactured in the east began to appear in New Mexico with the advent of Santa Fe Trail trade in 1820, and the region was linked to the expanding transcontinental railroad network in 1880. In addition to fostering trade in manufactured goods, the railroad was integral to the exploitation of the territory's natural resources (e.g., timber, coal, and minerals). The early part of the twentieth century was marked by steadily increasing mercantile and ranching activities. There was a housing boom on the West Mesa in the latter half of the twentieth century, primarily in present-day Rio Rancho. In this former rangeland, thousands of house lots have been sold to the migrants from throughout the U.S. (Raymond et al. 2004).

PREVIOUS RESEARCH

In addition to the recent OCA surveys of the CNM Rio Rancho (Kurota and Chapman 2008) and UNM West (Kurota and Hogan 2009) campuses, three other survey projects that have been completed in the immediate vicinity of the project area. One is a linear survey of 485 m of road located west of the CNM Rio Rancho Campus (CNM RRC) conducted by Marron and Associates (Brown et al. 2006). The second is a survey of the 40-acre Lions Gate North parcel conducted by the Office of Archaeological Studies (Hannaford 2006). This parcel is located about 800 m west of the northwestern corner of the CNM RRC. The third project was a linear survey of the Paseo del Volcan Corridor, which runs east to west about 1 km to the south.

The sites documented during these surveys largely consist of artifact scatters of uncertain age, sometimes associated with fire-cracked rock scatters or ash stains. Hannaford (2006) interprets three of the lithic scatters in the Lions Gate parcel (LA 152555, LA 152558, and LA 152559) as quarry sites utilizing locally available chalcedony gravels. One of his other sites (LA 152556) yielded Kwahe'e Black-on-white, Santa Fe black-on-white, indented corrugated grayware, and Rio Grande Glazeware ceramics.

Numerous other survey and excavation projects have been completed in the general area over the past three decades as a result of rapid urban development in the City of Rio Rancho. In 1986, OCA surveyed a 900-acre parcel located about 1 mi east of the CNM RRC for the proposed Venada Airport. Thirteen archaeological sites and 211 isolated occurrences were documented during the survey (Hogan 1986). Most of the sites were lithic procurement areas of unknown age associated with outcroppings of Santa Fe gravels (Hogan 1986). Two Cody complex projectile points were also found during the survey.

Mariah and Associates conducted block surveys near the intersection of Highway 550 and Tamaya Road, about 5 mi northeast of the CNM RRC. Acklen and Bertram (1985:18) report that high dune overlooks in this area often contain sites spanning the Late Archaic to the historic period, while ridges overlooking large arroyo valleys tended to have sparse lithic artifact scatters. Areas of low topography and gentle slopes typically had isolated occurrences but few sites. Artifact assemblages from sites in the area were homogeneous and consisted primarily of debitage from core reduction and tool manufacture. The most common lithic raw material was a poor-quality chalcedony, with small quantities of chert, quartzite, Jemez obsidian, and other igneous materials (Acklen 1987:56).

In the 1990s, Rio Grande Consultants completed surveys of two parcels south of Highway 550 and about 4 mi northeast of the CNM RRC. Schmader (1990a) documented 36 archaeological sites during survey of a 915-acre parcel, and another 70 sites and 524 isolated occurrences were documented during survey of a 1200-acre parcel (Brandi 1993). Archaeological sites documented in this area are characteristic of the general trend of the region. Most of these sites are lithic scatters sometimes mixed with Rio Grande Glazewares of the Glaze A to Glaze D/E period. Occasional projectile points indicate are indicative of an Archaic as well as Developmental-Classic occupation. The most common features at the sites are ash stains, fire-cracked rock concentrations, and cobble features that may be agricultural facilities.

Rio Grande Consultants also conducted excavations at three sites in an area of the Town of Alameda Grant, about 2 mi southwest of the CNM RRC (Schmader 1990b). LA 45995, with Archaic and Early Developmental components, consisted of 8 thermal features and over 1000 surface artifacts. LA 45996 was an Early Developmental hamlet with three pitstructures. LA 45997 consisted of a surface scatter of lithics, ceramics, and ground stone and two ash stains exposed in a trench profile. One of those stains produced a radiocarbon date of 3645±170 rcy BC, indicating the presence of a buried early to middle Archaic component (Schmader 1990b:19).

Five sites were excavated and six sites were tested by Lone Mountain Archaeological Services, Inc. in the area of the Sandoval County Landfill, about roughly 3 mi east of the CNM RRC (Seymour et al. 1997). Again, most of these sites were lithic and ceramic scatters, sometimes associated with ash stains and hearth features. The Lru-Kish Kachreu site (LA 107577) also contained a burned Late Archaic structure with a hearth, however. Two other Late Archaic sites were excavated by TRC Mariah and Associates on the Town of Alameda Grant area, roughly 3 mi south southeast of CNM RRC (Turnbow et al. 1997).

In the summer of 2005, Parsons and Brinckerhoff conducted testing and excavations at eight sites along the area proposed for the construction of Paseo del Volcan between Unser Boulevard and Iris Road. The preliminary report of this undertaking documents the discovery of charcoal and ash stains and/or fire-cracked rock in buried contexts at five of the eight investigated sites (Raymond 2005).

Chapter 5

RESEARCH DESIGN AND FIELD METHODS

by Patrick F. Hogan and Alexander Kurota

Research designs are traditionally developed by identifying a research question and then selecting one or more sites where excavations will yield data relevant to that question. This process is necessarily reversed for data recovery programs because outside factors determine which sites will be investigated. Consequently, the kinds of data likely to be recovered from the sites will largely determine what research questions are addressed. In this case, the sites are typical of those found across the northern Llano de Albuquerque – small debitage scatters with few or no temporally diagnostic artifacts. Given the limited information previously recovered from such sites, we anticipated that research would focus primarily on defining lithic procurement strategies, although settlement and subsistence practices also would be investigated. The research design therefore posed three basic questions: when were the sites occupied; what activities were performed at those locations; and what was the organization of the lithic technology?

WHEN WERE THE SITES OCCUPIED?

The question of chronology is fundamental to all archaeological inquiry. Ordering sites in time is basic to reconstructing the culture history of a region and to examining cultural change. Grouping sites that are at least broadly contemporaneous is also an essential step in defining the settlement and subsistence patterns characteristic of the different time periods. Priority during the fieldwork therefore was given to the search for buried features from which charcoal could be recovered for radiocarbon dating.

The search was made using a combination of auger probes, shovel test pits, and hand-dug excavation units. Initial testing was conducted in locations where surface artifacts were concentrated and then expanded outward. Later, as geoarchaeological studies were completed, we were better able to focus our search on those parts of the slopes where buried cultural materials were most likely to be preserved. This approach was feasible because the surface sediments covering the cultural materials were generally shallow; nevertheless, it was not practical to systematic test the entire site area. Consequently, brushing and grading operations by the construction contractor were monitored to ensure that all features at the sites were documented and sampled.

Radiocarbon dates were obtained for one or more components at three of the sites (no dates were obtained from LA 160886), so we were largely successful in addressing this research question. As expected, the site components represent relatively short-term occupations but the range of dates was somewhat surprising. They indicate intermittent use of the project area from the late middle Archaic through Historical periods, largely mirroring the occupational history for the northern Llano de Albuquerque as a whole (Schwendler and Railey 2009:199–217).

WHAT ACTIVITIES WERE PERFORMED?

In defining site type, archaeologists are making a generalization about the kinds of activities conducted at a site and the nature and duration of the occupation, which is a necessary step in identifying the settlement/mobility patterns. Like most of the sites recorded during earlier surveys in the surrounding area, the sites on the CNM RRC are situated near gravel outcrops containing nodules of Rio Grande chalcedony and consist largely of the debris from the initial reduction of those nodules. Based on that evidence, they were classified as lithic procurement areas. The classification tentatively identifies the major activity at the sites but leaves open questions about the larger context in which the lithic procurement activities occurred.

A frequent assumption is that lithic raw materials were obtained through *direct procurement*; that is, groups traveled to the study area specifically to collect lithic raw materials which were then transported back to the residential base. Because the stone itself is the resource being targeted, artifact assemblages at direct procurement sites are expected to consist primarily of the debris resulting from reduction to assess the quality of the material and/or to remove cortex from the nodules prior to transport. Most direct procurement was probably limited to day trips, given the ubiquity of lithic materials in the Middle Rio Grande region and evidence that groups tend to minimize the cost of transporting lithic raw materials (Arakawa and Nicholson 2009). Thus the sites are unlikely to have associated hearths or other evidence of short-term occupations.

Binford (1979) argues that mobile hunting and gathering groups rarely employ direct procurement, however. Instead, lithic procurement tends to be *embedded* in routine subsistence activities. In this behavioral context, the group's efforts would have been directed primarily toward the collection of food resources, and lithic procurement would have been an incidental, opportunistic activity that happens to have high visibility in the archaeological record. Embedded procurement sites are therefore expected to evidence subsistence activities as well as lithic procurement, and to include features and other evidence of short-term occupation. Consequently, our efforts to address this research question were focused on the identification of subsistence-related activities and the general nature of the occupations.

Our excavation strategy was designed to recover three data classes. First, we hoped to obtain archeobotanical and faunal materials providing direct evidence of the food resources being targeted. Those materials are most likely to be preserved in sheltered contexts, particularly when charred, which reinforced the emphasis given locating and sampling features and other buried cultural deposits. The recovery of subsistence remains during previous excavations at sites in the area has been disappointing, presumably because organic preservation at open sites is generally poor. To enhance recovery, the entire fill of small features – hearths and roasting pits – was collected for flotation, and midden deposits and structure floors were sampled heavily. Second, functional analysis of flaked and ground stone tools from the sites was expected to provide indirect evidence for subsistence activities. Third, the types of features present, the distribution of artifacts relative to the features, and the size of the artifact assemblages were expected to contribute information about the general nature and duration of the occupations. For these last two data sets, excavations were needed to expose the occupation areas and to recover all or a large sample of the artifacts associated with each component. Thus the emphasis given to probing for subsurface features had to be balanced by the need for hand-dug, area-extensive excavations.

This approach was only partially successful. The sites had few formal and informal tools and, although charred macrobotanical remains were recovered from several features and a small collection of faunal remains was obtained from LA 158642, the subsistence resources being targeted could not be positively identified. Nevertheless, the components at three of the sites appear to be camps occupied by groups engaged in hunting, wild plant gathering, or cultivation. At these sites, lithic procurement appears to have been embedded in subsistence activities. LA 160886 was the only site at which lithic procurement appears to have been the primary activity.

HOW WAS THE LITHIC TECHNOLOGY ORGANIZED?

The organization of lithic technology comprises the various strategies and methods employed by a cultural group to ensure that adequate stone tools are available for a task despite any "spatial and temporal differences between the location of lithic raw material and the locations of stone tool use..." (Parry and Kelly 1987:300). Consequently, the organization of lithic technology is closely linked to the subsistence and settlement/mobility strategies employed by prehistoric groups. Lithic materials from known sources can be used to trace the movements of prehistoric groups and the degree to which the lithic technology is dominated by a curated versus expedient tool kit can provide insights into the mobility strategies utilized by the group creating the assemblage (Bamforth 1986, Parry and Kelly 1987, Shott 1986, 1996, Young 1994). As tool production tends to be staged as groups move from one location to another, analysis of the debitage assemblage can provide important information concerning both the manufacturing activities conducted at the sites and strategies for conserving raw materials.

Analysis of the debitage from the CNM RRC sites was formulated to provide information about non-local lithic materials, the manufacturing stages represented at the sites and the relative emphasis given to core reduction versus bifacial reduction and tool manufacture. The information, in turn, was used to address issues relating to the behaviors associated with the lithic procurement. The most common interpretation is that the tool stone collected from the Rio Grande gravels was minimally reduced and then transported to a residential site or basecamp some distance from the procurement area. However, little attention has been given to determining whether the lithic raw materials were transported as nodules, trimmed cores, flake blanks, early stage bifaces, or finished tools. It is also possible that lithic raw material was collected for local use rather than transport. That is, groups may have used the locally-available raw materials to produce or maintain the tools needed for the subsistence related activities in which they were engaged. This kind of expedient lithic technology tends to be characteristic of sedentary groups and of mobile groups in areas like northern Ceja Mesa where lithic raw materials are ubiquitous (Andrefsky 1994; Parry and Kelly 1987). It also results in a debitage assemblage very similar to the primary core reduction associated with lithic procurement, although the assemblage should include some expedient tools, which tend to be discarded once a task is completed.

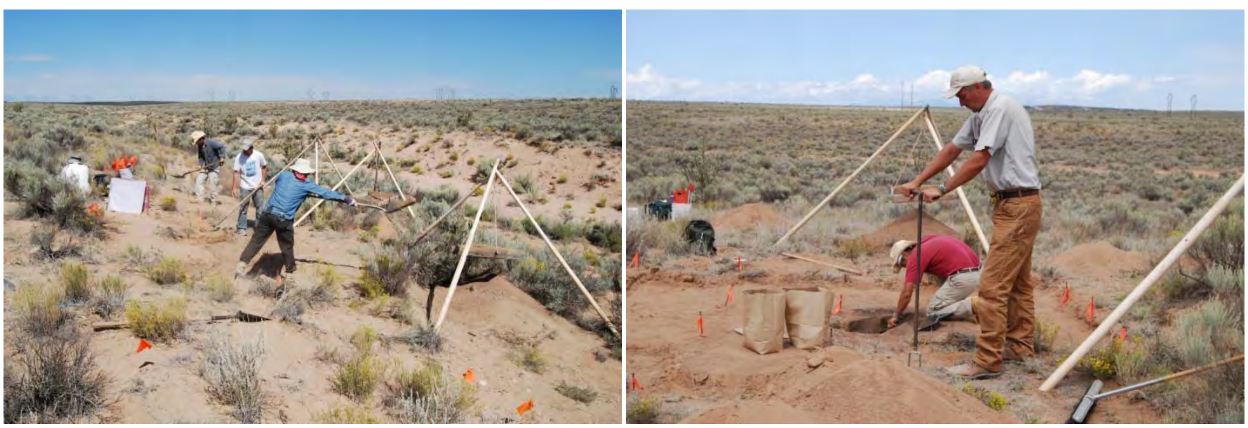
Again, the analysis yielded useful information if not definitive answers to the research questions. The debitage from all of the sites consisted predominantly of core reduction debris, although there was evidence for limited bifacial reduction at LA 156842. While not conclusive, the debitage from the Archaic components suggests that nodules were partially worked before they were brought back to the camps for further reduction to remove additional waste material. Based on the relatively high flake to core ratios, it is likely that some of this tool stone was carried away from the site as small trimmed cores. The debitage from the Ancestral Puebloan components, in contrast, reflect all stages of core reduction, which appears to have been directed toward the production of flakes. This reduction trajectory is typically indicative of expedient tool production, although few flake tools were recovered. Their absence could be a function of the small sample size, or the flake tools may have been employed in tasks that produced no recognizable use wear. Alternatively, the collected lithic material may have been transported as flake blanks.

FIELD METHODS

The data requirements of the research design dictated an excavation strategy that was directed initially toward the discovery of any significant subsurface cultural deposits at the sites. In the later stages, the emphasis shifted to a full investigation of the discovered features and to the recovery of a large sample of artifacts. Fieldwork began with the crews systematically resurveying the site areas at a 5 m transect interval and pinflagging all surface artifacts and features. Artifacts were then piece-plotted using a Topcon GTS-220 Electronic Distance Measurement (EDM) and collected for laboratory analysis. Plots of these data were generated to define artifact concentrations, which largely determined the placement of the initial test pits. Previously recorded features were relocated and new features mapped.

Once the surface collection was completed, the EDM was used to prepare a topographic map of the site and to lay out a north-south baseline for the grid, oriented to magnetic north. If the survey datum was in a suitable location, then it was incorporated into the baseline; otherwise a new site datum was established consisting of a rebar stake with an aluminum cap marked with OCA-UNM and the site's field number. In either case, the baseline datum was assigned grid coordinate N100 E100 and arbitrary elevation of 100 m. The grid was extended east and west of this baseline as needed to position excavation units. Grid points, the site boundaries, and the surface artifact locations were added to the site map and, as the excavations progressed, the locations of all excavation units and prehistoric features were added.

Initial excavations consisted of a combination of auger holes, shovel test pits, and 1 by 1 m test pits to define the site stratigraphy and probe for buried features. The 1 by 1 m units, designated as Study Units (SUs) were positioned to investigate surface artifact concentrations and surface-visible features (Figure 5.1a). These units were expanded as necessary to uncover activity areas surrounding features or to follow-out occurrences of sub-surface artifacts. Auger holes were then used to probe for additional subsurface features in the areas adjacent to the more productive excavation units (Figure 5.1b). After excavation, the study units were mapped using the EDM.



a b

Figure 5.1. Excavations in progress: (a) OCA crew excavating 1 x 1 m grid units along the slope of an unnamed arroyo; (b) auger testing outside excavation areas.

All units were excavated by hand in 10 cm arbitrary levels or natural stratigraphic units, and all excavated sediments were screened using 1/8-inch mesh. Artifacts and other analyzable materials such as charcoal recovered from the excavations were bagged and taken back to the OCA lab. These artifacts and samples were provenienced by 1m grid square or feature, and by 10cm level or stratum. The excavations were documented on OCA Excavation Level Record and Feature Excavation Record forms. Profiles of the units and plans and profiles of the features were drawn to scale on graph paper, and photographs were taken at each stage of the excavation. Excavations in the SUs ceased when sterile soil strata were exposed or no artifacts were recovered from a level and the level preceding it.

All discovered features at the sites were completely excavated, and the areas surrounding the features were excavated to expose possible buried occupational surfaces and additional features. Prior to beginning feature excavation, the vegetation was removed from each feature to reveal its shape and size in plan view. Once this was accomplished, smaller features such as hearths and roasting pits were bisected, and one half of the fill was removed as a single stratigraphic unit. In bisecting a feature, two chaining pins were positioned on opposite sides of the feature and a line with a line level was strung between the pins. This level line was used as a point of reference to measure depths for the profile drawing of the remaining feature fill. If the remaining fill had well-defined stratigraphy, then the second half of the feature was excavated in discrete stratigraphic units. If no stratigraphy was discernible or if there was obvious evidence of bioturbations (e.g., animal burrows or plant root activity), then the remaining part of the fill was excavated as a single unit. All of the excavated fill from the small features was bagged for flotation and fine screening of the heavy fraction.

Structures were excavated in 1 by 1 m grid units, as were the activity areas surrounding all of the features. After a structure was exposed in plan, the fill from one half of the structure was removed to floor level to expose the structure and fill in profile. Pollen and flotation samples were collected from the fill immediately above the floor but the remainder of the excavated sediments was screened. After the profile drawing was completed, the remainder of the fill was removed, and the floor was exposed. Any interior features then were excavated following the procedures for small features described above. A scaled plan drawing was made of the structure was made once the excavations were completed.

Stratigraphy at the sites was examined by Scott Worman, the project geoarchaeologist, during the early stages of the excavations. This study quickly established that the earliest dune deposits at LA 158640 and LA 158642 had formed during the late Pleistocene. After a period of stability marked by soil formation, there was a period of erosion and renewed aeolian deposition, probably dating from the middle Holocene. Most of the intact cultural deposits at the sites were associated with this depositional unit. The uppermost depositional unit consisted of a 4-11 cm thick layer of sand deposited during the twentieth century that masked the cultural deposits. The geoarcheological study further established that slope erosion had differentially affected deposits in the site area. As a result, cultural materials on the middle hillslopes are likely to be lag deposits or secondary deposits that have been transported downslope. Intact cultural deposits are more likely to occur either at the foot of the slope where a wedge of sediments has accumulated, or at the summit where water erosion has been minimal. This last finding allowed us to focus our excavations in the areas most likely to yield the range of data needed to address our research questions.

After the excavations were completed, all excavation units were backfilled and, to the extent possible, the ground surface was restored to its original contours. Because of the season and the fact that the ground surface would be disturbed again during construction of the CNM campus, re-vegetation of the excavation units was not attempted.

A backhoe was used during the excavations at LA 158642 to remove overburden covering the buried midden deposits in Area 2 (Figure 5.2) and to excavate a stratigraphic trench extending from the top of the dune to the arroyo. It was not used to probe for buried cultural materials. Mechanical stripping is an efficient method for locating buried features but it removes the artifacts associated with those features. Hand excavation avoided this information loss and, because most of the cultural deposits at the CNM RRC sites were only shallowly buried, it was almost as effective in locating buried cultural deposits. Nevertheless, the initial phases of construction were also monitored to pick up any features missed during data recovery.

Figure 5.2. Backhoe scraping at LA 158642, view looking east.

Site preparation for the construction consisted of clearing vegetation from the construction area and extensive re-contouring of the terrain to level the building site and channel surface runoff. An access road was also bladed and graded. Those operations were monitored by OCA archaeologists. After each sweep by the mechanical equipment, an archeologist inspected the cleared swath for artifacts or evidence of features. When cultural materials were found, construction was halted in that part of the construction site to allow the archeologists to inspect and document the discovery. Individual artifacts or small artifact clusters were documented as isolated occurrences. Their locations were documented using GPS and the artifacts were either collected (if they were within the boundaries of the investigated sites) or recorded in the field using the same attributes employed for the laboratory analysis. At least a 2 by 2 m area was shovel scraped around ash stains or fire-cracked rock clusters to expose the features in plan. They were then excavated and sampled using the same methods employed during data recovery. The UTM coordinates of the discovery features were recorded using GPS, which allowed them to be tied into the grid systems of the excavated sites. No additional features were found at LA 158640 and LA 158642 during the construction monitoring but four features were discovered and excavated within the boundaries of LA 158641.

Chapter 6

EXCAVATIONS AT LA 158642

by Alexander Kurota, F. Scott Worman, and Douglas Rocks-Macqueen

LA 158642 originally was document by OCA crews in February 2008 as a small lithic and ceramic artifact scatter situated on a north-facing hillslope overlooking an entrenched tributary of Arroyo de la Barranca (Kurota and Chapman 2008). The scatter covered an area of 35 by 25 m and consisted of 14 flaked stone artifacts and one Rio Grande grayware sherd. The sherd suggested a transitional Coalition/Classic period date for the site. The lithic assemblage consisted of 10 flakes, three pieces of angular debris, and one tested rock, all chalcedony. They were characteristic of the early stages of reduction typically associated with lithic procurement activities. The northern edge of the artifact scatter abutted the southern bank of the arroyo, where extensive gravel deposits are present. As exposed in the arroyo wall, the surface sediments at the site are part of a thick deposit of aeolian sand. Three auger tests, reaching a depth of 1.4 m, were completed in the central part of the artifact scatter during the survey. Although no artifacts or ash/charcoal stained sediments were encountered, the probes encountered deep sandy sediments, so the possibility that there were buried artifacts or features at the site could not be discounted.

The character of LA 158642 had changed somewhat by the time the excavation crew began work at the site. Heavy rains and high winds had uncovered a small concentration of ash-stained sediments and burned animal bone (Feature 3) about 38 m northwest of the survey datum, and a large, faint lens of ash-stained sediments had been exposed in the south wall of the arroyo, about 55 m north northwest of the datum. A hearth (Feature 1) also had been exposed in the north wall of the arroyo, opposite the ash lens and at about the same relative elevation (ca. 60 cm below modern ground surface). The boundaries of the site were expanded to encompass these newly exposed features. The originally-recorded artifact scatter was designated Area 1, the area defined by Feature 3 and the ash lens was designated Area 2, and the area around Feature 1 was designated Area 3 (Figure 6.1).

LA 158642 is situated on the lower north-facing slope of a stabilized dune ridge and in a relatively flat area bisected by the drainage immediately to the north of the ridge. LA 158640, which was also excavated during this project (Chapter 7), is located on the opposite, south-facing slope of this same ridge. The drainage, which runs roughly east-west through LA 158642, is an unnamed tributary that eventually feeds into the Arroyo de la Barranca. It is incised to a depth of as much as 2 m at the site. The difference in elevation across the site is 9 m, with the lowest point in the bottom of the arroyo and the highest, on the hillslope at the southwest boundary. There is a potential for flooding in the low areas adjacent to the arroyo, and the entire site is moderately susceptible to wind erosion. Of the native plants recorded in the area (Spellenberg 1979), the most common at the site are snakeweed, grama grass, sand dropseed and galleta grass. Scattered cholla cactus is also present.

Excavations at the site uncovered four components. The earliest is a small Late Archaic residential occupation in Area 2, immediately south of the drainage. This component includes a possible structure, a large roasting pit, several smaller pit features, as well as midden deposits. Study Unit 2 and two small test pits, Study Units 6 and 7, were opened to investigate this occupation. The site's second component consists of a hearth, Feature 1, exposed in the northern bank of the arroyo. This feature was sampled but, because the north side of the arroyo is not part of the proposed construction area, no excavations were conducted in Area 3. The third component consists of the originally recorded artifact scatter located in the eastern portion of the site now designated Area 1. A Coalition/Classic-period date is suggested for this component based on the presence of a single Rio Grande plainware sherd. Excavations in this area were limited to two 1 by 1 m test pits (Study Units 4 and 5) that were opened to assess the stratigraphy in this part of the site. Finally,

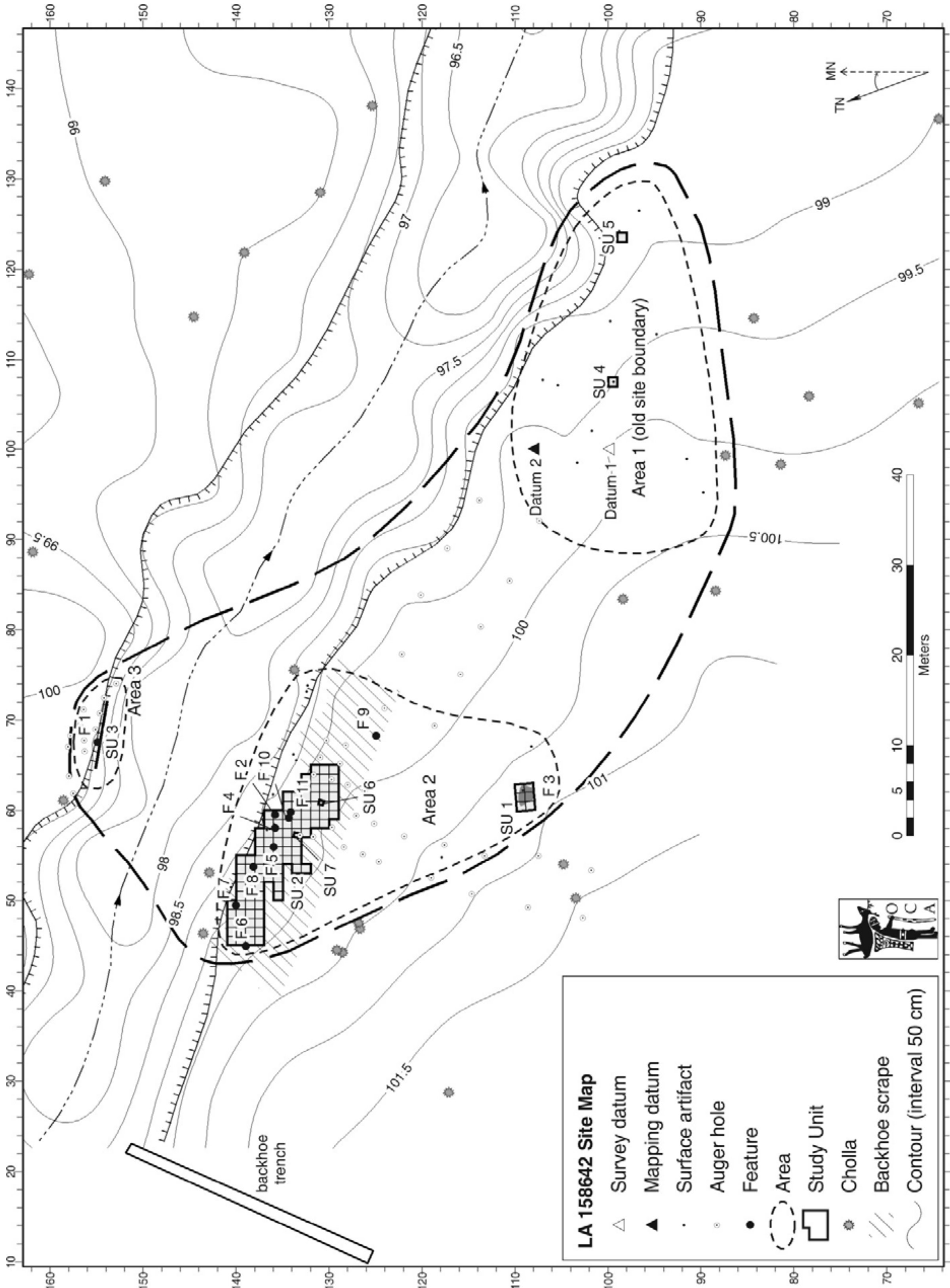


Figure 6.1. Map of LA 158642 showing excavated areas and discovered features.

the fourth component is a hearth (Feature 3) dating to the historical or recent period located at the southern edge of Area 2. Study Unit 3 was opened to investigate this feature.

SITE STRATIGRAPHY

by F. Scott Worman

Preliminary descriptions of the sediments exposed in each study unit were completed during the excavations to guide subsequent excavations and provide baseline information about the matrix in which cultural materials were encountered. Subsequently, Worman completed formal, in-field pedostratigraphic recording of selected excavation units in Area 2, the arroyo wall in Area 3, and a backhoe trench excavated to the west of Study Unit 2. The geoarchaeological studies were undertaken to provide insight into site formation processes and local landscape change. Worman's methods and data are presented in Appendix B, and the results are incorporated as relevant here and throughout the remainder of this chapter.

Study Units 6 and 7

Study Units (SUs) 6 and 7 were excavated as 50 by 50 cm test pits positioned on the hillslope above and to the south of the lens of ash-stained sediments visible in the south bank of the arroyo. They were dug to test the depth and extent of buried cultural deposits. Diffuse charcoal and ash staining and artifacts were encountered in both soundings at depths between 38 and 87 cm bmgs (below the modern ground surface). Formal pedostratigraphic descriptions were completed before block excavations were undertaken. The westernmost of the two, SU 7, is located at the foot of the north-facing slope of the stabilized dune ridge. The eastern test pit, SU 6, is roughly 2 m away and slightly downhill, at the toe of the slope. The soils and sediments at the two locations are similar, with minor differences reflecting somewhat greater post-depositional mixing in SU 7.

Study Unit 7

The western 50 by 50 cm test pit has loose 20th Century aeolian deposits at the surface, similar to the recent surficial deposits ubiquitous on Albuquerque's west mesa. Because there is no evidence of pedogenic alteration, the surface sediments are designated a soil C horizon (parent material) here[1]. The subjacent unit is a buried A horizon with inherited carbonates. Weak structure and slight color changes reflect minor pedogenic alteration. Soil characteristics are more weakly expressed than in the buried A horizon in Study Unit 3 at LA 158640 but are slightly stronger than those described by Hall (2006) for his "historic A horizon soil." The sediments very likely were deposited within the past few hundred to one thousand years. Due to the generally homogeneous texture and color of the uppermost three strata, krotovina were not highly visible. The lack of depositional structures and the gradual lower boundary of the buried A horizon, however, indicate that the sediments have been bioturbated to a significant degree.

The underlying 2Bk horizon is stained by charcoal and it yielded several artifacts. Although the upper boundary is gradual, changes in clastic content, and minor texture and color changes indicate different origins for the Ab and 2Bk horizons. The presence of rounded and subrounded gravels in the 2Bk unit reflects inputs from a small fluvial system in addition to the accumulation of sediments emplaced by aeolian processes. Because some of the carbonates likely are inherited and whitening of the horizon may be due in part to gypsum, carbonate morphology does not provide much insight into the timing of initial deposition.

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[1] Slight color changes and massive or weak structure in the surficial deposits at LA 158640 warranted the designation as A horizons at that site.

The weak ped structure and lack of clay films, however, imply that the unit very likely is not more than a few thousand years old. During subsequent block excavations in the area, several features and numerous artifacts were encountered within this stratum.

The 3Bkj horizon at the base of the sounding exhibits minimal pedogenic alteration. The color and texture are consistent with sediments identified by Hall as unaltered sandy parent material emplaced roughly 10,000–15,000 years BP. He states that, "The most conspicuous aspect of the eolian sand is the red paleosol that occurs everywhere at the top of the late Pleistocene sand unit" (Hall 2006:6). The clear upper boundary of the 3Bkj unit suggests that the red paleosol was removed in this location by erosion, probably related to the small wash or swale that deposited the gravels in the overlying unit.

Study Unit 6

The eastern 50 by 50 cm test pit, exposed similar strata. The C, Ab and 3Bkj horizons are virtually identical in the two locations and provide the same information concerning the timing and processes of deposition. The only significant difference between the two exposures is that 2Bk and 2Bk2 horizons can be differentiated in SU 6 in place of the single 2Bk horizon in SU 7. At least some of the carbonates in both horizons likely are inherited, so carbonate morphology again provides little insight into the timing of deposition. The weak blocky ped structure and lack of clay films imply that neither is more than a few thousand years old at most.

The differentiation of two Bk horizons at the eastern sounding is important for three reasons. First, the decrease in gravels and upward-fining texture from the lower to the upper horizons indicate decreasing stream competence through time. The small wash or swale carried a greater volume of water earlier in time, and aeolian deposition gradually became dominant over fluvial deposition and reworking. It is not possible to determine from the current evidence whether this reflects a minor climate shift or geomorphic processes such as stream capture or dune migration.

The second important observation is that the charcoal staining and the majority of the recovered artifacts are associated with the lower horizon. This implies that the human presence was coincident with the period of greater stream flows and that site use dwindled or ceased as flows became weaker and less frequent. This could reflect fewer visits to the site because of generally drier conditions, or it might imply that people were utilizing a resource specifically associated with the moist swale. The presence of dispersed charcoal in what is inferred to be a swale also suggested that the primary locus of activity was upstream, a prediction borne out by the discovery of numerous features upstream during subsequent block excavations.

The third reason that differentiation of the horizons is significant is that it shows that bioturbation has impacted the area of SU 6 less severely. Given the depths and thicknesses of the horizons in the two soundings, it seems likely SU 7 was located nearer the center of the ancient swale while SU 6 was located at the edge. Most likely, increased moisture and enhanced edaphic conditions persisted for a longer period of time at the center of the swale while the periphery became desiccated. The greater moisture availability at the center of the swale fostered a higher level of biotic activity for a longer period of time, resulting in increased bioturbation. Although it may seem odd that insect krotovina were more abundant and visible at the eastern locus, both Stein (1983) and Johnson (1989) propose that severe bioturbation makes burrows largely invisible because there is no discernable difference in color or texture between the matrix and the materials that fill them.

In sum, then, the data from these two test pits suggest that the deepest sediments probably were emplaced during the Pleistocene. Subsequently, a small swale formed in the area, eroding the soils that had formed at and near the surface of the Pleistocene deposits. People utilized the site while the swale carried relatively larger and more frequent flows, and visited the site less often, if at all, as flows diminished. Eventually, the flows ceased and roughly 25–30 cm of aeolian sand were deposited, presumably filling the swale completely. Finally, 20th Century erosion and redeposition emplaced the surficial sediments. Unfortunately, the timing of all events but the initial emplacement of sediment in the Pleistocene and the deposition of the surface unit is poorly constrained. In general, soil characteristics suggest that the pre-Hispanic occupation occurred during the past one to few thousand years.

Backhoe Trench

After the initial investigations at the soundings were completed, culturally sterile overburden was removed mechanically and controlled archaeological excavations were undertaken over a larger area. In addition, a backhoe trench was opened west of (and upstream/ uphill from) the expanded Study Unit 2 to continue the stratigraphic study. The trench was excavated roughly perpendicular to the incised arroyo, cutting south from the bank to approximately the mid-slope of the stabilized dune. It was approximately 25 m long and 1.5 m deep and exposed a complicated series of strata deposited by aeolian and fluvial processes. Formal soil descriptions were completed in the location of what appeared to be a shallow swale where dispersed charcoal was present in the fill. In addition, a measured profile drawing of the exposure was created and formal descriptions of each of the depositional units were recorded (Figures 6.2 and 6.3). As with other study loci, the formal soil descriptions are presented in tabular form in Appendix B.

A shallow, buried swale is exposed in cross-section approximately 11.5 m south of the north end of the backhoe trench. The soils and sediments in the swale fill are similar to those encountered in SUs 6 and 7. The surficial unit is the same as that present across most of the area, a 20th Century aeolian sand. The subjacent unit is a weakly-developed B horizon, suggesting that recent erosion has removed the buried A horizon that was preserved in the location of the soundings. The Bw horizon is similar to the 2Bk horizons described in SUs 6 and 7 in terms of color, structure, clast content and carbonate and clay film morphologies. The subjacent Bw2 horizon, with dispersed charcoal staining, appears to correlate with the 2Bk2 horizon in SU 6, exhibiting virtually the same color, ped structure, clastic content, texture, and clay film and carbonate morphologies[2]. These similarities imply that the units in both locations have the same origin and age; they are fill in the small swale exposed in the soundings and in cross section in the backhoe trench.

The Bw3 horizon in the backhoe trench exposure is finer in texture and the color and structure are somewhat different from the 3Bkj horizons exposed in SUs 6 and 7. In addition, the gradual boundary between the Bw2 and Bw3 horizons contrasts markedly with the clear boundaries at the base of the Bk horizons in the test pits. The differences suggest that the swale partially filled in the location of the backhoe trench prior to the human occupation. The texture and clast content of the Bw3 horizon imply significant aeolian inputs and relatively weak flows in the channel; it probably was an ephemeral channel through sandy deposits that formed and refilled multiple times. The clear to abrupt boundaries at the base of the Bk and Bw horizons

[2] The different subordinate distinguishing modifiers (k vs. w) used in describing the strata do not in this case suggest that the pedogenic processes are significantly different. Instead they reflect a tension inherent in soil science related to the disparate origins of the discipline in agriculture and geology; the first tends to focus on describing the current state of soils while the second is more concerned with soil genesis and development (Holliday 2004:8–19 provides a cogent overview). Carbonates are present in both profiles, requiring a k designation from the agricultural perspective. The designation as Bw in the backhoe trench reflects a geological or soil geomorphic orientation and the recognition that the majority of the carbonates are inherited and not pedogenic. Both strata also could have been designated Bkj to suggest minor accumulation of pedogenic carbonates.

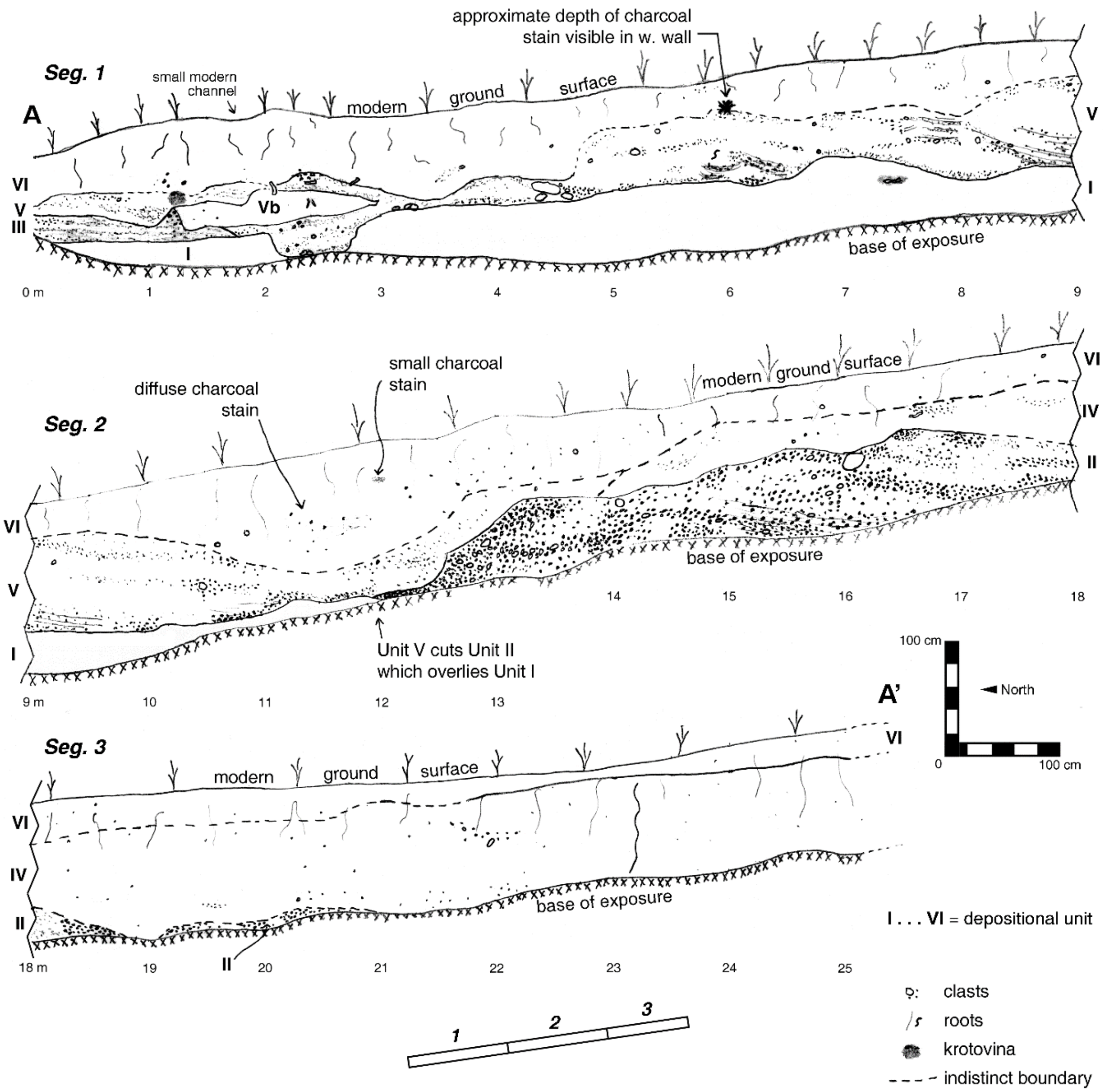

Figure 6.2. Backhoe trench profile sketch showing depositional strata to the west of the site, view looking southeast.

are the base of the swale. In SUs 6 and 7, the swale appears to have incised to the depth of a Pleistocene sand sheet, while in the backhoe trench the base cuts into ancient channel deposits.

The pedostratigraphic observations at the backhoe trench do not change in any significant way the interpretations of the timing or landscape context of the human occupation derived from observations at the test pits. In both loci, it appears as though activities were focused around a shallow swale. The degree of soil development in the associated deposits suggests that the human occupation is unlikely to have occurred

Figure 6.3. Overview of backhoe trench profile segment, view looking northeast.

more than one or a very few thousand years in the past. Interestingly, the stratigraphic position of the charcoal staining in the backhoe trench exposure and in the soundings suggests human presence during the period of greatest flows in the swale, with weaker and less frequent flows both before and after. Owing to those increased flows, the swale may have been cutting headward during the human occupation, with erosion removing the Bw3 sediments at the location of the test pits and downstream. The 2C and Ckm horizons exposed below the shallow swale in the backhoe trench are the same as depositional units V and I, described below.

Along its length, the backhoe trench exposes a complicated series of strata emplaced by aeolian and fluvial processes. Each of the depositional units shown in Figure 6.2 is described here, followed by a brief consideration of what they reveal concerning the long-term history of geomorphic change in the study area. Stratum I, at the base of the northern end of the trench, is a weakly-lithified yellowish fine sand. Variable HCl reactivity and the presence of obvious $CaCO_3$ accumulations along vertical cracks and rare horizontal laminae suggest that cementation of the sediments is due to processes other than illuviation of pedogenic carbonates; the carbonates reflect later translocation from overlying deposits. The laminae suggest that this very likely is a sand or sandstone member of the Santa Fe Group emplaced by the ancestral Rio Grande.

Stratum II is a coarse, gravelly fluvial deposit that overlies Stratum I where the contact is exposed. The size of clasts and degree of rounding indicate that the ancient channel was probably larger and more competent (i.e., it carried flows capable of moving larger clasts) than the current arroyo adjacent to the backhoe trench. Localized $CaCO_3$ cementation and laminar structures at the upper boundary are present, indicating stage II carbonate morphology (stage designations after Machette 1985). While this would suggest a timing on the order of ~24,000 to >130,000 years for initial deposition, the relationship to Stratum IV and the likelihood that the petrocalcic horizon was exposed to weathering for a significant period of time in the past indicate that Stratum II very likely is significantly older. Burial by later deposits may have inhibited further accumulation of pedogenic carbonates in Stratum II.

Stratum III is a coarse, gravelly fluvial deposit that overlies Stratum I at the very northern end of the backhoe trench. It is strongly rubified but lacks significant accumulations of pedogenic carbonates.

Although the gravels are somewhat smaller, Stratum III may correlate with Stratum II, as both are cross-cut by Stratum V. In any case, Stratum III is another channel deposit and it antedates Stratum V.

Stratum IV overlies Stratum II in approximately the southern half of the backhoe trench. It is a well-sorted, fine loamy sand with occasional small pebbly lenses, indicating aeolian deposition and rare rilling at the surface. Evidence of pedogenic carbonates including whitening, cementation, laminar structures at the upper boundary, and prominent root channels and dissolution pipes, indicate a weathered stage III morphology; Stratum IV is an ancient petrocalcic horizon that has since been exhumed and eroded to some degree. The unit is similar to the paleosol developed on the Rincones surface described by Hall (2006), for which he infers initial deposition more than 2.5 million years ago followed by exposure and erosion approximately 20,000 years BP. Given its stratigraphic position above the Santa Fe group, it is likely that the paleosol is somewhat younger in this instance. In any case, the sediments very likely were emplaced on the order of more than a million years in the past, which means that Stratum II also was deposited on the order of more than a million years in the past.

Stratum V, present in roughly the northern half of the backhoe trench, is a weakly-cemented gravelly deposit with numerous lenticular concentrations of clasts indicating predominantly fluvial deposition. Stratum Vb is a sandy facies inset into Stratum V, suggesting a temporary but significant diminution in stream competence. Although the boundaries are indistinct, Stratum V appears to cross cut (i.e. is younger than) Stratum IV. This chronological relationship is corroborated by the weak evidence of pedogenic alteration of the deposit; pedogenic carbonates, clay films and other indications of significant soil formation are absent in Stratum V. The cementation and, in Stratum Vb, the weak granular structure are broadly consistent with the degree of soil formation noted by Hall (2006) for sediments deposited on the order of 10,000 to 15,000 years BP. The cambic B horizon he documents is not expected here due to reworking of the sediments by the fluvial system. Although the age of the unit likely is late Pleistocene to early Holocene, it remains poorly constrained by the current data. In addition, deposition very likely was diachronic. The channel probably initially formed uphill, towards the southern end of the unit. Over the millennia, it probably formed and filled many times and slowly migrated northward and progressively cut downward, eventually culminating in the formation of the current arroyo.

Stratum VI is a well-sorted fine loamy sand with occasional small lenticular, pebbly facies that is present near the surface along the entire length of the backhoe trench. It is predominantly aeolian in origin, with the pebbly facies indicating rare surficial rilling. As with Stratum V, the timing of deposition is poorly constrained by the current data and it likely was diachronic. The only clear evidence of pedogenesis is the development of weak to moderate structure, variably expressed at different points along the exposure. The weak soil development and absence of any indication of cambic or argillic horizons suggest that the unit is Holocene in age. As in Study Unit 3 at LA 158640, at the summit of the stabilized dune, it is tempting to infer that initial deposition was related to the mid-Holocene altithermal (~7000–5000 BP), but this hypothesis cannot be tested rigorously with the current data.

As described above, dispersed charcoal staining is present in a shallow swale that is set into Stratum VI sediments and filled by reworked Stratum VI sediments. The staining is inferred to be related to the cultural deposits excavated in Study Unit 2. Based on the associated artifacts and pedogenic alteration of the surrounding matrix, the occupation probably is late Archaic; the swale most likely formed during the later Holocene and carried peak flows at the time of the human presence. This, in turn, indicates that portions of Stratum VI were reworked as recently as 2,000–1,000 BP.

Stratum VII, not shown on the profile drawing, is the 20th Century aeolian deposit present across most of the study area. It is variably present across the surface and as much as 5 cm thick along the backhoe trench. The absence of a buried A horizon below Stratum VII shows that recent erosion removed and/ or reworked surficial sediments in this area.

The strata exposed in the backhoe trench reflect a long history of repeated cycles of channel formation and filling interspersed with deposition of extensive sand sheets and extended periods of relative landscape stability that facilitated soil formation. Stratum I likely was emplaced by the ancestral Rio Grande at some time between the Miocene and lower Pleistocene. Stratum II and possibly Stratum III represent an ancient channel of a tributary to the Rio Grande. Clast sizes and rounding indicate that the channel carried more significant flows than the current arroyo. Because pedogenic characteristics and stratigraphic relationships show that it very likely is more than a million years old, it is reasonable to assume that it indicates a period with climatic conditions significantly wetter than those dominant during the Holocene.

Stratum IV reflects deposition of a sand sheet that buried the ancient channel at least a million years ago. Stratum V represents the later formation of a channel that incised through that sand sheet, probably within the past 20,000 years. As noted by Force *et al.* (2002), when channels form repeatedly they typically follow the same or similar paths at different points in time, and Stratum V indeed cuts through Strata II, III, and IV. It may have removed or reworked sediments deposited in channels that formed in the intervening millennia. Clast size and rounding show that the more recent channel carried weaker flows than the oldest channel, but probably stronger than those that occur in the current arroyo. Channel formation may have been related to climatic changes following the last glacial maximum or near the Pleistocene – Holocene boundary.

Stratum VI is another extensive sand sheet, this one deposited during the Holocene. A shallow swale in Stratum VI is exposed in the backhoe trench and swale-fill deposits were present in SUs 6 and 7 further downstream. Clast sizes and rounding suggest weak ephemeral flows in the swale. Stratum VII is a thin sheet of sand deposited and reworked by aeolian processes that is present across most of Albuquerque's west mesa. Unlike the other strata, deposition probably was triggered by human activities as opposed to climate changes.

An incised channel has been present in the general location of Study Area 2 throughout at least significant portions of the past million years. Stratigraphic relationships and the northward dip of the strata show that the exact location of that channel has changed as the channel has moved progressively northward toward its current location. It also has cut downward through time as the landscape has slowly been lowered by erosion that has removed sediments to the Rio Grande. The general northward movement is very likely due to the general locations of large landforms and the preferential deposition of aeolian sands on the north and east faces of those landforms as a result of predominantly southwesterly winds.

Area 3

Although excavations were not undertaken in Area 3, the soils and strata associated with Feature 1were described. Feature 1 is a large ash stain visible in the north wall of the arroyo that bisects LA 158642, directly opposite the cultural deposits in Study Unit 2. The recent aeolian surficial deposits present across the rest of the area have been removed by erosion in Area 3, and the Btk horizon now exposed at the surface exhibits moderate pedogenic alteration, including moderate structure, relatively weak but visible clay films and strong HCl reactivity. At face value, the degree of soil development would seem to indicate at the very least a thousand years of *in situ* pedogenesis. The soil data are equivocal in this case, however. The texture and clastic content indicate deposition by fluvial processes, and the combination of fine soil texture with the increased water inputs to the solum in a channel can dramatically accelerate the development of clay films and ped structure. Similarly, at least some of the carbonates likely are inherited. In addition, the clear lower boundary would have been at least somewhat obscured by soil welding were this an ancient soil. Very likely, this is a relatively recent deposit, perhaps no more than a few centuries old.

The materials in which the subjacent Bkb horizon has formed were deposited by aeolian processes. The moderate structure and carbonate morphology could indicate initial deposition several millennia in the past, but the pedological data again are somewhat problematic. The development of ped structure could have been accelerated by the downward movement of water and translocation of clays from the overlying unit, especially while that unit was at or near the base of a channel. Similarly, some of the carbonates may be inherited, and additional accumulations could be due to inputs of carbonates and other chemical salts dissolved in the water carried in the channel in the past.

The gradual lower boundary of the Bkb horizon implies that it is genetically related to the subjacent Bkbj horizon, which exhibits weaker pedogenic alteration. Charcoal staining, flecks, and larger pieces of what appears to be wood charcoal are present in the unit, and the clastic content and texture imply a combination of aeolian and fluvial inputs. The upper 10 cm of the underlying Bkb2 horizon also contain charcoal, although it is less abundant than above. Boundary morphology again indicates that the horizons are genetically related. HCl reactivity increases in the Bkb2 horizon. Nodules are present, implying that at least some of the carbonates may be pedogenic, but variable clast coatings suggest inherited $CaCO_3$ and the nodules themselves could be present because of fluvial erosion and redeposition.

The gradual boundary at the base of the Bkb2 horizon suggests that it is genetically related to the subjacent 2Bk horizon. Gravels increase dramatically in that lower unit, which coarsens downward to a clast-supported channel deposit with clasts as large as 4 cm. Variable carbonate coatings again imply that some or most of the carbonates are inherited. Large rodent krotovina are common in this horizon, and rodent and insect burrows are present throughout the profile. The channel is cut into the C3Bk unit at the base of the exposure. The basal unit shows little evidence of pedogenic alteration aside from strong reactivity to HCl. Color and texture suggest that it may be part of one of the widespread Pleistocene sand sheets.

The sediments exposed in the arroyo bank clearly show that a channel formed through sandy deposits. Gravels at the base of the channel show that it initially carried strong flows capable of displacing coarse gravel and flushing finer sediments from the system. The channel fill fines upwards, and textural changes from the 2Bk to Bkb2 to Bkbj to Bkb horizons suggest that aeolian processes gradually became dominant over fluvial as flows decreased and the channel filled. The stratigraphic position of the charcoal stain (Feature 1) suggests burning when a shallow swale that carried moderate to weak discontinuous flows was present. The Btk horizon now at the surface indicates that a second channel formed later, perhaps immediately prior to the incision of the current arroyo.

Despite clear evidence for channel formation and filling, the pedostratigraphic data are not particularly useful for constraining the timing of deposition. As noted above, the lowest stratum probably was deposited by aeolian processes during the Pleistocene. The patterns of variable pedogenic alteration of horizons in the channel fill (the Bkb to 2Bk horizons) and of the Btk horizon now at the surface could be explained by either of two scenarios. The Btk horizon could be on the order of several thousand years old, and the subjacent units could represent a Pleistocene soil formed in channel deposits and from which the A and Bt horizons were removed by erosion. The charcoal incorporated in the channel fill could have been derived from a natural fire.

An alternative and equally plausible scenario requires that the Btk horizon be relatively young, with clay films, ped structure and carbonate morphology attributable to repeated exposure to water rich in suspended sediments, dissolved carbonates, and other chemical salts when it was at the base of a channel. In that case, the structure and carbonate morphology of the underlying Bkb horizon are also due to infiltration of water that flowed in the channel, channel filling occurred during the past one to few thousand years, and the charcoal could have a cultural origin. In fact, if the pedogenic alteration of the two uppermost units can be attributed primarily to repeated inundation in a channel setting, the charcoal and the strata correlate well with those observed in Study Unit 2 on the other side of the arroyo. With the present data, it is not possible to differentiate with certainty between the two scenarios. However, the bimodal distribution of carbonates through the soil column, with strongly HCl reactive sediments in the two uppermost and three deepest units, provides some support for the second scenario. If the channel fill deposits were an ancient truncated soil, then carbonate content should decrease monotonically below the Bkb horizon.

The timing of deposition could better be constrained by examining a larger exposure of soils and sediments, particularly in a trench excavated perpendicular to the modern arroyo. Such an exposure would allow for correlation with hillslope soils. The ages inferred from the degree of pedogenic alteration of hillslope deposits are not subject to the same uncertainties because they are not significantly affected by water flowing in modern or previous channels. On the other hand, it probably would be easier and more cost-effective to constrain the timing of deposition and check for correlation with deposits in SU 2 by excavating a portion of the charcoal stained sediments, screening for artifacts, and/ or radiocarbon dating several charcoal fragments.

Site Formation Processes and Landscape Change

The backhoe trench cut into the lower portions of the north-facing slope of the stabilized dune at LA 158642 allows for some reconstruction of catenary relationships there (i.e. relationships of soils and sedimentary units relative to their positions on a hillslope). Unit VI, present near the surface along the entire trench, appears to be Holocene in age. Very likely, it correlates with the Holocene deposits present at the summit of the dune, and was deposited down the north-facing, lee side of the dune throughout the Holocene. It is generally thinner higher on the slope, suggesting that erosion by water may have removed Holocene sediments from portions of the backslope, as it did on the south-facing slope examined at LA 158640. Erosion appears to have been less significant on the north-facing slope, however, perhaps due to relatively higher rates of deposition on the downwind side of the hill, as well as the different aspect and resulting differences in effective moisture, temperature, vegetation and other variables (Burnett *et al.* 2008). The relatively lower rates of erosion imply that intact, buried archaeological deposits might be present along the entire north-facing slope of the stabilized dune.

Below Unit VI on the upper portions of the slope is Unit IV, the eroded petrocalcic horizon. This is a buried relict landform probably more than a million years old; the later Pleistocene sediments encountered on the south-facing portion of the dune likely were deposited against this older landform. Given the low infiltration rates for sediments cemented by $CaCO_3$, the potential for runoff would have been high when the unit was exposed at or near the surface. Stratigraphic relationships suggest that the previous channel(s) represented by Unit V carried relatively large flows that may be related, in part, to rapid runoff from surrounding landforms. The processes responsible for channel formation may be broadly analogous to those that eventually led to overland flow and erosion on the south-facing slope; both were due to the relatively low infiltration rates of previously-buried soil horizons. For the north-facing slope, however, these processes appear to have played out for the most part prior to the Holocene.

The current data do not show conclusively whether an incised tributary channel to the Rio Grande has continuously been present since its initial formation in the study area. In addition, the timing of the incision of the current arroyo is unknown. It is likely that, for extended periods of time in the past, there was no continuously incised drainage system that connected to the Rio Grande. This is particularly true of the millennia after deposition of large sand sheets. Aerially extensive deposition of sandy sediments would have dramatically increased infiltration rates and the capacity of sediments to retain water, thereby reducing runoff and the ability of water to transport sediments and form channels. As opposed to the current deeply and continuously incised channels, shallow swales would have been common and these likely would have carried only weak flows following rainstorms.

Assuming for the moment that an extensive sand sheet was deposited across the study area during the mid-Holocene altithermal, as seems plausible given the pedological data presented above, infiltration rates would have been high and runoff potential low for an extended period following deposition – as late as 4,000–3,000 BP. With the correspondingly reduced stream competence, a continuously incised drainage network connecting to the trunk stream (the Rio Grande) is less likely. Entrenched channels are formed by running water. Counterintuitively, the absence of incised channels in a semiarid landscape implies more locally available water because incised channels are orders of magnitude more effective in removing sediments and water from the landscape than are weak overland flows (Parsons *et al.* 2004, Wilcox *et al.* 2003). Without continuous channels, the majority of any runoff that did occur would accumulate in shallow, discontinuous swales. The concentration of runoff and sediments creates a resource-conserving dryland with higher net primary productivity than one with a homogeneous distribution of water, plants, and soil (Wilcox *et al.* 2003; see also Yair 1994). Runoff concentration and net productivity would increase through time as soil formation reduced infiltration rates, until runoff passed the threshold at which incised channels form.

Given its shallow, U-shaped profile, it is likely that the swale associated with the archaeological deposits at LA 158642 reflects concentration of runoff in a landscape lacking a continuously incised drainage system. The apparent focus of human activities around the swale suggests that the Archaic period inhabitants utilized some type of seasonally abundant, predictable resource, perhaps dense stands of grasses that produce edible seeds (e.g. *Oryzopsis hymenoides* or *Sporobolus giganteus*). Other archaeological finds in the area may reflect later visitation to the area for the purposes of gathering the same resources and/ or for hunting.

The relatively improved edaphic conditions associated with the absence of a continuously incised drainage systems could have persisted as late as the regional cycle of channel formation that occurred in the later 19th Century (Bahre 1991). In addition, the evidence suggests that people were present during the time of highest flows in the shallow swale. This could reflect the slow increase in runoff due to soil formation coupled with improved moisture availability due to minor climatic fluctuations. In any case, it appears as though people probably took advantage of a landscape that was more productive, at least during the late Archaic period, because of the absence of a continuously entrenched arroyo system. This reconstruction must remain somewhat speculative as long as the timing of the incision of the current arroyo is unknown.

However, the apparent continuity of cultural materials across the current channel (i.e., from Study Unit 2 to Area 3) and evidence for swales in both locations provides some support for the hypothesis that the channel was not present when those archaeological materials were deposited.

Implications for Future Research

This study, and the related study at LA 158640 have at least two significant implications for future work in the area. First, the distributions of gypsum and carbonates in the soil columns reflect recent increases in inputs of both to the solum and show that both materials continue to be translocated downward from the surface sediments. The inherited carbonates and gypsum in the surficial unit that blankets the area probably reflect significant soil disturbance upwind and uphill related to recent development and, farther west, open-pit mining of gypsum near San Ysidro. Carbonates and gypsum derived from eroded soils and exposed geologic units most likely are brought to the site both directly as dust and indirectly as precipitates that accumulate in local stream channels and then are mobilized and redeposited by aeolian processes.

The additional inputs of $CaCO_3$ can make inferring the ages of surficial and near-surface deposits problematic, as in the location of Feature 1 at LA 158642. In addition, because gypsum is translocated downward rapidly through the soil column it may cause whitening of sediments and otherwise contribute to the appearance of advanced carbonate morphology in buried strata. The presence of redeposited gypsum could explain the anomalously low carbonate percentages determined by Hall (2006) in the lab for strata that exhibited stage II or stage III morphologies in the field. Because of the recent inputs, then, chronological inferences based solely on apparent carbonate morphology should be reviewed carefully.

The second important observation is that the entire area is covered by a layer of sand, up to 11 cm thick in the soil profiles examined here, that was mobilized and redeposited during the 20^{th} Century. Unsurprisingly, this layer creates conditions in which it is difficult to detect archaeological materials from surface observations. Evidence for bioturbation is ubiquitous at the loci examined in this study, and all excavation units were placed where artifacts had been encountered at the surface or near where stained sediments were exposed by arroyo incision. It is reasonable to infer that the artifacts were visible at the surface because of bioturbation. Where sites are more deeply buried, where they are not exposed by arroyo formation, or anywhere bioturbation is minimal, archaeological materials are likely to go undetected. These conditions are particularly applicable to the summit and north-facing slope of the stabilized dune investigated here. The clear implication is that standard archaeological survey techniques will fail to identify undisturbed or buried sites, precisely those sites that are likely to be best preserved. Clearly, all construction activities in the area should be carefully monitored as ground-disturbing activities are likely to reveal previously undocumented sites.

DESCRIPTION OF THE EXCAVATIONS

Because LA 15842 is a multi-component site, the excavations are described in chronological order of the occupations. The most extensive excavations occurred in Study Unit 2, which focused on the Late Archaic component uncovered at the edge of the arroyo in the northern part of Area 2. The more limited excavations in Area 3 investigated an Early Developmental component, while Area 1 encompassed a component tentatively dated to the Coalition/Classic period. Finally, Study Unit 1 in the southern part of Area 2 uncovered a Historic/Recent component.

The Late Archaic Component, Study Unit 2

Study Unit 2 was the overall designation given to the excavations undertaken to investigate an ash lens found in the northern part of Area 2 that ultimately proved to be the remnants of one or more Late Archaic occupations. The cultural deposits in this area first appeared as a layer of charcoal-flecked, ash-stained sediments about 15 to 25 cm thick and at least 10 m long exposed in the south bank of the arroyo. A few flaked and ground stone artifacts were scattered downslope (to the north) of this deposit that had apparently eroded from the ash lens and been washed downslope toward the arroyo bed. These cultural materials had not been visible when the site was first documented during the survey, indicating that the deposits had been recently exposed by runoff associated with the heavy rainstorms that has passed through the area during the four months prior to the excavations.

Initially, eight auger tests spaced about 5 m apart were used to probe the sediments along the ash stain exposed in the arroyo bank. Those tests indicated that the cultural deposits extended for at least 10 m along the arroyo and several meters into the hillslope. Three of the auger holes encountered very darkly stained sediments with abundant charcoal at 30–40 cm below modern ground surface (bmgs) in an area about 1 m south of the stain exposed in the arroyo wall. Excavations were initiated at this location.

Study Unit 2 (SU 2) began as a 1 by 2 m north-south trench cutting into the slope and through the cultural deposits. The unit was eventually expanded to 17 sq m, primarily to the west, exposing three features in the downslope part of the cultural deposit. Each 1 by 1 m units in SU 2 was excavated down to the inferred occupation surface, a use-compacted surface of ashy sediments immediately above the underlying culturally-sterile loamy sand. The excavations uncovered a large roasting pit (Feature 2), a hearth (Feature 4) located 1 m west of the roasting pit, and a possible structure (Feature 5) found about 1 m west of Feature 4. All three of these pit features originated at the occupation surface. Numerous fire-cracked rock fragments, several flaked lithic artifacts, and a mano also were found resting on the occupation surface. A basin metate fragment found in the recent aeolian sands a few centimeters downslope of the excavation appears to have been displaced by erosion, and was probably also associated with this occupation.

At this point, the ash layer was clearly visible across the south wall of the excavation but, as it plunged into the hillslope, it was covered by an increasingly thick mantle of aeolian sediments. Seventeen auger holes and two 50 by 50 cm test pits (SUs 6 and 7) were dug into the hillslope above SU 2 to assess the depth and extent of the cultural deposits. These tests established that the deposit extended about 5 m into the hillslope, and for about 20 m along the arroyo, both upstream and downstream from the excavation. As no artifacts had been recovered from the overlying sediments during the initial excavations in SU 2, it was decided that a backhoe would be used to remove 60 to 70 cm of overburden. Backhoe scraping ceased about 5 to 10 cm above the cultural layer, and the remaining natural sediments were shovel-scraped until the upper surface of the ash-stained deposits was fully exposed. Once this was accomplished, excavation of the cultural deposit resumed. The cultural deposit was elliptical in cross-section, ranging from 5 to 40 cm in thickness. For this reason, 1 by 1 m grid units along the perimeter of the stain had only one 10 cm level excavated while those in the middle had up to four levels. Yet, all of the excavations stopped at the same elevation which was just below the ashy lens that was the cultural layer. The entire ash stain measured about 12 m northwest-southeast and 5 m northeast-southwest. In all, 69 sq m of the cultural stratum buried under 20 or up to 40 cm of natural eolian deposits were hand excavated. An additional 46 sq m in the western half of SU 2 was shovel scraped to identify features but the excavated sediments were not screened (Figure 6.4).

Figure 6.4. Excavation in progress in Study Unit 2, view looking south.

A total of nine features, one natural burn stain and eight cultural features, were discovered and excavated in SU 2 (Table 6.1). The ashy sediments to the north of our original excavation unit proved to be shallow and intermittent. Three concentrations of ash in this area were defined as features (Features 6, 7, and 8) but there were few associated artifacts. We therefore focused our efforts on excavation of the thicker, more darkly stained sediments to the south and east of our original excavation unit. Two additional features (Features 10 and 11) were found in this area, about 1 m south of Feature 2. Feature 11 was a hearth pit; Feature 10 appeared to be an associated ash pit. Feature 9 turned out to be a natural stain due to a burnt bush and was labeled as non-cultural. A large stain, Feature 5, was located in the central part of SU 2 and a small hearth, Feature 4 was just east of Feature 5. Additional ashy deposits were found spreading south and southeast from the concentration of the features and appeared to be a mixture of midden and debris from the hearths and ash pits. These sediments were excavated to recover a larger sample of artifacts from the site, and to heavily sample the midden for flotation. Lithics and several pieces of fire-cracked rock were recovered from the additional 1 by 1 m blocks as well as charred faunal remains, seeds and charcoal.

Possible Structure, Feature 5

Feature 5 was a very shallow pit structure located about 1 m west of Feature 4. It was discovered during the excavation of the midden fill in the central portion of SU 2 where it appeared as a dark gray stain of irregular shape. The feature was bisected north-south and the western half was removed first as a single stratigraphic unit (Figure 6.5). This half was screened for artifacts and a few lithics were recovered. The eastern half was not screened but collected in float bags for laboratory analysis. The feature had one zone of a thick black loamy sand 7.5YR2.5/1 (dry) accumulating 10 cm below a caliche rich sand deposit. It included a large number of small pebbles (<1cm) which may have been part of the floor preparation. Alternatively, they may have been deposited by surface runoff in the adjacent drainage swale. Many rodent burrows were noted in the fill but none had significantly impacted the shape of the feature.

Table 6.1. LA 158642 Summary of Late Archaic Features in Study Unit 2.

Feature Number	Feature Type	Size Length x Width (cm)	Depth (cm)	Plan view shape	Profile shape	Contents
2	Roasting pit	150 x 130	25	Oval	Basin	267 lithics, small mammal bones
4	Hearth	30	30	Circular	Basin	4 lithics, goosefoot, juniper, indet. plant
5	structure	225 x 170	10	oval	Shallow depression	25 lithics, small mammal bones juniper seed and wood from saltbush/greasewood, juniper, and cholla
6	Ash pit	30	7	Circular	Basin	1 lithics, small and indeterminate mammal bones
7	Hearth	55 x 27	11	Oval	Basin	4 lithics, seeds from goosefoot and indet. plant
8	Hearth	40 x 35	17	Oval	Basin	Seeds from groundcherry and indet. plant
10	Ash pit	45 x 40	15	Oval	Irregular	18 lithics, seeds from cheno-ams, goosefoot, cholla (?), juniper and indet. plant
11	Roasting pit	60 x 60	27	Semi-square	Basin	43 lithics, goosefoot, cholla and juniper seeds, small mammal bones

Once fully excavated, the feature was very shallow semi-rectangular depression measuring 2.5 m northeast-southwest by 1.7 m northwest-southeast with a maximum depth of 10 cm. Its walls gradually became part of the floor with no signs of formal surfaces preparation. Similarly no signs of plaster or wall preparation were observed. Two possible postholes were found within the depression. One was near the northern and the other was next to western edge of the feature, suggesting that Feature 5 may be the remnants of a small very shallow structure. Both postholes were about 6 cm in diameter and 4 cm deep. No evidence for the entry into the structure was noted. The location of the two postholes along the north and western edges and the proximity of hearth Feature 4 to the east, however, suggests that the structure may have opened to the east or northeast. A shallow depression reaching about 3 to 4 cm below the floor was found in the northwestern portion of Feature 5. The depression was elongated in plan view and measured 90 cm northeast-southwest by 40 cm northwest-southeast. Although no artifacts or charcoal were found inside the enclosure, it is possible this depression may have served a specialized purpose such as temporary storage or to hold a basket. The dark ashy fill inside the feature suggests that the structure may have burned although no evidence of oxidation was observed along the walls or the floors of the feature.

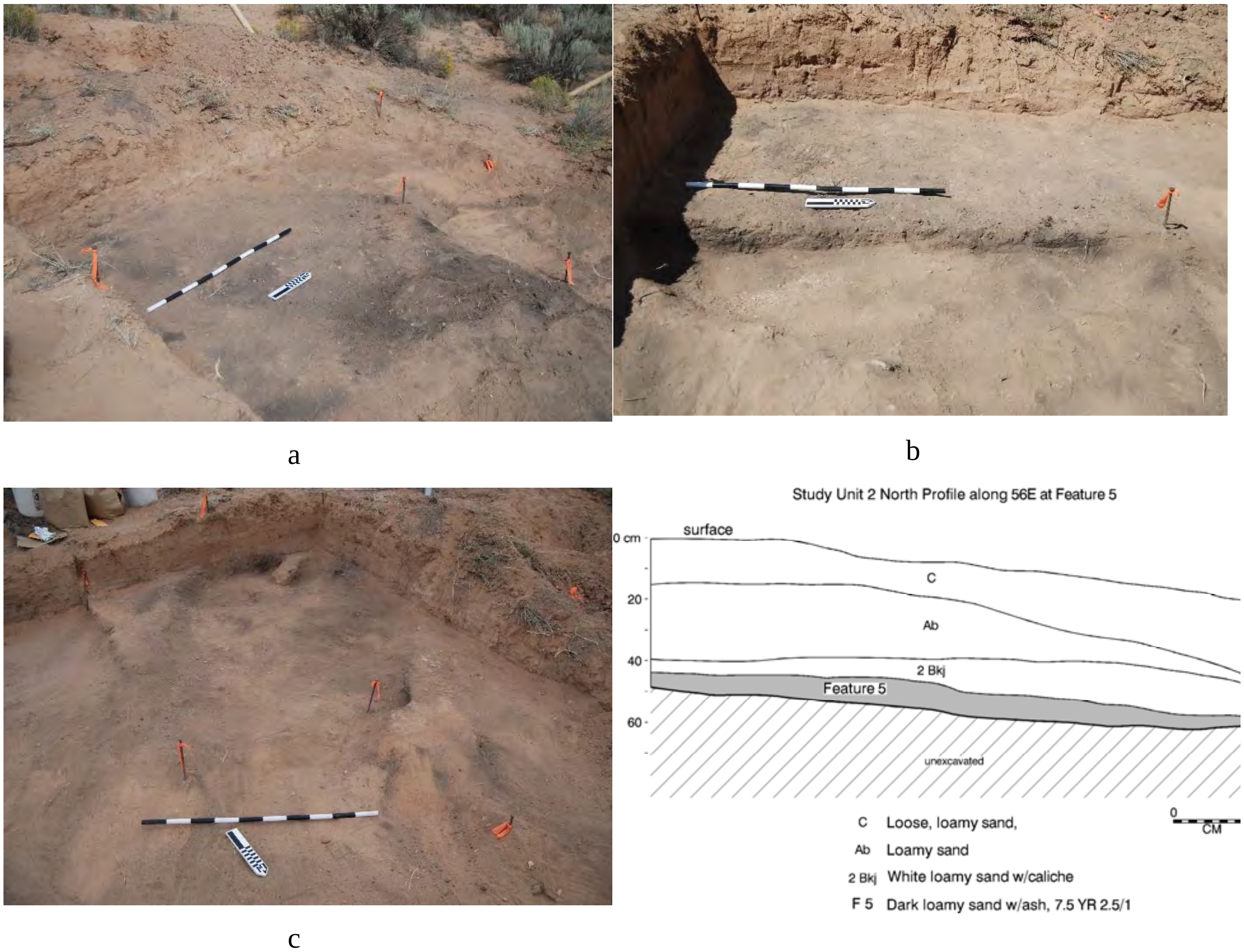

Figure 6.5. LA 158642 Feature 5: (a) pre-excavation, view to northwest; (b) profile, view to west; (c) post-excavation, view to southwest; (d) west view profile sketch.

Artifacts recovered from Feature 5 include 16 flakes, 8 pieces of angular debris, and 1 bifacial thinning flake. A charred juniper seed recovered from Feature 5 was submitted for radiocarbon dating. The charcoal produced a conventional radiocarbon date of 3030 ±40 BP (Beta 265705) or a calibrated age of cal 1300 BC with two standard deviation range of cal 1400 to 1190 BC and 1140 to 1140 BC.

The macrobotanical analysis of all charred material from inside the structure identified one juniper seed and wood charcoal from saltbush/greasewood, juniper, and cholla in descending order of frequency. These plants may have been used as part of the feature's roofing and wall material. Additionally, two faunal fragments were also recovered. One was a calcined long bone fragment from a small mammal and the other was an unburned piece from an indeterminate mammal.

Activity Area East of Feature 5

The area east and southeast of the structure contained sediments with abundant ash and charcoal, as well as flaked and ground stone artifacts. The excavations therefore were expanded into this locale to expose (and excavate) all cultural features and sample a large portion of the cultural (midden-like) deposits. A total of four pit features including three hearths or roasting pits and an ash pit were found during the fill removal (Figure 6.6). The presence of these features suggests that this area represented an activity locale where food preparation, processing, and consumption took place, as well as lithic reduction.

Feature 2. This feature, a large roasting pit, was exposed by the original trench at the eastern edge of the unit (Figure 6.7). The feature was discovered during the excavation of the ashy fill in the northern part of SU 2 about 1.5 m south of the eroded arroyo edge and 3 m east of Feature 5. Initially, the feature appeared as an irregular stain containing dark gray ash mixed with occasional pieces of fire-cracked rock. The stain measured about 2 m north-south by 1.5 m east-west with weakly defined edges. However, additional stripping of the upper feature fill mixed with the above layer of ash aided in better definition of the edges of the features. The feature was first bisected north-south and the western half was removed first as a single stratigraphic unit. Two zones of fill were visible in the profile. Zone I was a light gray 7.5 YR 7/1 (dry) sandy loam of granular structure which contained pieces of charcoal and light ash. This zone also had rodent burrows running through it and was at the top of the feature. It is proposed that Zone 1 was part of Zone II but had been disturbed by rodents that mixed up Zone I with the surrounding soil. Zone II was a black 7.5YR 2/1 (dry) sandy loam fill mainly consisting of ash sediment mottled with charcoal. The pit had an informally made bottom which was merely excavated into the natural sediment. Very light oxidation stains were noticed at the bottom of the pit but quickly faded away once the feature dried up exposed to the sunlight. When fully excavated, the feature had an irregular to semi-oval shape in plan view measuring 150 cm north-south by 130 cm east-west. In cross-section, the pit was basin-shaped reaching 25 cm beneath the inferred occupation surface (Figure 6.8).

Five fire-cracked rock fragments (avg. 10 cm in diameter) were found in the pit and 50 additional fragments were scattered on the occupation surface surrounding the feature indicating that the feature at one point functioned as a roasting pit while the surrounding rock concentration represents a rake out. Flakes were found in both zones of the fill. A total of 266 flakes and one piece of angular debris was recovered from inside the fill of Feature 2. One flake was a sharpening flake.

The macrobotanical analysis of the charred plant remains revealed that a high volume of juniper seeds, smaller amounts of cholla seeds, a prickly pear embryo, and other indeterminate seeds were also present inside the feature. The seeds/embryos from these plants were likely procured purposefully to be roasted inside Feature 2. Wood charcoal recovered from the feature was identified as coming from juniper. This plant was probably used as primary fuel in the fire.

A charred juniper seed recovered from the feature was submitted for radiocarbon dating. The charcoal produced a conventional radiocarbon date of 3380 ±40 BP (Beta 265703) or a calibrated age of cal 1680 BC with two standard deviation range of cal 1750 to 1600 BC and 1570 to 1540 BC. This places the feature into the early part of the Late Archaic period.

Seven fragments of burned and unburned animal bone were recovered from inside Feature 2. They include 5 burned fragments from a small mammal, 1 burned indeterminate mammal, and 1 unburned long bone fragment from a small mammal. While the unburned fragment may be of natural origin, the other burned pieces are deemed to be cultural, indicating that small mammals, such as a cottontail rabbit, prairie dog, or squirrel were cooked/roasted inside Feature 2. The data indicate that possibility that Late Archaic roasting pits were used both for plant and small mammal roasting.

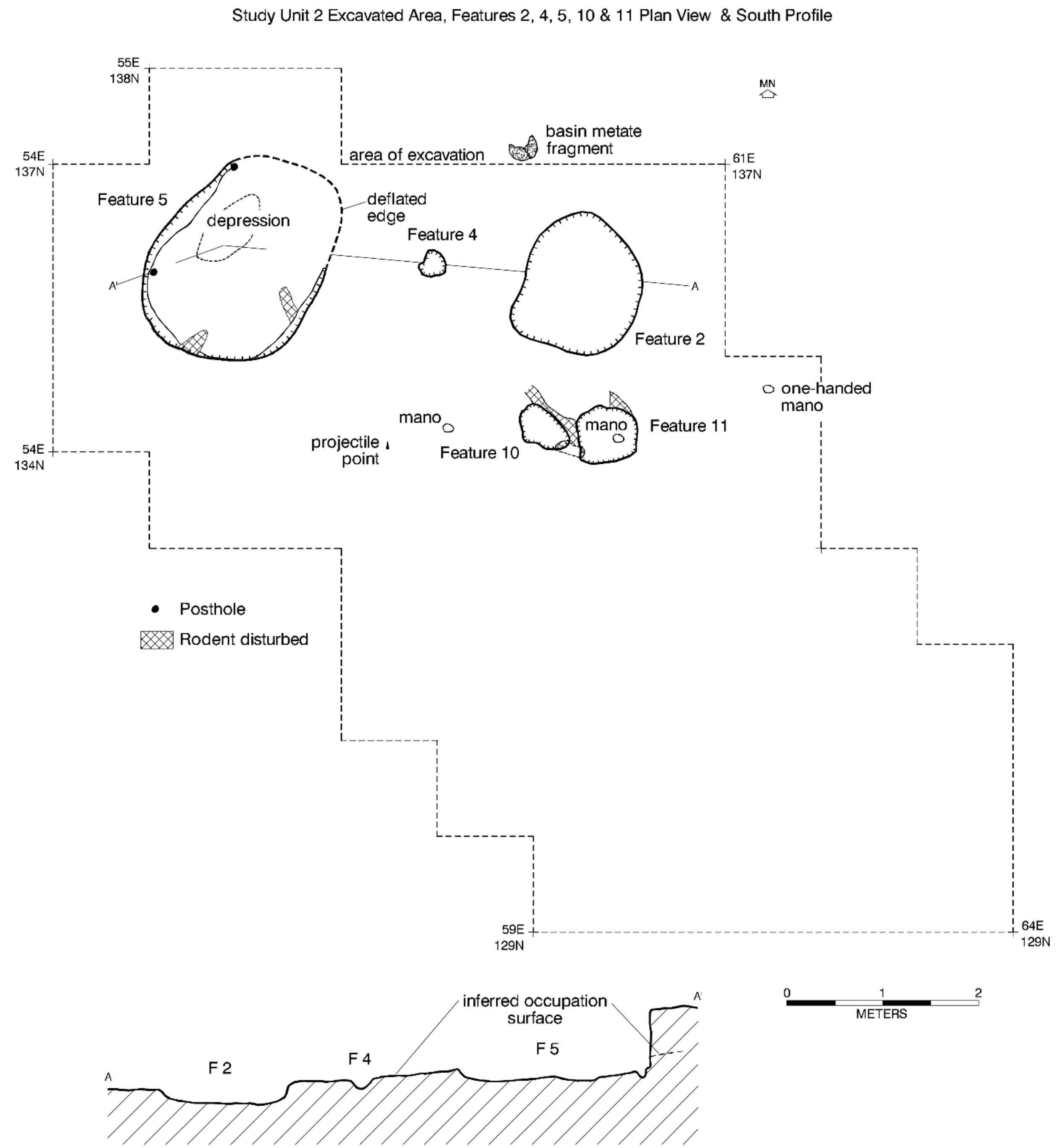

Figure 6.6. Excavated features and piece-plotted artifacts in the screened part of Study Unit 2.

Feature 4. Feature 4, located 1m to the east of Feature 5 and 1 m to the west of Feature 2, was a bowl-shaped pit measuring 30 cm in diameter and 30 cm deep. The feature was discovered during the removal of the midden fill in SU 2. Initially, the feature appeared as an irregularly shaped stain although its edges became more defined once the excavation progressed.

Figure 6.7. LA 158642 Feature 2: (a) pre-excavation (view to northwest); (b) profile (view to east); (c) post-excavation (view to west).

The excavation started by bisecting the feature north-south and the eastern half was removed first. Two zones of fill were observed in the exposed feature fill profile. Zone I was a brown (Munsell chart 7.5YR4/3, dry) sandy loam with dark staining. This matrix was located primarily in the top central part of the feature and constituted the main feature fill. Zone II was a brown (7.5YR5/4) sandy loam filled with dark ash-and-charcoal stained sediments. A profile was drawn of the feature and the rest of the feature fill removed. Insect disturbance was noted in the feature. The lowest part of the feature, Zone III was a mixture of the feature fill and the underlying natural sediments. The mixing probably occurred due to rodent disturbance. This matrix consisted of light brown (7.5YR6/4, dry) loamy sand containing very few ashy pockets.

Once fully excavated, the feature was oval-shaped in plan view and had a basin shape with flat bottom in cross-section (Figure 6.9). Four pieces of angular debris represent the entire lithic assemblage from Feature 4. Numerous burned seeds from goosefoot, juniper, and those from an indeterminate plant were recovered from the fill of Feature 4 suggesting these plant material were cooked here for consumption. The feature is interpreted as a small hearth, possibly associated with the structure (Feature 5).

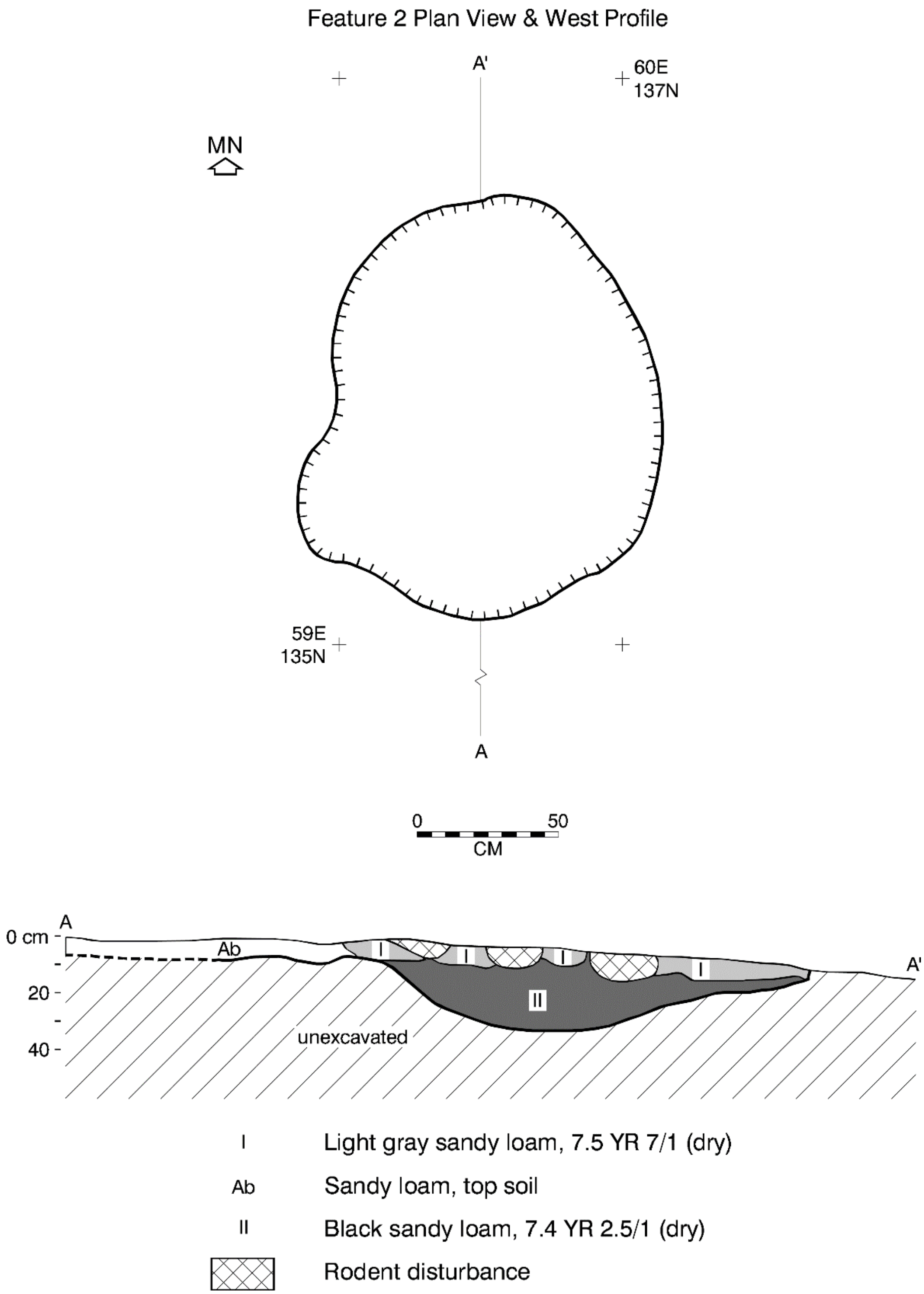

Figure 6.8. Plan view and profile sketch of Feature 2.

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b

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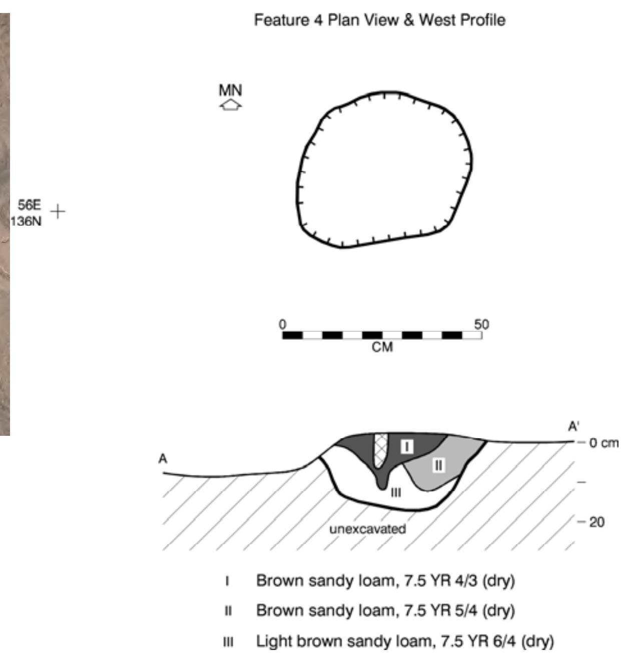

Figure 6.9. Feature 4: (a) pre-excavation, view to northwest); (b) profile, view to west; (c) post-excavation, view to southwest; (d) plan view and profile sketch.

Feature 10. This feature was an oval pit with an irregular bottom (Figures 6.10 and 6.11). It was located 10 cm west of Feature 11 and 50 cm to the south of Feature 2. The excavation of this feature began by bisecting it north-south and excavating its western half. The feature fill was a very dark gray (Munsell chart 10YR3/1) ashy sand with pieces of charcoal. A profile was made of the east face of the exposed fill and then the rest of the feature was excavated. The whole feature fill was collected for flotation processing. A rodent tunnel was found running along the north through the eastern edge of the feature. These rodent tunnels may have changed the border of the feature so the exact shape and dimensions of the original feature could only be estimated. It was 40 cm north-south by 45 cm east-west and was 15 cm in depth from its

Figure 6.10. Features 10 and 11: (a) pre-excavation (view to east); (b) feature 10 post-excavation Feature 11 profile (view to north); (c) Feature 10 and 11 post-excavation (view to east).

a

b

c

point of origin. Six pieces of fire-cracked rock were recovered from Feature 10 and these may have been a rake out from Feature 2 or Feature 11.

Excavation of Feature 10 recovered 18 flaked lithic artifacts most of which came from the flotation processing. They include 15 flakes, 2 pieces of angular debris, and 1 bifacial thinning flake. A variety of charred seeds was also recovered from the feature after the flotation processing. These include cheno-ams, goosefoot, possible cholla, juniper seeds and cones, and those from an indeterminate plant. The juniper and goosefoot seeds were in the highest quantity. The feature was likely an ash dump for Feature 11 and the seeds were probably dumped here accidentally from the cooking process in the hearth Feature 11.

Feature 11. This feature was a circular hearth or roasting pit with a basin shaped bottom (Figures 6.10 and 6.11). The feature was located 10 cm east of Feature 11 and about 50 cm to the south of Feature 2. The excavation of this feature began by bisecting it east-west and excavating its southern half. The feature fill contain two zones. Zone 1 was the main feature fill and consisted of a gray (Munsell chart 7.5YR5/1) ashy sand with pieces of charcoal. Zone 2 was a very dark gray (7.5YR5/1) ashy sand located below a mano found resting on the top of the feature. A profile was made of the north face of the fill and then the rest of the feature was excavated. A rodent tunnel was found running along the north edge of the feature and may have altered the northern portion of the feature. Several pieces of fire-cracked rock were recovered from the feature. When fully excavated, the feature had a semi-square shape in plan view measuring 60 cm north-south by 60 cm east-west and was 27 cm in depth.

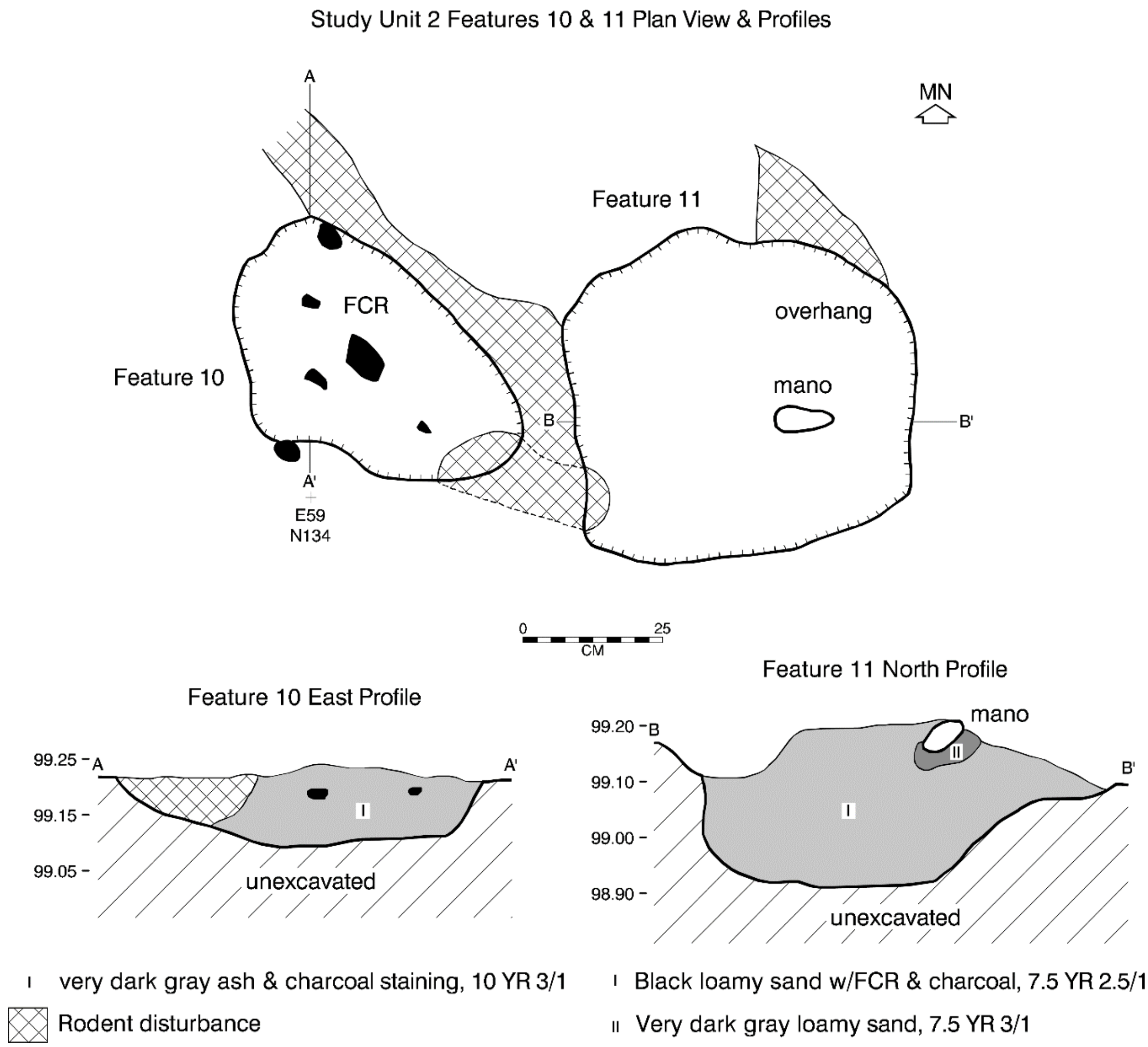

Figure 6.11. Features 10 and 11 plan and profile sketch.

Forty-three flaked lithics and ground stone artifacts were recovered from inside the ashy fill of Feature 11. They include 27 flakes, 8 pieces of angular debris, 6 bifacial thinning flakes, 1 utilized flake, and 1 mano fragment. This feature showed the highest diversity of artifacts suggesting various food preparation activities took place in its proximity. The six bifacial thinning flakes is the highest concentration of this type of artifact found at the site and also attest to biface manufacture that probably took place near the feature.

The macrobotanical analysis of the charred material from Feature 11 revealed the presence of goosefoot, cholla, juniper seeds, and juniper cones as well as seeds from an indeterminate plant. This is a similar seed assemblage to that found in the ash pit Feature 10 and confirms the interpretation that the seeds were cooked or roasted in the hearth, Feature 11, and some were accidentally discarded into the ash pit, Feature 10. Wood charcoal recovered from the feature came from juniper and from an unknown conifer. These materials were likely used as fuel in the fire.

Two long bone shaft fragments from a small mammal were also recovered from the hearth although neither of them was burned. Feature 11 was a probable hearth where various types of seeds were cooked. The presence of fire-cracked rock inside the fill indicates the feature may in fact have functioned as a small roasting pit.

Midden Deposits

The area immediately south of the roasting pit (Feature 2) and structure (Feature 5) showed a dense ash and charcoal staining indicating that this part of the Late Archaic component probably served for dumping refuse. The excavations in SU 2 were further expanded sample this layer of cultural deposits. The ash stain had an irregular shape running in a northwest-southeast direction, parallel to the flow direction of the unnamed arroyo. It was 6.5 m long northwest-southeast and up to 5 m wide northeast-southwest (Figure 6.12) and extended southeast from the excavated cluster of features. A square-shaped mound of gravel and coarse sand was found in the northern part of the midden. This mound was about 15 cm high and covered an area of roughly 4 sq m. The gravels probably were deposited by a high energy flash flood which would have redirected the flood water from the unnamed arroyo to a depression. The lack of artifacts and ash within the mound, as well as its position beneath the cultural material, indicates this alluvial deposit took place prior to the Late Archaic occupation of the site.

A profile sketch was made of the midden in the southeastern corner of SU 2 (Figures 6.12 and 6.13). The eastern and southern wall profiles show that the midden consisted of two superimposed cultural lenses capped by the natural eolian sand. The natural stratum (Stratum II) was brown (7.5YR 4/4 sand to loamy sand matrix which contained numerous rodent burrows and plant roots. No charcoal or ash were observed in this unit. The next lens beneath the natural matrix was a brown (10YR 4/3) loamy sand, Stratum IIIA, which contained light ashy staining, sporadic fragments of charcoal, several pieces of fire-cracked rock and moderate amounts of flaked lithic artifacts. This lens was at least 6 m long and reached about 20 cm in thickness in its western portion. Finally, the eastern part of Stratum IIIA was a very dark grayish brown (10YR 3/2) loamy sand, Stratum IIIB, which contained large amounts of ash, charcoal, as well as faunal and macrobotanical remains and moderate to high density of flaked lithics. The lens had an amorphous shape in plan view reaching up to 3 m in diameter and was about 15 cm thick in its central part.

Aside from the ashy sediments and amorphous patches of charcoal stains no additional features were discovered. Nevertheless, the excavated midden yielded large amounts of flake lithics which provided useful information on interpreting the activities that took place at the Late Archaic camp. In all, 55 sq m were excavated and screened in SU 2, and a total of 740 flaked lithic and ground stone artifacts were recovered from the features, the midden, and surrounding grid units. The analysis of the spatial distribution of artifacts revealed that most artifacts (*n*=273) were recovered from in and around the roasting pit, (Feature 2) and the hearth (Feature 4). A less dense concentration of material was present in the vicinity of Feature 10 and especially Feature 11 (Figure 6.14). This suggests that two distinctive activity areas are represented, one near Features 2 and 4 and the other near Features 10 and 11. No artifacts were recovered in the area between these two activity areas.

Of particular interest are the 273 flaked lithics, one basin metate fragment, and many pieces of fire-cracked rock recovered from the activity area in and around Feature 2. Such a large number of lithics recovered mostly from inside the roasting pit indicates that the feature may have served for trash dumping after its use as a roasting pit. Alternatively, it is possible that lithic materials had been put in the fire intentionally to heat treat the stone during the food roasting process. A similar example of combined food roasting and heat treating of lithic artifacts has been observed at a suspected Apache roasting camp in the Carrizalillo Hills of Southwestern New Mexico (Kurota 2010).

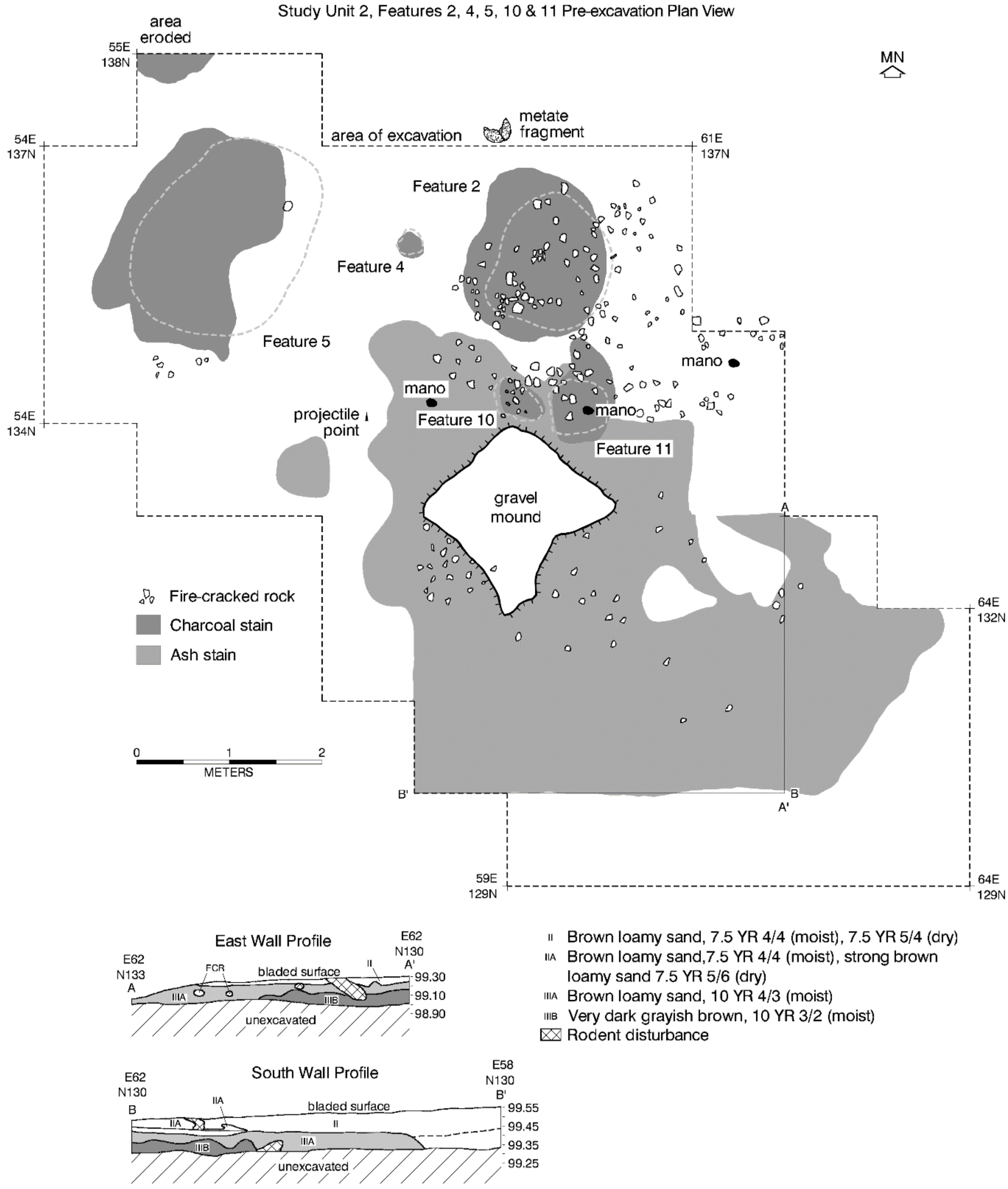

Figure 6.12. Ashy sediments and fire-cracked rock found in the screened part of Study Unit 2.

Figure 6.13. Overview of midden profile fill in southeast corner of Study Unit 2.

The other activity locale encompassing Features 10 and 11 had only about half as many lithics as the Feature 2 activity area but equal amounts of fire-cracked rock. Additionally, three one-hand cobble manos and a complete obsidian projectile point were collected from this locale. One of the manos was about 80 cm west of Feature 10, the second was 1.5 m to the east-northeast of Feature 11, and the third mano was found resting on top of Feature 11 fill. The presence of the three manos within this activity area suggests that intensive food preparation activities took place. The obsidian point was found just outside the midden fill about 1.5 m west-southwest of Feature 10. Because the item is in an almost complete state (only a small portion of one of the tangs is missing), it was most likely lost by the site occupants since complete light-weight tools would rarely be discarded by nomadic hunter-gatherers. Finally, six bifacial thinning flakes were recovered from inside Feature 11 suggesting that biface manufacture also took place at the inferred activity locale.

A moderately high density of artifacts was also noted near the southeastern corner of SU 2. This area also had large amounts of ash, charcoal and charred botanical remains, suggesting that it may have been used for chance dumping. At the same time, it is also possible that the cultural material south of the features and in the southeastern corner of SU 2 may have accumulated naturally by wind and water action, perhaps after the site was abandoned by the Late Archaic people. Unfortunately, the area to the north of the feature cluster (Features 2, 4, 5, 10, and 11) had been eroded by the arroyo action so the nature of activities in this area, if any, is unknown.

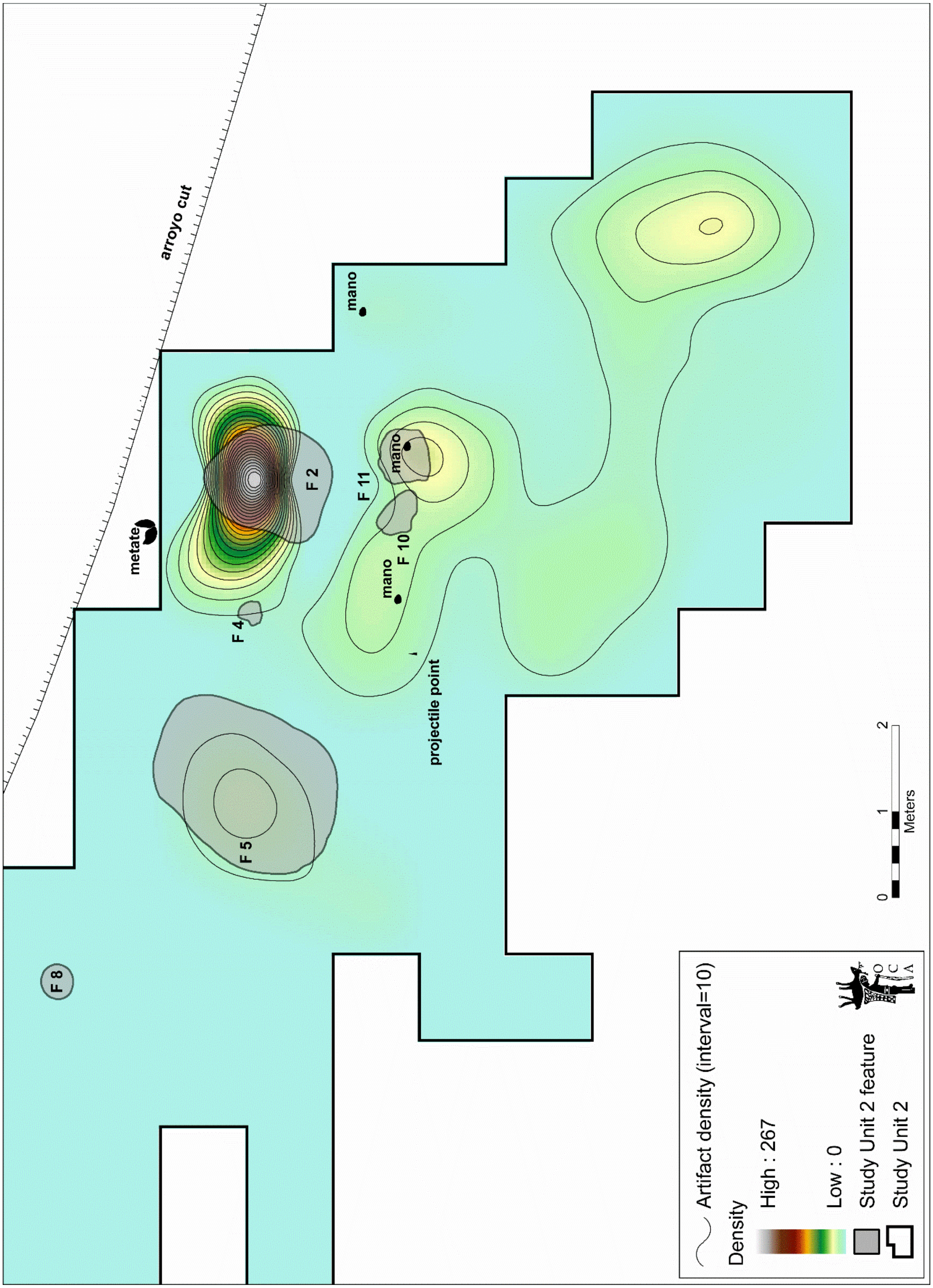

Figure 6.14. Schematic map showing distribution of artifacts in the screened part of Study Unit 2.

The analysis of faunal remains revealed charred bone fragments from cottontail rabbit as well as from small and medium-size rodents, and other small mammals. An egg shell fragment from an indeterminate bird species was also recovered. All these charred faunal material indicates that opportunistic hunting and perhaps egg collecting provided protein food during the Late Archaic camp. Shells from at least three different species of snail were also recovered from flotation samples. However, because these items were not burned they are deemed to be natural in origin.

Dispersed Features in Western Part of Study Unit 2

Three additional features were found in the area west of the structure. This part of the site had very little ash, charcoal, and very few lithic artifacts were visible in the sediment exposed by the backhoe. For this reason, grid units were shovel-scraped but not screened during the search for buried features. Three features were discovered after shovel scraping about 5 to 10 cm of the natural sediment. A small ash pit, Feature 6, was discovered in the far western end of SU 2 about 11 m west of the structure. Feature 7, a small hearth, was found near the edge of the unnamed arroyo about 5 m northeast of Feature 6. Finally, another hearth, Feature 8, was located about 3 m northwest of the structure. Although no radiocarbon dates were obtained from these features, their association with the same occupation surface where the other features in SU 2 were found suggests they also date to the Late Archaic period.

Feature 6. Feature 6 was not as well defined but appeared to be a roughly circular pit measuring 30 cm in diameter and 7 cm maximum depth (Figure 6.15). It was located 5 m southwest of Feature 7 and was the westernmost of the features found in SU 2. The feature was bisected north-south with the west side being removed first. A profile was made of the east wall of the bisected feature, which showed one zone of fill, a gray (Munsell chart 5YR5/1) sandy ash that was mottled. A few small pieces of charcoal were found in the feature. The other half of the feature was removed and collected for floatation. Rodent activity was noted in the northwestern portion of the feature. Some insect burrowing was also observed.

A single piece of angular debris was recovered from the feature fill during the flotation processing. Macrobotanical analysis of the charred plant remains identified juniper wood. This plant was probably used as fuel in the fire. This feature probably functioned as an ash pit.

Feature 7. Feature 7 was an oval thermal pit with a basin-shaped bottom. The feature was located 5 m north west of Feature 8 and was near the edge of the arroyo. The excavation of this feature began with bisecting it east-west and removing its southern half of its fill. The profile showed one zone of fill, a very dark gray (Munsell chart 7.5YR3/1) ashy sand with pieces of charcoal (1-2 cm). A profile drawing was made of the north face of the bisect and then the rest of the feature was excavated. The whole feature fill was collected for flotation processing. A rodent tunnel was found running through the northwest portion of the feature but the tunnel did not severally disturb its fill. No fire-cracked rocks was present but a few lithics were discovered inside the feature. In plan view, the excavated feature was an elongated rectangle extending 55 cm northwest-southeast by 27 cm northeast-southwest; it was basin-shaped in cross-section reaching 11 cm in depth from its point of origin (Figure 6.16).

Two flakes and two pieces of angular debris were recovered from inside the feature fill. The macrobotanical analysis of charcoal recovered from Feature 7 revealed the presence of seeds from goosefoot and an indeterminate plant. Additionally, wood charcoal from juniper and an unknown conifer were also recovered. The goosefoot seeds and those of the indeterminate plant were likely cooked inside the feature to be consumed by the site occupants while the juniper and the unknown conifer are believed to have been used as fuel in the fire. The feature was probably a hearth that was used to roast or cook the goosefoot seeds.

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b

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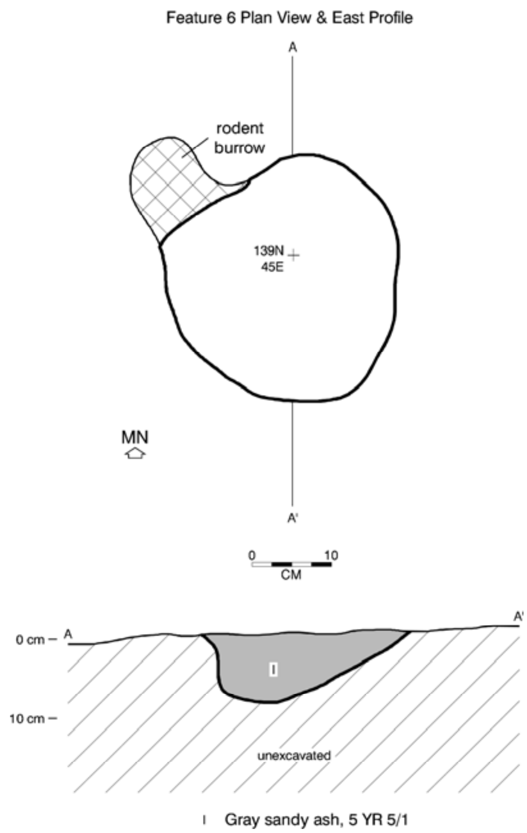

d

Figure 6.15. Feature 6: (a) pre-excavation (view to north); (b) profile (view to east); (c) post-excavation (view to north); (d) plan view and profile sketch.

Feature 8. Feature 8 was a thermal pit (Figure 6.17) located 5 meters to the east of Feature 7. Feature 5 was 3 m to the southeast of Feature 8. The feature was bisected east-west and the southern half of the feature was removed first. This reveled one zone of fill consisting of a brown (Munsell chart 7.5YR5/2) ashy sand mixed with very small pieces of charcoal. A profile was made of the north face of the fill after which the rest of the feature was excavated. The whole feature fill was collected for flotation analysis. Rodent disturbance was noted in upper central part of the feature. Additional disturbance may have been caused by the backhoe scraping, which may have removed the top portion of the feature. No fire-cracked rocks and only one flake and one piece of angular debris were found inside the feature. The fully excavated feature was oval in plan and measured 35 cm north-south by 40 cm east-west. In cross-section, the pit had a basin shape and reached at least 17 cm beneath the occupation surface.

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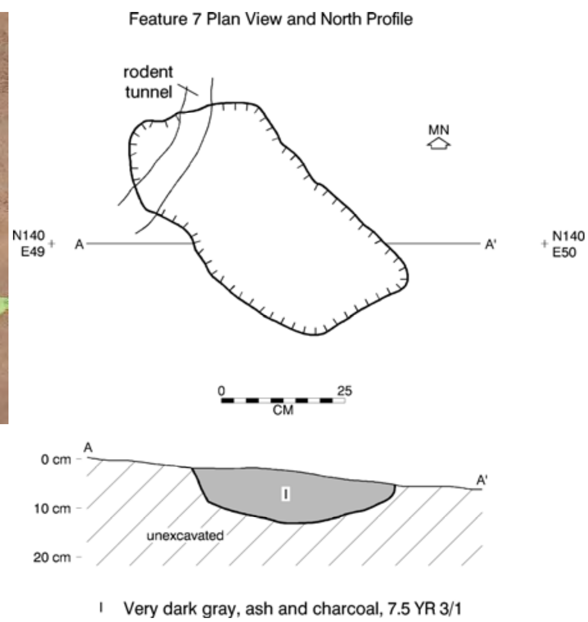


d

Figure 6.16. Feature 7: (a) pre-excavation (view to northeast); (b) profile (view to north); (c) post-excavation (view to north); (d) plan view and profile sketch.

Charred seeds from groundcherry and those from an indeterminate plant were recovered from inside Feature 8 while the wood charcoal was identified to be of juniper. While the juniper wood most likely served as fuel for the Feature 8 fire, the groundcherry seeds were likely cooked inside the feature. Groundcherry seeds are known to have been eaten fresh by numerous historic Native groups in the Southwest and can be also prepared as preserves or relish both of which require about 15 minutes of cooking (Niethammer 1974:70–71).

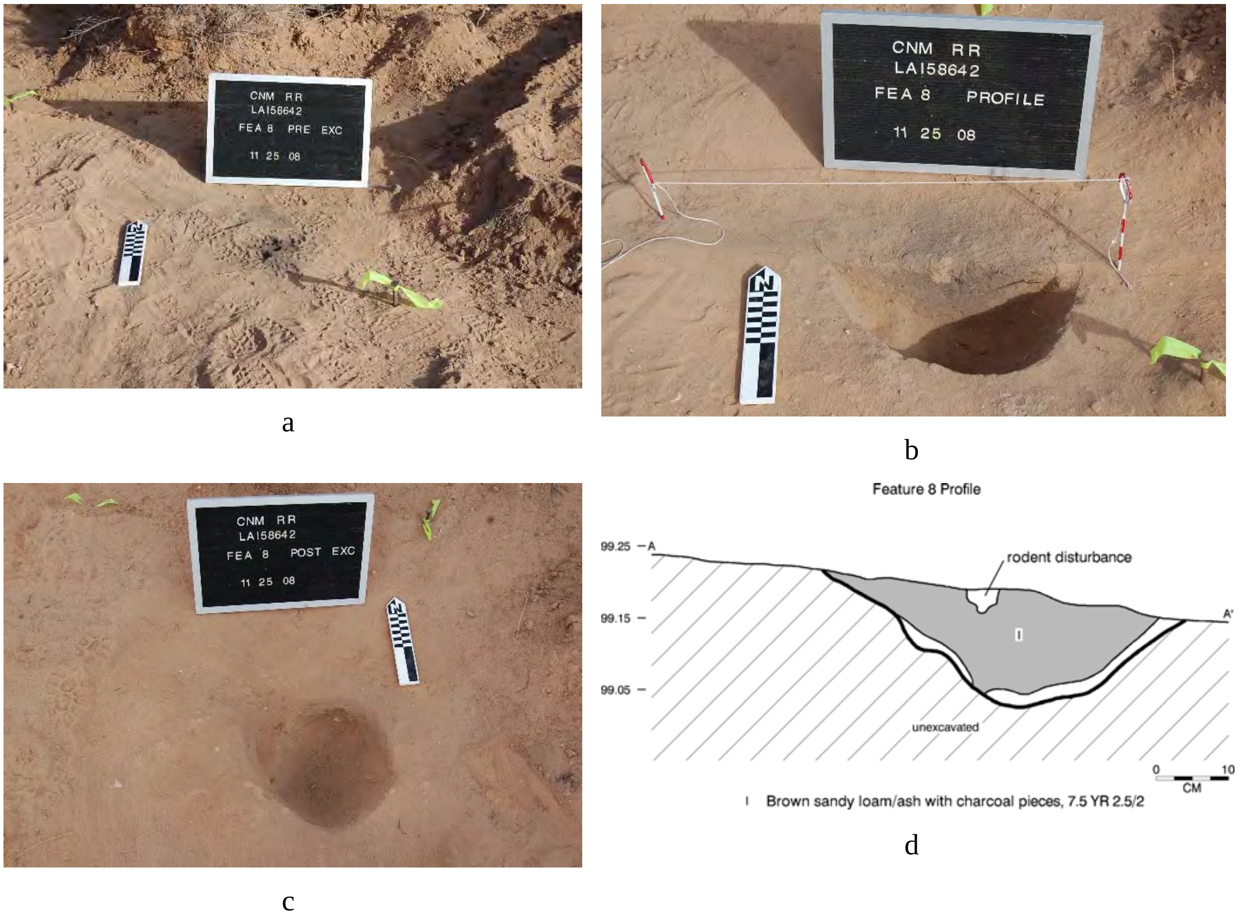


Figure 6.17. Feature 8: (a) pre-excavation (view to north); (b) profile (view to north); (c) post-excavation (view to north); (d) profile sketch.

Artifact Assemblage

The artifact assemblage recovered from SU 2 totaled at 740 flaked lithics and ground stone (Table 6.2). Of these, about 50% (*n*=364) were recovered from feature contexts while the other half (*n*=376) came from the general grid excavation units. The vast majority of the artifacts are angular debris (*n*=398) and flakes (*n*=318), although one sharpening and one utilized flake were also found. Debitage consisting of flakes and angular debris is almost the exclusive artifact type recovered from the features (Table 6.3). Biface manufacture at the site is suggested by the presence of 11 bifacial thinning flakes and a Stage 1 biface. Feature 11 yielded six of the bifacial thinning flakes which could indicate this was the general locale of the biface manufacture.

The debitage is dominated by angular debris, flakes with platforms consistent with early stages of lithic reduction, and a high proportion of flakes with some dorsal cortex. This suggests that Late Archaic occupants of LA 158642 engaged in extensive lithic reduction activities. Additionally, several tested cobbles made from poor quality lithic material were also encountered on the site, which were likely discarded because flaws in the cobbles made further reduction impractical. The poor quality of the tested cobbles sharply contrasts with higher quality lithic material from which most of the flakes were made. No cores of these better quality chalcedonies and cherts were recovered from SU 2, which may indicate that they were carried away by the site's occupants.

Table 6.2. Lithics from the Middle Archaic Component in Study Unit 2 at LA 158642.

Material	Artifact Type													
	Angular Debris	Biface, Stage 1	Flake	Flake, Bifacial Thinning	Flake, Other	Flake, Sharpening	Flake, Utilized	Ground stone, nfs	Mano, Flat/Convex	Mano, nfs	Metate, Flat/Concave	Projectile Point	Tested Rock	Total
Chalcedony	316	1	253	8	1	-	1	-	-	-	-	-	2	582
Chert	44	-	34	2	-	1	-	-	-	-	-	-	-	81
Granite	-	-	-	-	-	-	-	1	1	-	1	-	-	3
Jasper	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Limestone	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Obsidian	-	-	2	-	-	-	-	-	-	-	-	1	-	3
Quartzite, fine grain	10	-	14	-	-	-	-	-	1	1	-	-	-	26
Quartzite, med/coarse	19	-	11	-	-	-	-	-	-	-	-	-	-	30
Quartzitic sandstone	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Silicified wood	8	-	2	1	-	-	-	-	-	-	-	-	-	11
Siltstone	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Total	**398**	**1**	**318**	**11**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**2**	**740**

Table 6.3. Lithic Artifacts Recovered from Middle Archaic Features and Midden Deposits (Study Unit 2).

Feature No.	Artifact Type													
	Angular Debris	Biface, Stage 1	Flake	Flake, Bifacial Thinning	Flake, Other	Flake, Sharpening	Flake, Utilized	Ground Stone, nfs	Mano, Flat/Convex	Mano, nfs	Metate, Flat/Concave	Projectile Point	Tested Rock	Total
SU 2 grid	215	1	148	3	1	-	-	2	1	1	1	1	2	376
2	157	-	109	-	-	1	-	-	-	-	-	-	-	267
4	4	-	-	-	-	-	-	-	-	-	-	-	-	4
5	8	-	16	1	-	-	-	-	-	-	-	-	-	25
6	1	-	-	-	-	-	-	-	-	-	-	-	-	1
7	2	-	2	-	-	-	-	-	-	-	-	-	-	4
8	1	-	1	-	-	-	-	-	-	-	-	-	-	2
10	2	-	15	1	-	-	-	-	-	-	-	-	-	18
11	8	-	27	6	-	-	1	-	1	-	-	-	-	43
Total	**398**	**1**	**318**	**11**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**2**	**740**

A complete corner-notched projectile point was also recovered from a grid excavation unit roughly in the south-central part of SU 2. The point is made of gray obsidian and has exaggerated serrated edges with corner notches and a slightly expanding flat stem. While the point resembles a San Pedro or En Medio style projectile points, the maximum length of the point, 30 mm, falls out of the normal size range for the Late Archaic projectile points. However, if the point was made from an obsidian nodule it is likely the nodule would not have offered enough size to make it a larger, more common-size Late Archaic point. Shackley (2009) sourced the gray obsidian material to be originating from Cerro Toledo rhyolite which can be found in the Jemez Mountains to the north of the project area. Therefore, it is suggested that the obsidian was likely procured from the Rio Grande drainage system.

The material assemblage observed on the Late Archaic flaked lithics is vastly dominated by chalcedony (*n*=582) constituting almost 80% of all artifacts from SU 2. Other frequently observed materials include chert (*n*=81, 11%), medium to coarse grain quartzite (*n*=30, 4%), fine grain quartzite (*n*=24, 3.2%), and silicified wood (*n*=11, 1.5%). The remaining materials were found in minor quantities and include obsidian (*n*=3), jasper (*n*=1), and limestone (*n*=1).

The ground stone assemblage recovered from SU 2 totaled six artifacts including a basin metate, 3 manos and two unspecific ground stone fragments. The metate was made from granite and consisted of two re-fitting fragments which made up about 50% of the original tool. The object was recovered at the northern edge of SU 2 just north of the roasting pit, Feature 2. Its proximity to this feature suggests it was used for food processing associated with the roasting pit. The three manos were merely utilized river cobbles, one made from granite and the other two from fine grain quartzite.

Summary of Late Archaic Component

Excavation of the Late Archaic component in SU 2 uncovered nine features, eight of which eight were cultural and one (Feature 9) was natural in origin (Table 6.1). Two of the features are deemed to have functioned as roasting pits, three were probable hearths, two probably served for ash or trash disposal, and one is believed to have been a shallow surface structure. The two radiocarbon dates obtained from two different features indicate non-contemporaneous occupations, one dating to cal 1680 BC and the other to cal 1300 BC.

The suspected surface structure (Feature 5) was located near the center of SU 2. Two hearths (Features 7 and 8) and the ash pit (Feature 6) were located to the northwest, and two roasting pits (Features 2 and 11), a hearth (Feature 4), and the ash pit (Feature 10) were situated to the east and southeast. All features clustered into an alignment running northwest-southeast parallel to the southeast-flowing arroyo immediately north of the features. Several flaked lithic artifacts, a basin metate, and ashy material were observed collapsing down into the arroyo from their original context. This suggests that a good portion of the Late Archaic component had been eroded by monsoon flash flood gushing through this drainage.

The spatial distribution of artifacts inside SU 2 revealed two distinctive flaked and ground stone artifact concentrations possibly representing two discrete activity loci. One is clustered around Feature 2 while the other encompassed the second roasting feature, Feature 11. Both of the roasting pits had moderate amounts of fire-cracked rock in their interiors and additional rocks scattered around their perimeters. These items are believed to be rake-outs from the thermal pits. Large amounts of charred goosefoot seeds and moderate quantities of cf. sunflower family, cholla, juniper, and prickly pear embryos were recovered from these contexts. In addition to the plant remains, both features also yielded moderate amounts of burned bones from small mammals. The high volume of flaked lithics from Feature 2 is interpreted as possible refuse, although some may have been intentionally heat treated while food was being roasting inside the feature.

As discussed earlier, two radiocarbon dates obtained from SU 2 indicate at least two separate occupations. The structure, Feature 5, was dated to cal 1300 BC while the large roasting pit, Feature 2, is earlier, dating to cal 1680 BC. It is reasonable to suggest then that some of the features found in SU 2 were associated with the use of the structure, while others likely date to the earlier occupation associated with the cooking event at Feature 2.

Not many Archaic structures had been excavated in the general Albuquerque's West Mesa and Rio Rancho area until the past two decades. However, recent testing and excavation projects have uncovered a number of these habitation features. At the point of discovery, these structures often appear as amorphous ash and charcoal stains but they do exhibit a more formal shape upon the completion of their excavation. Seymour and colleagues (1997) report excavation of a pit structure with two intramural pits. The structure comes from site LA 107577 (named Lru-Kish Kachreu Site) and dates to cal 1390 to 1045 BC or 1415 to 1135 BC placing its occupation into the Late Archaic period. The structure measured about 3 m in diameter and had a depth of 7 to 10 cm (Seymour et al. 1997:165). This depth compares well with the depth of 10 cm deep for the structure at LA 158642, although this structure had its maximum length of only 2.5 m and no features were found in its interior.

Finally, (Raymond et al. 2008) report of a concentration of 12 pit features excavated within what appears to be a man-made depression. Located along the Paseo del Volcan Boulevard to the south of the current project area, the features at LA 126406 also were dated to the Late Archaic period. Although they are not interpreted as being part of a structure, it is possible that such a habitation feature may once have been positioned above the pits.

The artifacts recovered from SU 2 consist almost entirely of debitage with only a very small number of formal tools. The presence of one projectile point, one Stage 1 biface, one sharpening flake, and one utilized flake point to activities associated with some hunting and food processing. Eleven bifacial thinning flakes also suggest biface manufacture. The fact that no cores or hammerstones were recovered from this locale indicates less focus on lithic reduction in the immediate site area perhaps due to the proximity of the habitation feature (Feature 5). Instead, such activities may have taken place at other nearby sites, which consist of lithic artifact scatters adjacent to chalcedony outcrops that probably represent specialized lithic procurement loci. The flakes and other lithic materials at the LA 158642 Late Archaic habitation camp may have been brought to the site after some of the cortex on the nodules had already been removed.

Another possible explanation for the absence of hammerstones and especially cores made of high quality chalcedonies and chert in SU 2 is that these items may have been carried away when the camp was abandoned. The inference that lithic reduction took place at LA 158642 is also supported on the documented platforms types and high proportion of dorsal cortex observed on flakes.

The observed material assemblage clearly shows the selection of locally available lithic sources consisting primary of chalcedony and chert nodules. These materials have been observed in the immediate vicinity of the site as partially buried outcrops of chalcedony and some chert nodules. They are mostly visible along the southern banks of the unnamed arroyo that cuts through LA 158642 and eventually feeds into Arroyo de la Barranca. It therefore can be suggested that the location of LA 158642 was selected close to the locally available lithic materials while harvesting the natural plant and animal resources of the area.

The presence of some rare lithic materials, such as the obsidian, silicified wood, and jasper could indicate a possibility of transportation of these scarce materials into the region. Alternatively, such lithic resources could have been brought in to the project area by flood waters and may have been collected from the gravels at the bottom of the unnamed arroyo. At the same time, evidence for short distance material/tool transport has been obtained on Shackley's (2009) XRF analysis of the gray obsidian projectile point recovered from SU 2. The point comes from Cerro Toledo rhyolite which can be found in the Jemez Mountains. Because the Jemez Mountains drainages feed into the Rio Grande system, it is likely the point was made from an obsidian nodule collected from one of the Rio Grande tributaries.

Faunal and macrobotanical analyses revealed that goosefoot seeds were harvested in large quantities and were roasted or otherwise cooked inside the thermal features. Other plant seeds recovered from the features include sunflower family, cholla, cheno-ams, prickly pear, groundcherry, juniper and those from other indeterminate plants. Because most of these plant seeds ripen in late summer or early fall, this is also the most likely part of the year during which the site occupations took place. Small amounts of charred bones belonging to cottontail rabbit, small and medium size rodents and other small mammals as well as a fragment of an egg shell all point to opportunistic hunting of small game provided the needed supplies of protein.

Early Developmental Period Component, Study Unit 3

A single thermal feature (Feature 1), which was dated to the Early Developmental period, was discovered on the opposite side of the drainage, approximately 15 m north of SU 2. This part of the site was designated as Area 3 (Figure 6.1). Investigations in Area 3 were limited because the north side of the arroyo will not be impacted by the proposed construction. Study Unit 3 (SU 3) was a 5 m long, east-west vertical face cut into the arroyo wall to expose Feature 1 in profile (Figure 6.18). Although no formal descriptions of the strata were made, information on the depth of the feature, its shape in cross-section, and the presence of disturbances was recorded. The feature was sampled for datable materials but was not excavated. In addition, 11 auger tests were dug on the slope immediately adjacent to the arroyo to probe for additional buried features. No ashy sediments or artifacts were recovered from these auger holes.

Feature 1

Feature 1 is a thermal pit exposed in the north face of the arroyo cut bank. The feature probably became exposed during recent rain storms and was discovered by OCA excavation crew while working in Study Unit 2. The feature is defined as a very dark ash-and-charcoal stain with its upper portion buried under 50 cm of the eolian sediment. The pit has a basin shape reaching about 52 cm beneath the level where the original ground surface for the prehistoric occupation was (Figure 6.19). The western wall of the pit is almost vertical while the eastern wall is gradually sloping towards the bottom of the pit. The pit bottom is nearly level with a slight sloping upwards to the east. At the top, the feature is about 55 cm in diameter, while the bottom is about 35 cm in diameter. A pronounced rodent burrow is visible in the upper half of the feature fill. Other rodent runs are present in the stratum beneath the feature. No signs of oxidation were observed inside or around the feature and neither fire-cracked rock was observed in the feature profile.

A 4-liter flotation sample of the feature fill was collected from a portion of the feature that had begun to detach from the arroyo wall. Macrobotanical analysis of the charred remains revealed the presence of cholla seeds and prickly pear embryos which were likely consumed after being cooked in Feature 1. Other charred plants parts were also observed and include juniper, cholla, sagebrush and saltbush/greasewood. These species were probably used for fuel in the fire.

A wood charcoal fragment from sagebrush recovered from the exposed part of the feature was submitted for radiocarbon dating. The charcoal produced a conventional radiocarbon date of 1240 ±40 BP (Beta 265702) or a calibrated age of cal AD 770 with two standard deviation range of cal AD 670 to 890. This places the feature into the Early Developmental period of Ancestral Pueblo occupation.

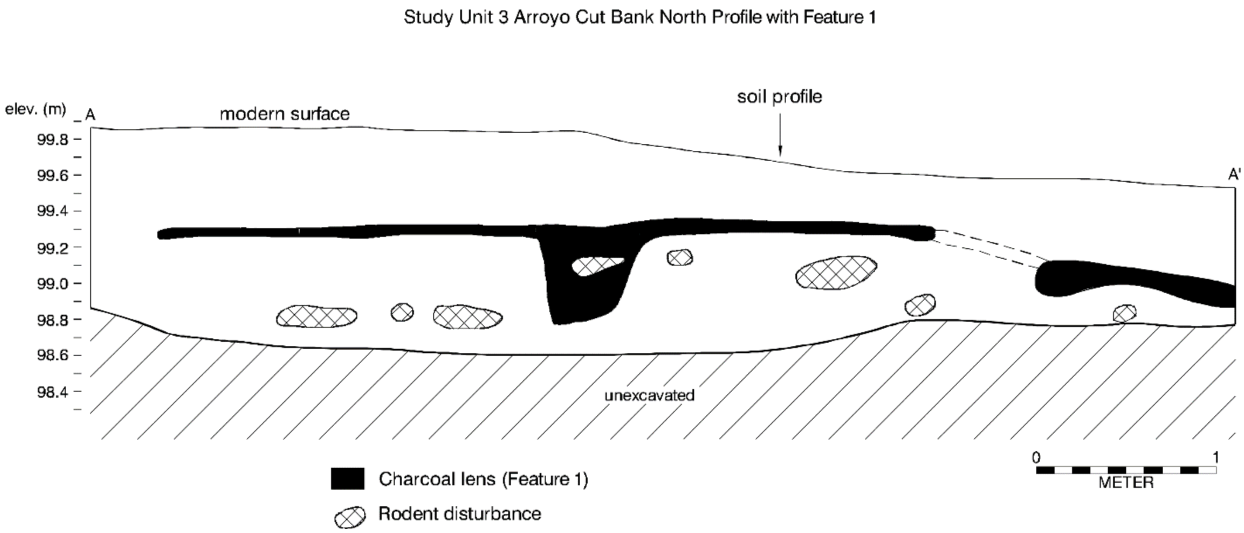


Figure 6.18. Profile sketch of Feature 1.

Figure 6.19. Overview of Feature 1 exposed in north cutbank of the unnamed arroyo, view looking north.

A 3–5 cm thick ashy lens with occasional charcoal specks extends about 2.2 m to the west and at least 1.7 m to the east of the feature. Another lens about 8–10 cm thick begins about 2.30 m east of the Feature 1 and continues for at least 2 m eastward. These lenses are believed to represent an occupation surface dating to the Early Developmental period and are believed to be associated with the use of Feature 1.

Despite the fact that oxidation was not observed along the pit walls of Feature 1, the pit likely functioned as a thermal feature. The presence of ashy lens outside the feature suggests a more intensive occupation at this location, and it is likely that additional features, perhaps even a small structure, are present in Area 3.

Coalition/Classic Period Ancestral Pueblo Component, Area 1

A Coalition/Classic Period occupation at the site is suggested by the presence of a single Rio Grande grayware body sherd that was documented during OCA's initial survey of the project area (Kurota and Chapman 2008). The sherd was found in what is now referred to as Area 1 in the eastern part of LA 158642 (Figure 6.1). Area 1 encompasses the original site boundaries marked out by the survey. It measures 40 m east-west and 20 m north-south and is relative level with only a 1.5 m change in elevation over the area. In addition to the sherd, the original survey documented 14 lithic artifacts in the area, 10 flakes, 3 pieces of angular debris, and 1 tested rock.

Two 1 by 1 m test pits (Study Units 4 and 5) were excavated in Area 1 to determine if any subsurface materials were associated with the surface artifact scatter. No artifacts were recovered from these test pits and the stratigraphy indicated that this part of the site was eroded, so there was little chance of finding intact cultural deposits. Ten auger holes spaced 5 m apart were placed in the ground at mid-slope between Areas 1 and 2. These tests confirmed that the hillslope was also eroded through the central part of the site as it did not retain any cultural material.

Study Unit 4

This study unit was a 1 by 1 m unit excavated to determine if any subsurface materials were associated with the artifact scatter in Area 1. It was located 10 m east of Datum 1. The surface of the unit had a few pieces of grass growing in it, and the sediments consisted of a brown (Munsell chart 7.5YR3/3) loamy sand. The unit was excavated down one 10 cm level through this loamy sand and then excavations were discontinued. Towards the bottom of the unit large amounts of caliche were encountered that increased in density as the level got deeper. This indicated that there was little chance of finding intact cultural deposits due to its considerable age.

Study Unit 5

Like SU 4, Study Unit 5 was a 1 by 1 m unit placed to determine if any subsurface materials were associated with the artifact scatter. The study unit was located 25 m east of Datum 1 and 15 m east of Study Unit 4 near the edge of the arroyo. As in SU 4, the surface consisted of a brown (Munsell chart 7.5YR3/3) loamy sand. One 10 cm level was excavated in SU 5 after which the excavations were discontinued. Large amounts of caliche were encountered and they increased in density towards the bottom of the unit. As discussed above this indicated that was little chance of finding intact cultural deposits.

The current work in Area 1 recovered 10 lithic artifacts. Except for one artifact from the excavations, the remaining nine artifacts were collected from the surface. They include one unifacial chopper made from fine-grained quartzite, one vesicular basalt netherstone, one flake, and seven pieces of angular debris (Table 6.4). Other than one limestone angular debris fragment, all of the debitage is chalcedony.

The Coalition/Classic period component seems to represent a very brief visit to the site. Perhaps the Ancestral Pueblo people were attracted to the site for the chalcedonies and cherts available within the arroyo bed and the nearby gravel outcrops.

Table 6.4 Lithic Artifacts Recovered from the Surface of Area 1 at LA 158642.

Material	Artifact Type				Total
	Angular Debris	Chopper, Unifacial	Flake	Netherstone, nfs	
Basalt, vesicular	-	-	-	1	1
Chalcedony	6	-	1	-	7
Limestone	1	-	-	-	1
Quartzite, fine grain	-	1	-	-	1
Total	**7**	**1**	**1**	**1**	**10**

Recent Historic Component, Study Unit 1

After mapping the site and piece-plotting and collecting the surface artifacts, excavations were initiated in Study Unit 1, a 2 by 3 m unit encompassing Feature 3. This study unit was located in the southern portion of Area 2, about 25 m south of Study Unit 2. The purpose of the excavation was to examine Feature 3 and the surrounding area to determine if the feature was cultural. The feature proved to be a badly eroded hearth. The study unit was excavated down one 10 cm level. A single sediment lens, Stratum I, was encountered within the 10 cm deep arbitrary level which ended on top of a slightly hardened erosional surface. The excavations did not go any further because the hard compacted layer was interpreted as cultural floor similar to that found in LA 158640. Several bone fragments and a few flakes were found adjacent to the hearth.

Feature 3

Feature 3 was a concentration of charcoal and burned animal bone fragments that covered 40 cm diameter area. The feature was contained within the same sandy loam as the surrounding area and was mixed with pieces of charcoal and numerous fragments of calcined bone (Figure 6.20). Faunal analysis identified the bones as cow or bison. The degree of calcination observed on the bone suggests that it was probably discarded into the fire. This matrix only had a depth of about 5 cm. The feature may have been used for cooking or as a heat source where bone was merely discarded. However, because of the degree of calcinations and fragmentation of the bone, any evidence of food use of these remains was obliterated. Feature 3 originated within or just below the stratum of recent eolian deposits.

Macrobotanical analysis of charcoal collected from the general Feature 3 concentration revealed the presence of charred twigs from juniper, pine, piñon, sagebrush, and saltbush/greasewood. A wood charcoal from sagebrush twig recovered from Feature 3 context was submitted for radiocarbon dating. The charcoal produced a conventional radiocarbon date of 60 ±40 BP (Beta 267771) or a calibrated age of cal AD 1960 with a two standard deviation range of cal AD 1690 to 1730 and AD 1810 to 1930 and AD 1950 to beyond 1960. This shows the feature is modern or late historic in origin. It is possible the feature was a part of a recent historic Navajo camp or an Anglo-Euro/American hunting or cowboy camp.

Seven flaked lithics were collected from the fill of SU 1. They consist of 1 flake and 6 angular debris fragments. Six of the lithics are chalcedony, one is chert. It is inconclusive whether these artifacts are associated with the use of hearth Feature 3 as it dates to the recent historic or modern period. It is possible the lithics come from an earlier and disturbed site component. Alternatively, the artifacts could be associated with the feature which would suggest its origin is affiliated with Navajo sheep herding camp perhaps dating to the first half of the 20th century.

SUMMARY OF THE EXCAVATIONS

In summary, seven study units totaling 69.5 sq m were excavated and screened at LA 158642, and 45 auger tests and 25 m of backhoe trench were used to probe other areas of the site. An additional 46 square meters of sediment was shovel scraped but not screened to expose cultural material in the western part of the site.

Cultural resources documented at LA 158642 indicate at least four occupational components. The earliest occupation dates to the Late Archaic period with two calibrated ages of 1680 BC and 1300 BC. The non-contemporaneous dates suggest two different site visits during this period. Eight excavated features and a deflated midden indicate the Late Archaic component was a seasonal residential camp focused on foraging wild plant resources, mainly goosefoot seeds as well as those from sunflower, juniper, cholla, prickly pear, cheno-ams, and ground cherries. Protein diet was supplied but opportunistic hunting of rodents, small mammals, and possibly the collection of bird eggs. The artifact assemblage indicates that flakes were used for cutting and scraping the wild plant material, while basin metates and one-hand cobble manos were used to grind and otherwise process the harvested seeds. The high volume of debitage with cortex and the documented platform types indicate extensive lithic reduction activities at the site. Although many flakes were made of high quality chalcedony and chert, cores and hammerstones are missing in the assemblage. This points to the possibility that blanks and other useful tool performs and materials were carried away upon the site abandonment. XRF analysis of the gray obsidian projectile point outlines its source to be that of Cerro Toledo rhyolite. Obsidian originating from this rock could have been collected from one of Rio Grande's tributaries.

The site's Early Developmental component was identified by the presence of a single hearth, Feature 1, exposed in the north face of the arroyo cut bank. Dating to the cal AD 770, the feature revealed charred seeds of cholla and prickly pear embryos. The feature was not excavated as current construction does not extend to the north side of the arroyo. This site component is a probable short term camp, although other cultural material is visible as ashy lens extending both to the east and west side of the hearth.

A possible component dating to the Coalition/Classic Period was suggested by the presence of single Rio Grande grayware sherd and a handful of flaked lithics found on the surface in the eastern half of the site (Area 1). Two 1 by 1 m excavation units and auger probes throughout Area 1 revealed no buried cultural deposits and the component was deemed to be largely surficial.

Finally, the latest component of LA 158642 was identified by the presence of a deflated hearth located on the surface in the southern portion of Area 2. The hearth, Feature 3, was marked by a concentration of fire-cracked rock and heavily calcined animal bone possibly from a bison but, more likely, from a cow. The radiocarbon date obtained from Feature 3 charcoal indicates the hearth probably dates to the recent historic period. This site component probably reflects a short term camp associated with herding sheep or cattle.

Chapter 7

EXCAVATIONS AT LA 158640

by Alexander Kurota, F. Scott Worman, and Douglas Rocks-Macqueen

LA 158640 was documented by OCA in February 2008 as a low-density scatter of lithic and ceramic artifacts covering an area measuring 110 m northwest to southeast by 60 m northeast to southwest-northeast and encompassing one associated rock feature (Kurota and Chapman 2008). The site is located on the summit and southeast-facing slopes of a stabilized sand dune and along the broad swale to the southeast of the dune. The swale is an un-entrenched drainage that flows into Arroyo de la Baranca roughly 500 m east of the site. Of the native plants recorded in the area (Spellenberg 1979), the most common at the site are snakeweed, grama grass, sand dropseed and galleta grass (Figure 7.1).

Figure 7.1. LA 158640 site overview, view looking northwest.

The surface artifacts at the site were clustered in two areas, identified as Proveniences 1 and 2 by the survey crew. Provenience 1 covered the western half of the site and measured approximately 55 m east-west by 35 m north-south. The survey crew recorded 42 flaked lithic artifacts – flakes, angular debris, and cores – including two small clusters of debitage that appeared to be the debris from individual reduction episodes. The rock feature, designated Feature 1, was located in a deflated area at the base of the dune slope near the southern edge of Provenience 1. The feature is a scatter of cobbles thought to be the eroded remnants of a hearth or roasting pit. Provenience 2 was situated approximately 20 m east of Provenience 1. It encompassed a diffuse scatter of nine flaked stone artifacts, three Rio Grande Glazeware body sherds, and a one-hand mano in an area measuring 50 by 30 m.

LA 158640 remained much as described in the survey records when the excavation crew began work at the site. In flagging the artifacts to re-establish the site boundaries, however, the excavation crew noted ash-stained sediments exposed in a recent rodent burrow on the crest of the dune in Provenience 1, which was re-designated as Area 1 for the excavation. A cluster of whiteware ceramics, flaked lithics, and a small amount of fire-cracked rock was also found just beyond the eastern boundary of Provenience 2 (re-designated Area 2) as defined during the survey. The site boundaries therefore were expanded to the north and east to encompass these newly exposed materials. Eight study units (SUs) were subsequently excavated at the site, six in Area 1 and two in Area 2 (Figure 7.2).

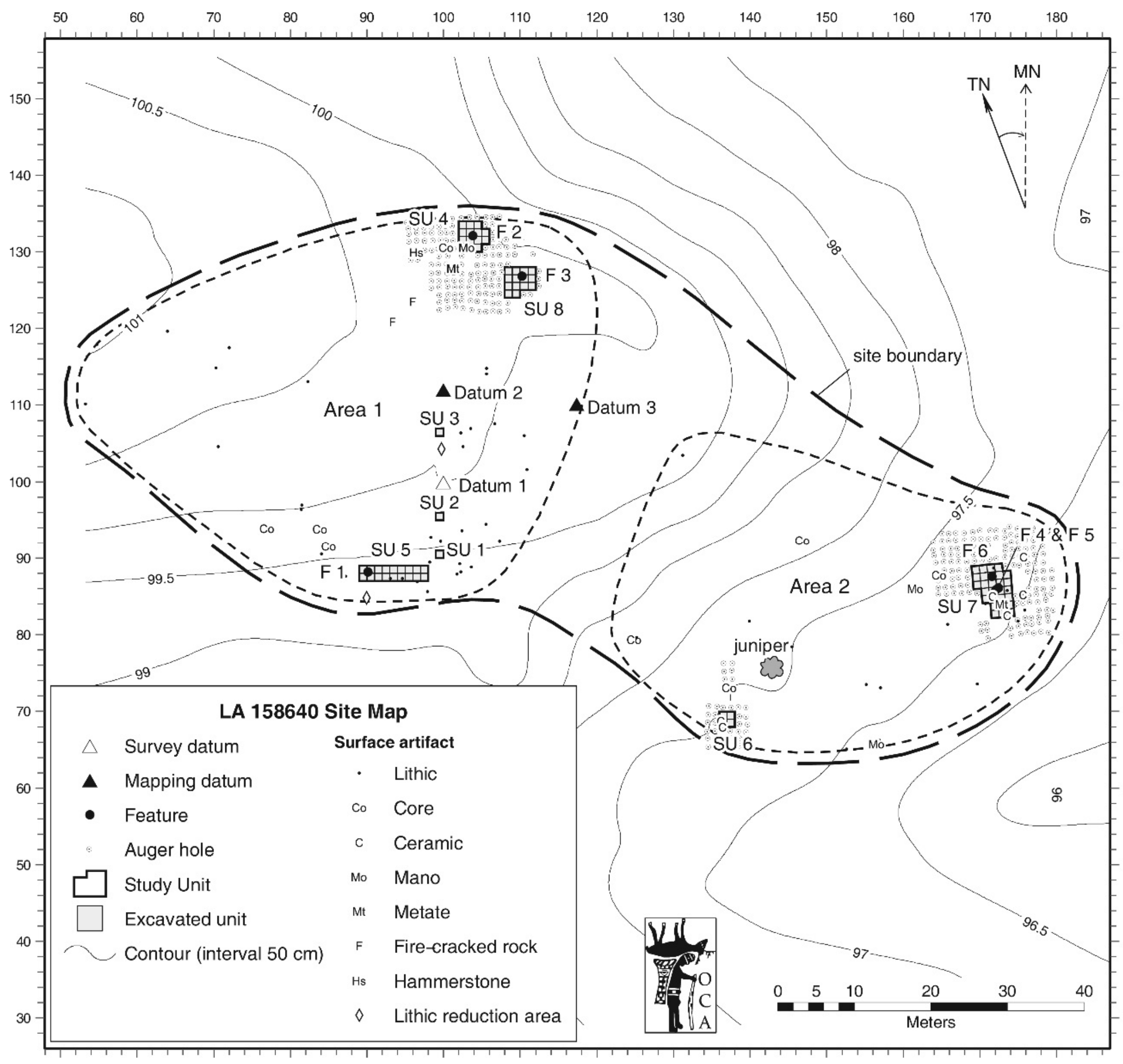


Figure 7.2. LA 158640 site map.

The initial excavations in Area 1 were three 1 x 1 m test pits (SUs 1–3) positioned to determine the geomorphological context of the lithic artifacts scattered over the dune slope. Study Unit 4 was then established over the ash stain noted on the top of the dune ridge (Feature 2), while Study Unit 5 was opened to investigate the rock cluster (Feature 1) noted by the survey crew at the base of the slope. Finally, Study Unit 8 was opened to uncover a second ash stain (Feature 3) found to the southeast of SU 4. The results of these excavations indicate that most of the artifacts in Area 1 are probably related to two or more occupations dating to the Basketmaker II or early Basketmaker III period. In Area 2, Study Unit 6 was opened in the artifact scatter with glazeware sherds, which proved to be the remnants of an ephemeral Pueblo IV occupation, while the excavations in Study Unit 7 uncovered a short-term camp dating to the Pueblo II period. LA 158640 is therefore a multi-component site evidencing sporadic short-term occupations during the past 2000 years.

SITE STRATIGRAPHY

by F. Scott Worman

Preliminary descriptions of the sediments exposed in each study unit were completed during excavations in order to provide baseline information about the matrix in which cultural materials were encountered. Subsequently, Worman completed formal, in-field pedostratigraphic recording of Study Units 1, 2, 3, and 6. Collectively, these study units provide a cross-section of the slope on which the site is situated, so the data generated by the analysis are relevant to understanding both site formation processes and local landscape change. The methods used for the analysis and formal descriptions of the pedostratigraphic units are presented in Appendix B. The results of the analysis are discussed here and in other relevant sections of the chapter.

Study Unit 1

Study Unit 1 is the southernmost of the three 1 x 1 m test pits spaced along the slope in the eastern part of Area 1 (Figure 7.2). It was positioned in an eroded area on the lower backslope of the hill, about 1 m northeast of Study Unit 5. These test pits were excavated in natural stratigraphic units, with Stratum I being the loose surface sediments and Stratum II, the more compact underlying deposits.

Local topography and comparisons of observed soil characteristics to the reference profile for the Grieta fine sandy loam (the NRCS soil unit at the site) suggest that at least 11 inches (~28 cm) of soil have been eroded recently from this location. The thickness, texture, and structure of the surficial unit are variable, and the structure and clay films indicate some degree of pedogenesis. Along with the abrupt lower boundary, these characteristics suggest that the stratum consists of an exhumed soil B horizon that has been thoroughly mixed with a significant quantity of recent aeolian deposits, prompting the AB designation in this location. The recent aeolian sediments are ubiquitous in the study area as a C or a weakly-developed A horizon,

The sediments comprising the surface horizon are strongly HCl reactive, but no calcium carbonate ($CaCO_3$) filaments, nodules or coatings were present and the unit was not visibly whitened. This combination of characteristics, along with the reduced reactivity of the subjacent unit, show that at least some of the carbonates are associated with the recent aeolian inputs (i.e, they are inherited, not the result of *in situ* pedogenesis). In addition, white coatings on ped faces in the subjacent unit do not exhibit enhanced HCl reactivity. These appear to be accumulations of gypsum ($CaSO_4*2H_2O$) or possibly another chemical salt. Given the very high mobility of chemical salts in all but hyperarid soils, this suggests that the recent aeolian inputs include an abundance of gypsum. The distributions of gypsum and carbonates in the soil column suggest recent increases in inputs of both to the solum, probably related to recent erosion in the region, and that both materials continue to be translocated downward from the surface sediments.

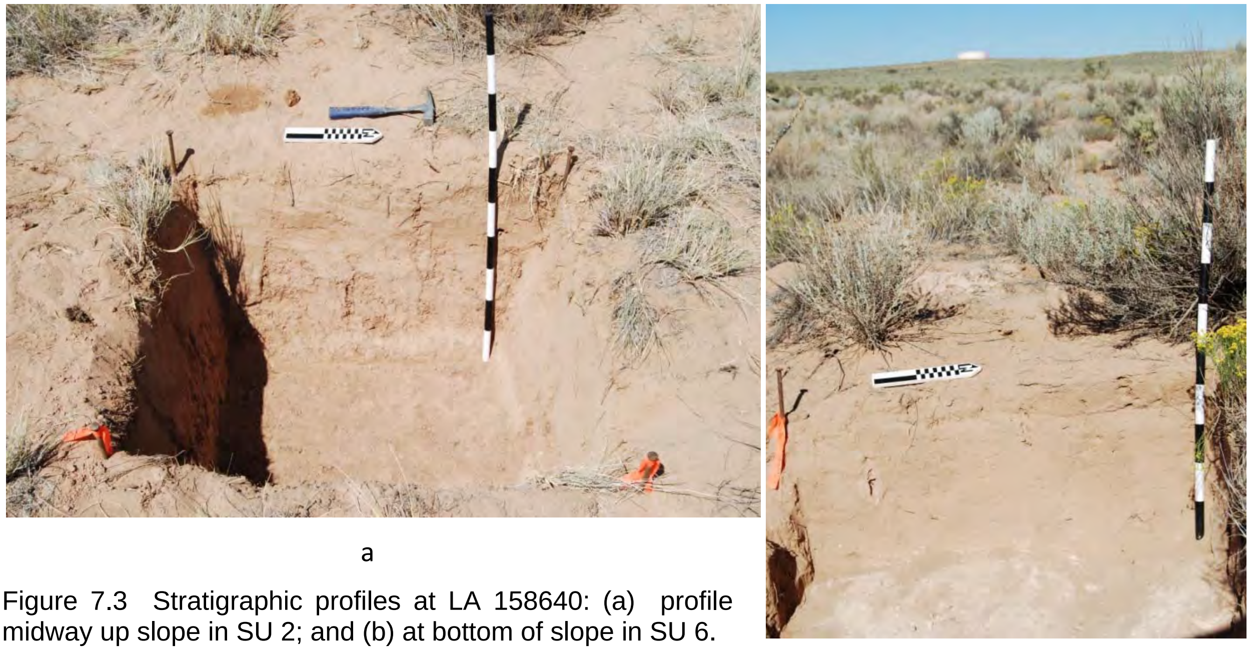
All pertinent characteristics of the underlying B horizons, including color, structure, clay film morphology, carbonate accumulations, and the gradual boundary between the two, indicate that they are genetically related horizons of a truncated ancient soil. The decrease in clay content and increase in $CaCO_3$ content with depth are expected in the B horizons of an intact dryland soil. Carbonates are more mobile in the solum because they are translocated downward in solution, while clays move downward as colloids. Holliday *et al.* (2006) report an Optically Stimulated Luminescence (OSL) date of more than 24,000 years BP for initial deposition of sandy sediments in which a soil with similar horizonation and stage II carbonate morphology has formed, at the Boca Negra Wash site (LA 124474) located several kilometers to the south (stage designations after Machette 1985).

Hall (2006, 2008) created a geochronology of the area adjacent to the site working from 12 OSL dates taken from backhoe trenches along the Paseo del Volcan corridor. He infers initial deposition roughly 15,000 – 10,000 BP of sandy sediments in which a soil with a reddened (5YR) argillic (Bt) horizon and subjacent calcic horizon (Bk) with stage I carbonate morphology has formed. Although none of the sediments encountered during this study were reddened to the same extent, it is reasonable to suggest that the presence of argillic or stage I calcic horizons implies similar terminal Pleistocene/ earliest Holocene ages for the deposits. The decreased rubification of the argillic horizons at the CNM sites may be attributable to the presence of significant quantities of gypsum that is rapidly translocated downward through the soil profile, effectively masking the reddening. Overall, the expression of time-dependent pedogenic characteristics in the two lower soil horizons exposed in SU 1, and particularly the Stage I–II carbonate morphology, suggest that they have been in place throughout the Holocene at the very least.

Variable soil characteristics, texture, and the presence of inherited $CaCO_3$ and $CaSO_4*2H_2O$ in the surficial unit are evidence of recent mixing and show that the surface deposit incorporates a large quantity of sediment recently emplaced by aeolian processes. Insect and rodent krotovina visible in the Btk(y?) horizon also provide direct evidence for recent mixing of sediments at and near the surface. Taken together, the data suggest that the larger landform has been stable throughout the Holocene; it appears to be a stabilized sand dune. Recently, however, significant erosion at this location removed the A horizon and an unknown quantity of the upper B horizon, and the upper few 10's of cm of sediments have been mixed by natural processes including faunalturbation. No artifacts were recovered during excavation of this unit. Unless affected by bioturbation, none are to be expected below the surficial unit in which they would be a lag deposit.

Study Unit 2

Study Unit 2 (Figure 7.3a) was located on the shoulder of the hillslope, 4 m north (uphill) of Study Unit 1. The surficial stratum in this test pit is calcareous fine loamy sand with virtually no evidence of pedogenic alteration. As in SU 1, it contains inherited carbonates and gypsum but unlike SU 1, there is little evidence for admixture with the subjacent deposits. The sediments on the surface in SU 2 are typical of the recent thin sandy surface deposits that are ubiquitous on Albuquerque's west mesa (Chapter 3, this volume). Similar sediments are noted in the reference profile for the Grieta fine sandy loam and they are present at all other study units at the site, with the exception of SU 1 where they have been altered or removed by erosion. They are the sediments that were informally identified as Stratum I during the excavations.



a

Figure 7.3 Stratigraphic profiles at LA 158640: (a) profile midway up slope in SU 2; and (b) at bottom of slope in SU 6.

b

The subjacent strata in SU 2 appear to be genetically related; they are the intact lower horizons of a truncated soil. Carbonate morphology and other pedogenic characteristics suggest that they correlate with the B horizons in SU 1, but the presence of a Bw horizon in the SU 2 profile shows that recent erosion has been less severe in this location. The degree of pedogenic alteration is consistent with initial deposition of these sediments during the late Pleistocene. The inferred age of the deposits suggests that the single lithic artifact recovered from SU 2 at a depth of approximately 20 cm is intrusive. Given the visible krotovina and the sandy texture of the sediments, the artifact was very likely moved downward from its original position as a result of bioturbation and/ or trampling (Wood and Johnson 1978 provide a useful overview of post-depositional disturbance processes. See Balek 2002, Johnson 2002 for recent overviews of bioturbation at archaeological sites, and Gifford-Gonzalez *et al.* 1985 on trampling). As in SU 1, the soils suggest macro-scale landform stability throughout the Holocene. Recent erosion in SU 2 was not as severe as in SU 1, but it did removed the A horizon prior to the emplacement of recent aeolian sediments.

Study Unit 3

Study Unit 3 was located at the summit of the stabilized dune, 10 m north of Study Unit 2. Characteristics of the surface sediments in SU 3 are identical to those in SU 2 and suggest the same age and origin. The subjacent stratum is a buried A horizon, however, and weakly expressed time dependent pedogenic characteristics are consistent with deposition and/ or reworking during the Holocene. The gradual lower boundary and relatively weak pedogenic alteration in the underlying Bwkj horizon indicate that it is genetically related to the buried A horizon. Together, the two are a preserved buried soil (paleosol) formed in a single depositional unit. The clear boundary between the Bwkj and the subjacent Btk horizon suggests that the lowest horizon is the remnant of an older, truncated soil. Carbonate morphology, clay films, texture and structure in the Btk horizon are consistent with deposition during the Pleistocene.

It is difficult to estimate with greater accuracy the timing of initial emplacement of the two buried depositional units (i.e., above and below the Bwkj – Btk boundary). Although the carbonate morphology in the Bwkj horizon tentatively was described in the field as a weak stage I, the constant HCl reactivity and lack of filaments and nodules in the three uppermost soil horizons suggest that many of the carbonates are inherited. In addition, the whitening observed in the Bwkj horizon may be due at least in part to recent inputs of gypsum and not to pedogenic carbonates. Together with the lack of clay films or an argillic horizon, these characteristics suggest that the sediments are younger than Hall's (2006) Pleistocene sand.

Hall documents a "historic A horizon soil" preserved in some locations above the Pleistocene sand, for which he infers an age of 100–200 years (Hall 2006: 5). Hall does not provide formal soil descriptions but he notes that the historic soil is non-calcareous and he gives a slightly darker color for the deposit. He does not describe any ped structure. Given these differences, it is tempting to suggest that the Ab/ Bwkj depositional unit in SU 3 is related instead to widespread mobilization of sand in the region that began during the mid-Holocene warm period (or "altithermal", ~5000–7000 BP) and lasted as late as 4000–3000 BP in the dune fields of the San Juan Basin to the west (McFadden *et al.* 1983, Wells *et al.* 1990).

A mid-Holocene age for the paleosol would be consistent with the concentration of artifacts at a depth of 10–20 cm bmgs (below the modern ground surface), in the upper portion of the buried A horizon. Their presence at that depth shows that the depositional unit cannot be as young as 200 years; the artifacts certainly were not produced during the recent historical period and very likely were deposited during the late Archaic. Although there is evidence for bioturbation, no post-depositional processes that would move artifacts larger than a few millimeters upward through the soil column (such as cryoturbation, argilloturbation, or tree throw) are likely in this location. More likely, the cultural materials were deposited at or near the upper boundary of the buried A horizon, and they may have been moved downward some few centimeters by trampling and faunalturbation prior to burial. It is possible that this area of the site might preserve intact, stratified late Archaic period cultural deposits, albeit affected to some extent by bioturbation.

The lowest depositional unit in SU 3 exhibits weak stage II carbonate morphology. Hall (2006) proposes that there is a Pleistocene surface associated with a stage II calcic paleosol that is variably preserved and exposed in the area. He presents a single OSL date of 130,000 +/- 30,000 BP for sediments below the calcic horizon (i.e. reflecting the timing of initial deposition); however, the date is somewhat problematic and should be considered a minimum age as dose-recovery tests showed that the sediments were close to saturation (Hall 2006: 16). As noted above, Holliday *et al.* (2007) present an OSL age of 24,000 BP for sediments below a stage II calcic horizon at the Boca Negra Wash site. It is highly likely that there are at least two and possibly many more locally preserved Pleistocene paleosols in the area, each associated with an episode of aeolian deposition triggered by interglacial – glacial or other climate shifts and followed by an extended period of landscape stability (Chapter 3, this volume). With the current data it is not possible to determine whether the Btk horizon at LA 158640 correlates well with either of the two dated units or with another that has not yet been described and dated. In any case, deposition must have occurred prior to the Holocene.

In sum, the soils and strata in SU 3 reflect a history of multiple cycles of deposition, soil formation, and erosion. The sediments at the base of the exposure were emplaced during the Pleistocene and then were stable for an extended period of time, allowing for development of a stage II calcic soil. Subsequently, erosion truncated that soil, removing the argillic and surface horizons. A second phase of deposition occurred during the Holocene, possibly associated with the mid-Holocene warm period. A weaker soil has formed in those deposits, and artifacts were deposited at or near the surface of that soil, probably during the late Archaic period. Soil characteristics and the vertical distribution of artifacts suggest that erosion was relatively minor in this location during the historical period, prior to the deposition of the current surficial stratum across the entire area during the 20th Century.

Study Unit 6

Study Unit 6 is a 2 x 2 m unit excavated in Area 2 to investigate a surface artifact concentration that included Rio Grande Glazeware body sherds. The unit was located downslope from and about 40 m southeast of SU 1 at the transition from lower backslope to the foot of the slope above the swale. The strata exposed by excavation are shown in Figure 7.3 b. The surficial deposit in SU 6 is essentially the same as that in SUs 2 and 3 but the subjacent ABkjb horizon formed in a separate depositional unit. Pedogenic characteristics suggest that it is cumulic, incorporating sediments transported downhill by slopewash as well as aeolian materials. In addition, krotovina and the lack of clear horizonation or depositional structures suggest that it is heavily bioturbated and that regressive (or proisotropic) pathways have dominated pedogenic processes in this location (Hole 1961; Johnson *et al.* 1987). Given the thorough mixing and homogenization of the unit, and the likelihood that deposition, mixing, and some removal of sediments have all been ongoing processes, it is not possible to determine its age with any degree of accuracy. The abrupt, erosional lower boundary that is not associated with a significant change in sediment texture, however, suggests that it is unlikely to be more than a few millennia old.

Ceramic artifacts were found at the surface and within the surficial deposits, and a flaked stone artifact was recovered from SU 6 at 20–30 cm bmgs. Given the evidence for significant mixing of the sediments and the inferred age of the surficial stratum, it is unlikely that any of the artifacts are in their original depositional context. It may be that the lithic artifact represents an earlier occupation or it may have moved downward through the soil column due to bioturbation. The ceramics, representing Classical (Pueblo IV) period visitation at the site, very likely would have been part of a lag deposit at the surface created by recent erosion prior to the accumulation of the uppermost stratum during the 20th century. They may have remained at the surface during deposition of those sediments due to processes similar to those that create many desert pavements by continually raising clasts above accumulating aeolian sediments (McFadden *et al.* 1987; Wood and Johnson 1978). Any chronological inferences based on vertical location should be considered tentative, however; it is unlikely that deposits in this location retain a high or even moderate degree of stratigraphic integrity.

The buried petrocalcic horizon at the base of the exposure exhibits stage III carbonate morphology. Hall (2006) proposes an age of greater than 2.5 million years for a stage III calcic paleosol developed on the local Rincones surface (an erosional surface on the Santa Fe Group gravels) that was, in his study area, subsequently exposed and eroded approximately 20,000 years BP. Hall's age estimates are within the range established by other studies of calcic soils in the region (Gile *et al.* 1966; Gile and Grossman 1979; Machette 1985). It is likely, however, that the paleosol here is somewhat younger, as it presumably overlies the Santa Fe Group which was deposited until the lower Pleistocene somewhat after 2.6 Ma. In any case, the sediments exposed at the base of SU 6 are the truncated lower horizons of an ancient soil that is far older than the human presence in the Americas or, for that matter, the appearance of modern humans anywhere.

Discussion

The excavation of study units at various points along the slope of the stabilized sand dune at LA 158640 allows for the study of catenary relationships. First applied to the study of soils by Milne in 1935 (Birkeland 1999: 235), the term catena in this context specifically refers to the variability of soils along a hillslope as well as the relationships between soils at different locations:

A soil catena is the variation of soils as a function of position along a slope. Soil morphology commonly differs from one position to the next as a function of the influences of either different local soil moisture regimes on pedogenesis, or geomorphic processes such as erosion of debris and soils upslope and deposition of the latter materials downslope (Birkeland and Gerson 1991:267).

In other words, soils vary in systematic and predictable ways along a slope because moisture inputs, average wind speeds and other variables are different in different geomorphic positions. Catenary studies, then, can be used to identify evidence for erosion or deposition and elucidate the pertinent processes by identifying any deviations from the expected patterns. Figure 7.4 presents graphically the variation in soils and depositional units along the slope at LA 158640 as well as inferred relationships between depositional units at the different loci.

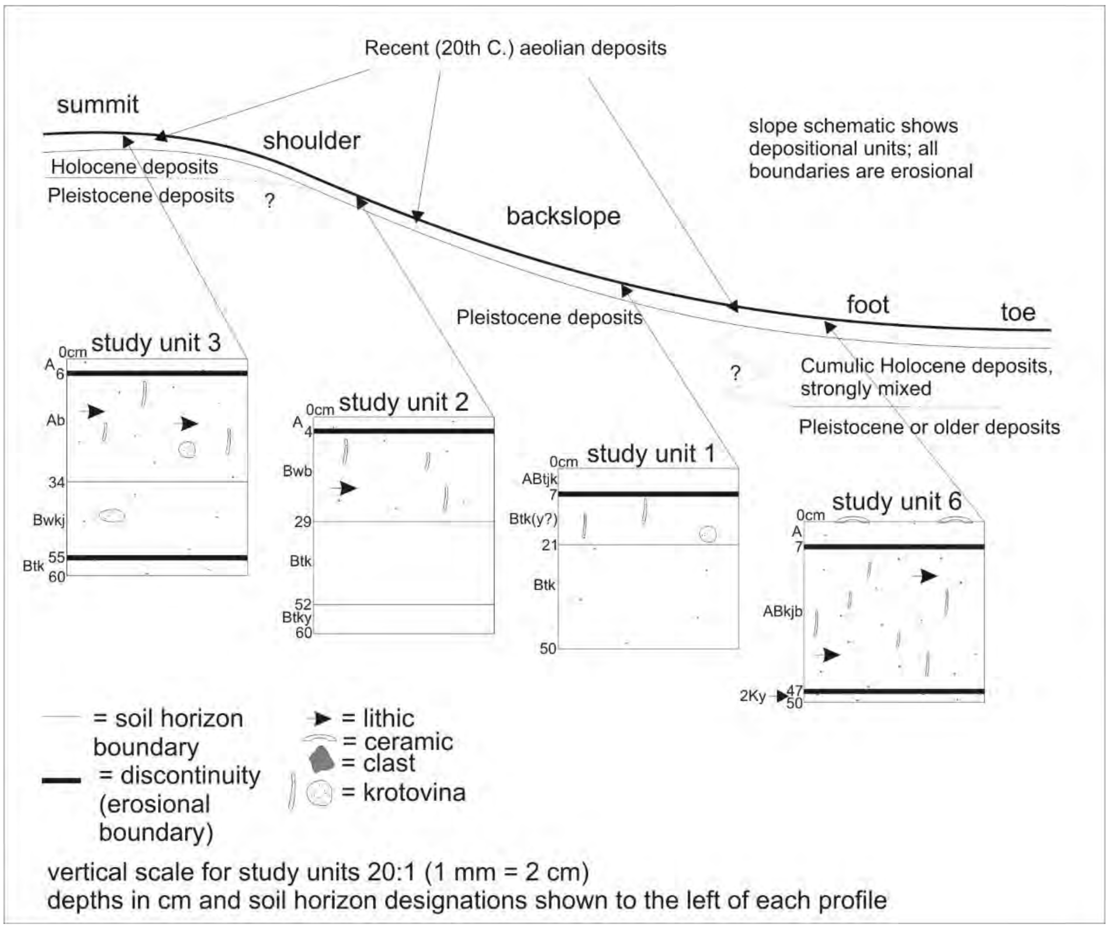


Figure 7.4. Measured profile drawings of selected study units at LA 158640 and schematic representation of relationships between inferred depositional units.

Comparison of soils exposed in the different study units shows that erosion has been most significant on the backslope, removing the A and upper B horizons from the soil developed in Pleistocene deposits. At the shoulder, the majority of the B horizon is intact, and at the summit the Pleistocene deposits are overlain by sediments that accumulated during the Holocene. At the base of the slope, erosion along the broad swale removed late Pleistocene deposits and exposed a far older paleosol before deposition related to erosion on the adjacent hillslope emplaced approximately 50 cm of sediments during the Holocene. The overall pattern shows that erosion by water has been the dominant process on the hillslope at least during the later Holocene. Rainsplash, sheetflow, and rilling have removed sediments from the backslope to the foot of the slope. Erosion has been minimal high on the slope where there is little or no uphill area to contribute run-on; discharge and therefore erosive potential are higher at lower points on the slope.

Evidence for hillslope erosion by water is somewhat surprising on a landform created by aeolian deposition where the generally sandy substrate would allow for rapid infiltration rates. It does, however, provide additional insight into the timing and processes of landscape change. Soils show that the dune itself was present by the late Pleistocene, and erosion by wind would have decreased dramatically once it was colonized by plants. Erosion by water would have been minimal for several millennia because of the rapid infiltration rates characteristic of the sandy sediments. As soils formed, however, pedogenic clays and carbonates would have accumulated in the B horizons; those horizons today are loamy in texture because of that accumulation. The textural changes gradually reduced infiltration rates, and by the mid- to later Holocene large storm events produced overland flow along the slope, initiating erosion (see Thornes and Gilman 1983 on the importance of large storm events in initiating geomorphic change in arid and semiarid environments). As that erosion removed sediment, the B horizons were exposed at or near the surface along the backslope, further reducing infiltration rates and increasing runoff and erosion. Pedogenesis, then, significantly affected long-term landscape change (c.f. Eppes *et al.* 2002, 2003).

The implication for the archaeological record is that cultural materials on the backslope likely have been affected by erosional processes. Where present, artifacts and clasts are a lag deposit and they may have been transported some distance downslope. Other artifacts likely were removed to the base of the slope. Intact, stratified deposits are possible at the foot of the slope, where a wedge of sediment has accumulated since the initiation of hillslope erosion, although stratigraphic relationships might be altered by redeposition of artifacts initially located on the adjacent slope. Undisturbed deposits are most likely at the summit where erosion caused by water has been minimal or absent. In addition, although it has no doubt impacted archaeological materials across the site bioturbation generally has been more significant at the base of the slope where biotic activity has been higher due to greater moisture availability.

EXCAVATIONS IN AREA 1

Area 1 encompasses the western half of the site, an area measuring approximately 50 m north-south by 60 m east-west. Surface artifacts were found primarily at the eastern edge of the area, on the lower southeast-facing slope of a low (2 m high) ridge (Table 7.1). Initial excavations therefore focused on this location. Ultimately, the remnants of two short-term camps dating to the Basketmaker period were uncovered in Area 1. These were the earliest components found at the site.

After mapping the site and collecting the surface artifacts, three 1 by 1 m test units (Study Units 1, 2, and 3) were positioned parallel to the hillslope through the main artifact concentration in Area 1. As described in the previous section, these units were excavated to a depth of 50-60 cm below the modern ground surface to define the site stratigraphy. Few subsurface artifacts were recovered from these units and all of those were in the upper 20 cm of deposits. Analysis of the site stratigraphy indicated that these artifacts were in a secondary context and had been transported downslope by erosion.

Study Unit 4, and later Study Unit 8, then were opened to investigate ash stains found on the summit of the ridge – the area where intact cultural materials were most likely to be preserved. Features were found in both areas marking occupations during the Basketmaker period. Relatively few artifacts were directly associated with the features but most of the artifacts redeposited on the lower slopes are probably related to those occupations. Concurrently, Study Unit 5 was excavated to investigate the cobble feature (Feature 1) documented by the survey crew near the base of the slope. A lag gravel deposit with chalcedony nodules was exposed in this area, and the associated artifacts suggest that those nodules were being collected and reduced by the site's inhabitants. We cannot be certain whether these lithic procurement activities were associated with the Basketmaker occupations or with one or more other use episodes.

Table 7.1. Surface Artifacts Collected from Area 1 at LA 158640.

	Artifact Type									
Material	**Angular Debris**	**Core, Irregular**	**Flake**	**Ground Stone, nfs**	**Hammerstone**	**Handstone, Indeterminate**	**Mano, Basin**	**Metate, Flat/Concave**	**Tested Rock**	**Total**
Basalt, vesicular	-	-	-	-	-	-	-	1	-	1
Chalcedony	24	1	12	-	-	-	-	-	3	40
Chalcedony, opaque	-	-	-	2	1	-	-	-	-	3
Chert	1	-	-	-	-	-	-	-	1	2
Other Lithic Material	-	-	-	-	-	-	-	-	1	1
Quartzite, fine grain	3	-	-	-	-	-	-	-	1	4
Quartzite, med/coarse	1	-	-	-	-	1	1	-	-	3
Sandstone	-	-	-	-	-	-	-	1	-	1
Siltstone	1	-	-	-	-	-	-	-	-	1
Total	**30**	**1**	**12**	**2**	**1**	**1**	**1**	**2**	**6**	**56**

Study Unit 4

Study Unit 4 was opened to investigate a small ash pocket on the crest of the dune ridge that was noted when the site was resurveyed by the excavation crew. The unit was located at the north end of the site approximately 23 m to the north northwest of Study Unit 3. The modern ground surface in this area was covered by light clumps of grass, and two metate fragments and a tested cobble were collected from this general area before excavations were initiated. The excavations started in 2 by 2 m area encompassing the ash stain but the unit was eventually expanded to 13 sq m to expose the occupation surface. The study unit was excavated in two 10 cm levels and both were within the Stratum I a strong brown (Munsell chart 7.5 YR 4/6) unconsolidated loamy sand corresponding to the recent aeolian deposits identified by Worman in SUs 1–3.

A hardened surface was encountered below Stratum I at the end of Level 2. That surface appears comparable to the abrupt boundary between the historic A horizon and the underlying Ab horizon in SU3. As discussed by Worman, the Ab horizon reflects a period of soil development in aeolian sediments deposited sometime during the Holocene. The ash found at the surface in SU 4 had been carried to the surface as rodents burrowed through a shallowly buried hearth or roasting pit (Feature 2) that originated at or near the top of the Ab horizon, marking aboriginal ground surface at the time of the occupation. SU4 was therefore expanded to uncover more of the occupation surface. Two manos, a large angular debris or core fragment, and a few pieces of fire-cracked rock were found clustered on the occupation surface about 1 m northwest of the feature. Other groundstone and fire-cracked rock fragments were scattered to the northeast and south of Feature 2 (Figures 7.5 and 7.6). Several flakes and angular debris also were recovered from the occupation surface. Roots were commonly encountered in Level 2 and rodent burrows were uncovered in the hearth and northwest corner of the study unit, indicating that bioturbation had intermixed the cultural deposits with the overlying recent aeolian sediments. This mixing probably accounts for the few flakes and small pieces of thermally-altered rock recovered from Level 1.

Figure 7.5. Overview of excavated Feature 2 in Study Unit 4, view looking northwest.

A total of 31 flaked lithic and ground stone artifacts were recovered during the excavation of SU 4 (Table 7.2). The flaked lithics consist exclusively of debitage, 3 flakes and 25 pieces of angular debris. Thirteen of these artifacts were recovered from the fill of Feature 2. The ground stone assemblages consists of two manos and a netherstone (metate) fragment. Two other metate fragments found on the surface approximately 2 m west and 2 m southwest of SU 4 may also be associated with this occupation. The ground stone at the site suggests that plant processing was a prominent activity at the site while the debitage is indicative of early stage core reduction.

Feature 2

Feature 2 was a circular pit uncovered in the central portion of SU 4. Once the ash stain had been exposed in plan, the pit was bisected north to south, and the eastern half of the fill was removed. After making a profile sketch, the rest of the feature was excavated. The cross-section showed two zones of fill (Figure 7.6). Zone 1 was a brown (7.5YR4/4 dry) loamy sand with light charcoal and ash staining that appears to have been introduced by burrowing rodents. Zone 2 was a dark brown (10YR3/3) loamy sand containing a larger amount of charcoal and greater volume of ash. Several rodent tunnels were found running through the feature although none severely disturbed the feature. When fully excavated, the feature was nearly circular in plan, measuring 95 cm east-west by 90 cm north-south. In cross, section, the pit had almost vertical walls and an undulated, flat bottom. Its maximum depth was 22 cm (Figure 7.7). The interior surface of the pit was lightly oxidized, indicating *in situ* burning. There was no fire-cracked rock in the fill but a few pieces were scattered on the use surface around the pit. Given the small quantity of rock present, it was likely used for stone boiling, which suggests that Feature 2 was probably a hearth and not a roasting pit.

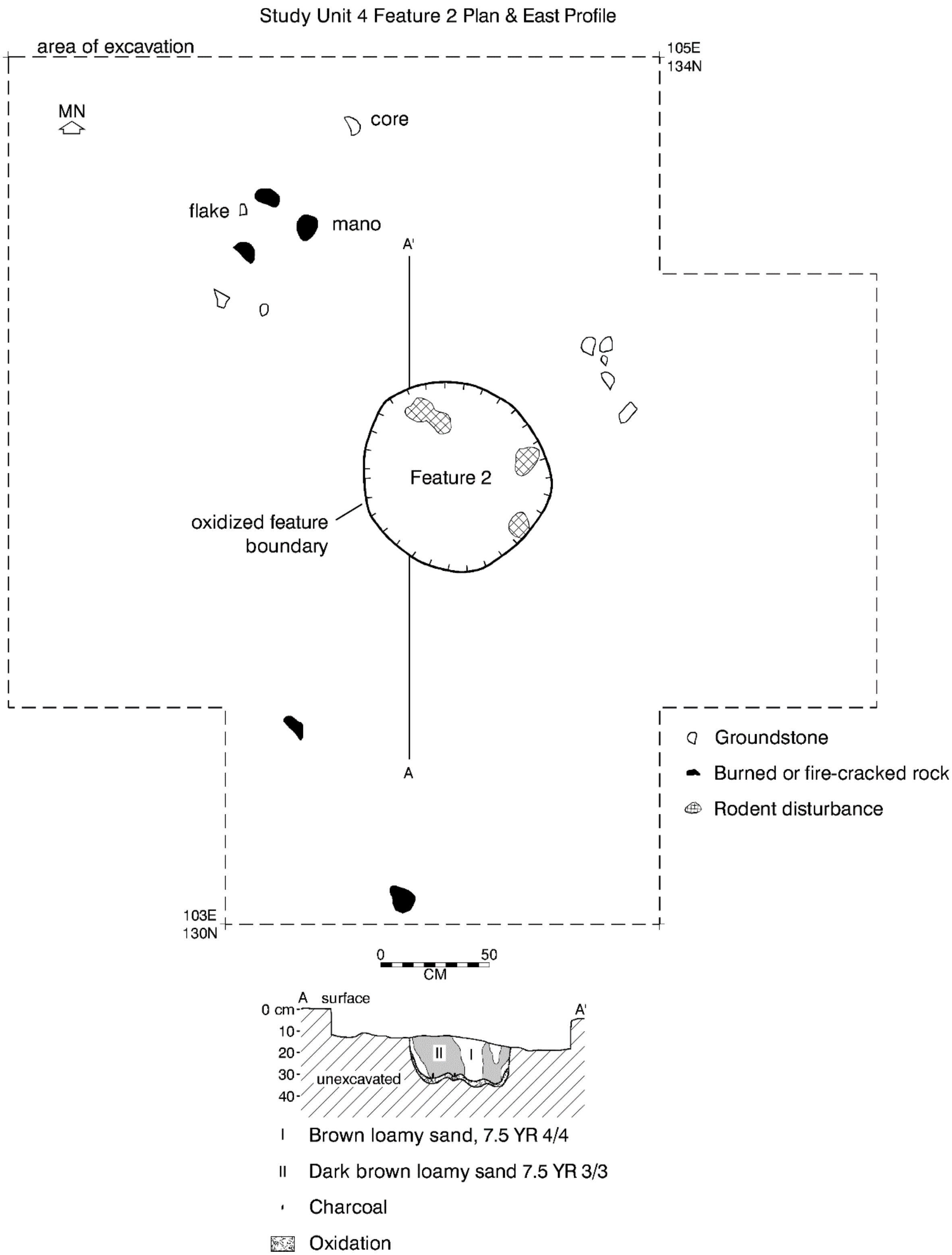


Figure 7.6. Plan of Study Unit 4 showing Feature 2 and associated artifacts.

Table 7.2. Lithic Artifacts Recovered from Basketmaker II Occupations Uncovered in Study Units 4 and 8 at LA 158640.

	Count of Count	**Column Labels**				
	Row Labels	**Angular Debris**	**Flake**	**Mano, Flat/Convex**	**Netherstone, nfs**	**Total**
SU 4	Chalcedony	22	3	-	-	25
	Chert	3	-	-	-	3
	Chert, white	-	-	1	-	1
	Tuff	-	-	1	1	2
	Study Unit 4 total	25	3	2	1	31
SU 8	Chalcedony	35	4	-	-	39
	Chert	4	1	-	-	5
	Obsidian	-	1	-	-	1
	Study Unit 8 total	39	6	-	-	45
Total		**64**	**9**	**2**	**1**	**76**

a

b

c

Figure 7.7. LA 158640 Feature 2: (a) pre-excavation; (b) profile; (c) post-excavation. (views to the northwest).

Flotation of the feature fill yielded mostly wood charcoal. The identifiable fragments were mostly juniper, with a small amount of cholla. These materials are believed to have been used as fuel in the fire. No potential subsistence remains were recovered from the feature. A small twig of juniper wood charcoal was submitted for radiocarbon dating. The sample produced a conventional radiocarbon date of 1800 ±40 BP (Beta 265700) or a calibrated age of cal AD 230 with a two standard deviation range of cal AD 120 to 330. This places the feature into the Basketmaker II period. One flake and 12 pieces of angular debris, none of which were burned, were also recovered from inside the hearth.

Study Unit 8

Study Unit 8 was located on the ridge summit, about 4 m southeast of Study Unit 4. It began as a 2 by 2 m unit placed over an ash stain discovered while pinflagging the surface artifacts. The northwest, southwest, and southeast 1 by 1 m grids in this unit were excavated down two 10 cm levels through Stratum I and into Stratum II. The northeast 1 by 1 m grid was excavated in 10 cm level as the recent aeolian sediments were shallower in this unit. The excavations exposed a rodent burrow filled with ash stained sediments, and SU 8 was expanded 2 m north following this burrow. This expanded excavation uncovered Feature 3, which also originated at the top of Stratum II, the Ab horizon identified by Worman. The study unit was expanded a further 2 m east to uncover more of the occupation surface, giving SU 8 a total area of 14 sq m. Except for a few scattered fragments of fire-cracked rock, no artifacts were recovered during the excavations in SU 8.

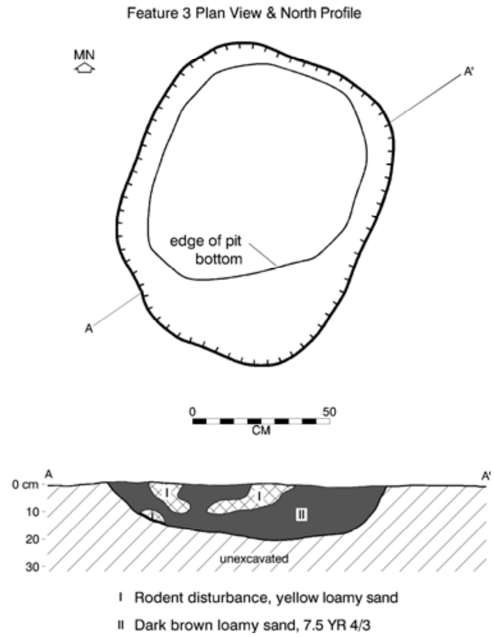
Feature 3

Feature 3 was an ash-filled pit in the northern part of SU 8. After exposing the ash stain in plan, the southeast half of the pit was excavated to expose a cross-section of the fill. The fill consisted of a zone of brown (7.5YR4/3) loamy sand that contained large amounts of charcoal and ash. The profile also showed several rodent burrows cutting through the feature (Figure 7.8). The pit is oval in plan, measuring 110 cm northeast-southwest by 90 cm northwest-southeast. In profile, it is a flat-bottomed basin with a maximum depth of 20 cm. The interior surfaces showed little oxidation, which suggests that the feature was used for only a brief period. No fire-cracked rock was found in the fill, and only a few fragments were found during the excavation of SU 8. It is therefore likely that Feature 3 served as a hearth rather than a roasting pit.

As in Feature 2, the macrobotanical material recovered from the fill of Feature 3 consisted primarily of fuel wood charcoal – juniper and a lesser amount of cholla. No other charred plant remains or faunal material was recovered. A fragment of cholla wood charcoal was submitted for radiocarbon dating. The charcoal produced a conventional radiocarbon date of 1660 ±40 BP (Beta 265701) or a calibrated age of cal AD 400 with a two standard deviation range of cal AD 260 to 290 and AD 320 to 440 and AD 490 to 520. This places Feature 3 into the late Basketmaker II or early Basketmaker III period. There is a statistically significant difference in the radiocarbon dates from Features 2 and 3 at the 0.05 level (t=2.47), indicating that the features probably represent separate occupational episodes.

Forty-five lithic artifacts, 6 flakes and 39 angular debris fragments, also were recovered from the fill of Feature 3 (Table 7.2). None of the artifacts showed evidence of heat alteration, which probably indicates that they were dumped into the pit after the hearth was no longer being used. Except for one obsidian flake, the debitage consists of chalcedony and white or tan chert, which are locally-available lithic raw materials. The high proportion of angular debris is suggestive of core reduction, while the high percentage of cortex on most of the debitage indicates an early stage of lithic reduction.

a



b

c

d

Figure 7.8. LA 158640 Feature 3: (a) pre-excavation (view to northwest); (b) plan-view and profile; (c) post-excavation (view to northeast); (d) excavated Feature 3 in Study Unit 8.

Auger Testing Outside Study Units 4 and 8

After the completion of excavation in SUs 4 and 8, the sediments around the two study units were inspected for additional buried cultural deposits using 8 cm wide bucket augers. One auger probe reaching from 40 to 70 cm beneath the modern ground surface was placed in the center of each 1 x 1 m grid unit outside the two study units. Because groundstone artifacts and flaked stone tools were found on the surface to the west and south of the two study units, this area was probed more intensively. In all, 134 auger tests were placed outside SUs 4 and 8. As no artifacts, charcoal/ash stains, or other cultural material were found during the auger testing, no further excavations were conducted in this part of the site.

Study Unit 5

Study Unit 5 was opened to investigate Feature 1, a loose concentration of cobbles noted by the survey crew in a deflated area near the base of the ridge slope at the southern edge of Area 1. The excavation began as a 2 by 2 m unit centered on the cobble concentration but was ultimately expanded to 9 by 2 m running eastward from Feature 1 toward SU 1. Stratum I in this unit was a 4 cm thick deposit of unconsolidated brown (Munsell chart 7.5 YR 4/6) loamy sand that partially covered a thin gravel deposit resting on consolidated loamy sand. Stratum I in SU 5 is the recent aeolian sand, while the consolidated loamy sand appears equivalent to the Pleistocene age Btk horizon described by Worman in SU 1. It therefore appears that erosion has also removed any Holocene sediments from this part of the ridge backslope, leaving a thin lag deposit of pebble to cobble size gravels derived from those sediments.

Only two artifacts were recovered during the excavation of SU 5, a hammerstone and a large angular debris or core fragment made from the local brown chert. Both were found adjacent to Feature 1. However, another 21 artifacts were collected from the surface in the vicinity of this study unit – 4 tested cobbles, 4 flakes, and 13 fragments of angular debris. Chalcedony is again the predominant lithic raw material in this assemblage (16), followed by fine-grained quartzite (3), and chert (2). Although these artifacts could have been eroded from the Holocene deposits, they more likely reflect exploitation of the lag gravels as a convenient source of lithic raw material.

Feature 1

Feature 1 was a loose cluster of natural cobbles located at the western end of SU 5. It consisted of 2 granite, 4 basalt, 1 chert, and 3 chalcedony cobbles ranging from 5 to 25 cm in maximum dimension (Figure 7.9). The aeolian sediment surrounding these rocks was excavated and screened as part of SU 5 investigation. No ash staining or oxidation was encountered during the excavation, which makes interpretation of the feature difficult. If it is the remains of a hearth or roasting pit, then it has been completely deflated as the cobbles were not arranged in any discernible fashion. Alternatively, the cobbles could be a random clustering within the natural lag gravel deposit.

Discussion

The excavations in Area 1 uncovered two large basin-shaped hearths (Features 2 and 3) on the crest of a low ridge in the western part of LA 158640. The features were about 12 m apart, and the radiocarbon dates of cal AD 230 for Feature 2 and cal AD 400 for Feature 3 indicate that they probably represent two separate occupations of the site during the Basketmaker period. Feature 1, found near the base of the ridge slope could be the eroded remnants of a hearth or roasting pit of unknown age, but is more likely a chance cluster of natural cobbles.

A total of 125 flaked lithic and 10 ground stone artifacts were recovered from Area 1, almost all of which are most likely associated with one or the other of the Basketmaker occupations. Apart from the artifacts recovered from Study Units 4 and 8, the geomorphic evidence indicates that the artifacts on the slopes below Features 2 and 3 have been carried downslope from those occupation areas as a result of slope erosion. The association of the 25 artifacts found in and around SU 5 is less certain. These artifacts could be part of a separate activity area that may or may not be associated with the Basketmaker occupations.

a

b

Figure 7.9. LA158640 Feature 1: (a) plan-view; (b) pre-excavation (view to southeast); (c) post-excavation overview of Feature 1 and Study Unit 5 (view to west).

c

The character of the features, the presence of ground stone, and the relatively small size of the artifact assemblage together suggest that Features 2 and 3 are the remnants of short-term residential camps. Although the pits are relatively large (roughly 1 m in diameter and 20 cm deep), only a small quantity of fire-cracked rock was associated with the features, which suggests that they were hearths rather than roasting pit and that the heated rocks were used for stone boiling. Neither feature yielded macrobotanical or faunal remains, so there is no direct evidence of the food resources being prepared. Fragments of two manos and a metate were recovered from SU 4, however, and two other metate fragments and a hammerstone were found on the surface near the excavation. No ground stone was directly associated with SU8 but two mano fragments were found on the lower slope directly below that excavation unit. These artifacts provide indirect evidence that seeds or other plant parts were processed at the camps.

The flaked lithic assemblage from Area 1 comprises 95 angular debris fragments, 22 flakes, 6 tested rocks, 1 core, and 1 hammerstone. Chalcedony (105) is the predominant lithic raw material, followed by chert (12), quartzite (5), obsidian (1), siltstone (1), and other lithic materials. Given the high proportion of angular debris and frequency of cortex on the debitage, the assemblage is interpreted as reflecting the procurement and early reduction of locally-available lithic raw material. Analysis of the debitage attributes (Chapter 10) further suggests that some cortex had been removed from the lithic nodules before they were brought to the site for further trimming. The high flake to core ratio for the assemblage could indicate that the reduced cores were then carried away when the group left the site. Given the high angular debris to flake ratio, some flake blanks may also have been removed.

EXCAVATIONS IN AREA 2

Area 2 encompasses the eastern half of LA 158640, an area measuring 55 m north-south by 40 m east-west. Two artifact scatters were noted in this part of the site, and 21 lithic artifacts were collected from the surface (Table 7.3). The first scatter consisted of a few lithic artifacts and a small cluster of Rio Grande Glazeware sherds noted by the survey crew about 40 m southeast of the main artifact scatter in Area 1. Study Unit 6 was opened to investigate this scatter, which proved to be the remnants of a pot drop or ephemeral use episode dating to the Classic period. A second, newly-exposed scatter was found by the excavation crew at the eastern edge of the site, approximately 35 m northeast of Study Unit 6. This scatter consisted of lithic debitage, Cibola Whiteware sherds, and a few pieces of fire-cracked rock. Study Unit 7 was placed in this area, and the excavations uncovered a short-term camp dating to the late Developmental period.

Table 7.3. Lithic Artifacts Collected from the Surface in Area 2 at LA 158640.

Count of Count	**Artifact Type**				
Row Labels	**Angular Debris**	**Core, Irregular**	**Flake**	**Mano, Flat/Convex**	**Total**
Chalcedony	6	3	4	-	13
Chert	4	-	-	-	4
Quartzite, fine grain	2	-	-	-	2
Quartzite, med/coarse	-	-	-	1	1
Tuff	-	-	-	1	1
Total	**12**	**3**	**4**	**2**	**21**

Study Unit 6

Three Rio Grande Glazeware body sherds had been found on the surface in the southwestern part of Area 2. Study Unit 6, a 2 by 2m unit, was excavated in this area to determine if any buried cultural deposits were present. As noted in the discussion of site stratigraphy, SU6 is situated at the base of the dune ridge in an area where sediments eroded from the hillside tend to accumulate. The unit therefore was excavated in 10 cm levels that penetrated through the upper A horizon and ended in the underlying AB horizon. The upper A horizon was only 2–4 cm thick and additional glazeware sherds were recovered from this deposit. A chert angular debris fragment was also recovered from Level 3 in the AB horizon (20–30 cm below modern ground surface). No features or other artifacts were found during the excavation. Two chalcedony cores were collected from the surface a few meters north and northeast of SU 6 but it is not certain that they are associated with the glazeware sherds.

Twenty-two auger tests, spaced 1 m apart, were placed in the ground to probe the unexcavated portion of a 6 by 6 m area surrounding Study Unit 6, and six additional probes were dug upslope of the unit. As no artifacts or evidence of subsurface features was found in the auger holes, excavation around Study Unit 6 was discontinued. The sherds from SU 6 are all glaze-on-yellow and probably come from a single Espinoso Glaze-on-yellow bowl. Thus the artifacts in this area likely represent either a pot-drop or a very ephemeral use episode dating to the Classic period. More specifically, the Glaze C rim suggests a date sometime between AD 1450 and 1500.

Study Unit 7

While reflagging the surface artifacts at the LA 158640, the excavation crew identified a small cluster of flaked lithics, ceramics, and a few fire-cracked rock fragments just to the east of the site boundaries established during the survey. The ceramics were Cibola Whitewares, which indicated an occupation dating to the Pueblo II or Late Developmental period. Further, because these artifacts had been only recently exposed, there was a possibility that the occupation remained largely intact. For these reasons, the eastern boundary of Area 2 was expanded to encompass the scatter and Study Unit 7 was opened to investigate the new component.

Study Unit 7 began as a 2 by 2 m excavation positioned over the sherds and fire-cracked rock but ultimately the unit was expanded to 29 sq m to expose the occupation. The grids in the original 2 by 2 m unit were excavated in three levels to a depth of 30 cm below modern ground surface. The top of the unit consisted of a 3-10 cm thick layer of recent aeolian deposits (the upper A horizon). The underlying sediments were more compact and appeared comparable to the AB horizon described by Worman in SU 6. Several lithics and pieces of thermally altered rocks were found in Level 1 but no artifacts were recovered from Levels 2 and 3. The remaining grids in SU 7 were therefore excavated in one level to remove the recent surficial deposit. These excavations exposed three features originating at the top of the AB horizon and a large basin metate that was resting on this surface (Figures 7.10 and 7.11). Features 4 and 5 may be a pair of hearths or a hearth and adjacent ash/warming pit. These features were situated near the center of the excavated area. The metate was found about 1.5 m south of Features 4 and 5 while the third ash-filled pit, Feature 6, was found about 2 m to the northwest.

Excavations were halted when no artifacts were found in the outermost grid units. A series of 132 auger holes, spaced 1 m apart, were then dug to systematically probe an area of about 15 by 15 m to the north, east, and west of SU 7. No artifacts or indications that additional buried features were present were found in those auger tests.

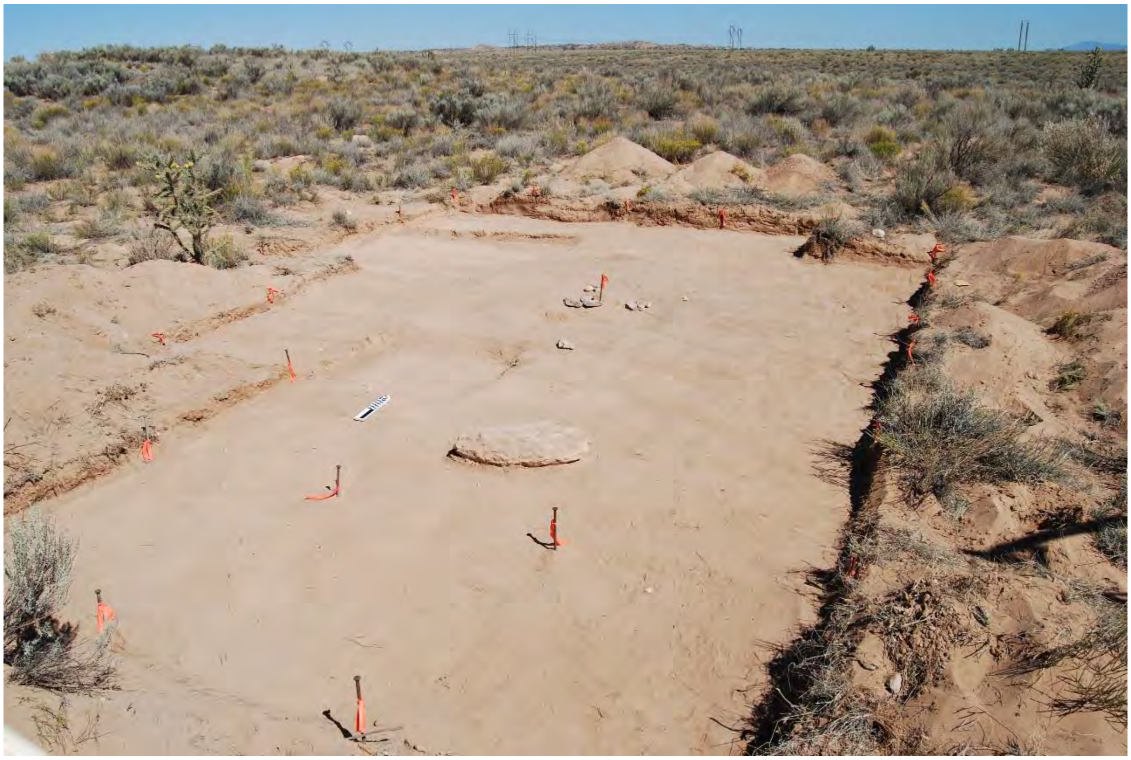


Figure 7.10. Overview of excavated Study Unit 7, view to northwest.

Feature 4

Feature 4 was first defined as an ash stain measuring 42 by 53 cm. The feature was bisected by removing the fill from the southeastern half of the pit. The resulting profile revealed a lens of light gray loamy sand with ashy pockets, very small flecks of charcoal, and thermally altered rock. The remaining half of the feature was then removed and also collected for flotation. Once fully excavated, the pit was oval in plan with a basin shaped in cross-section. It was 65 cm in diameter and 12 cm deep (Figure 7.12). Faint traces of oxidation were visible around the rim indicating a fire had burned within the pit.

Feature 4 was most likely a small hearth used for cooking. Numerous pieces of fire-cracked rock found in and around the hearth may have been used as heat reservoirs for pit roasting or for stone boiling. Apart from juniper and cholla wood charcoal, which were presumably used as fuel, flotation of the fill yielded only a charred cholla embryo and an unidentified plant part. The former suggests that cholla seeds may have been among the foods prepared and consumed at the site. Two chalcedony flakes and two pieces of angular debris were also recovered from the feature. None of these artifacts showed heat alteration.

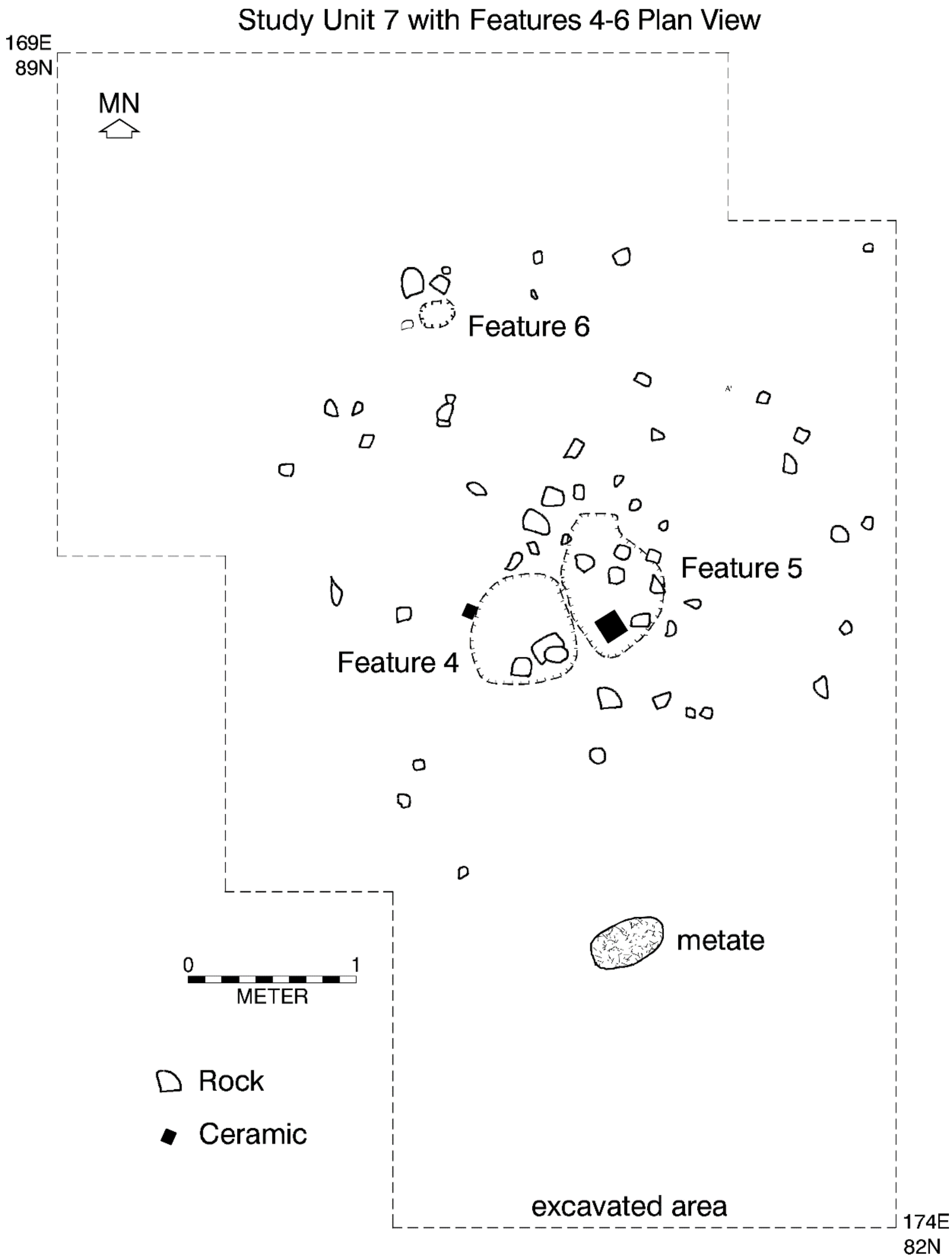
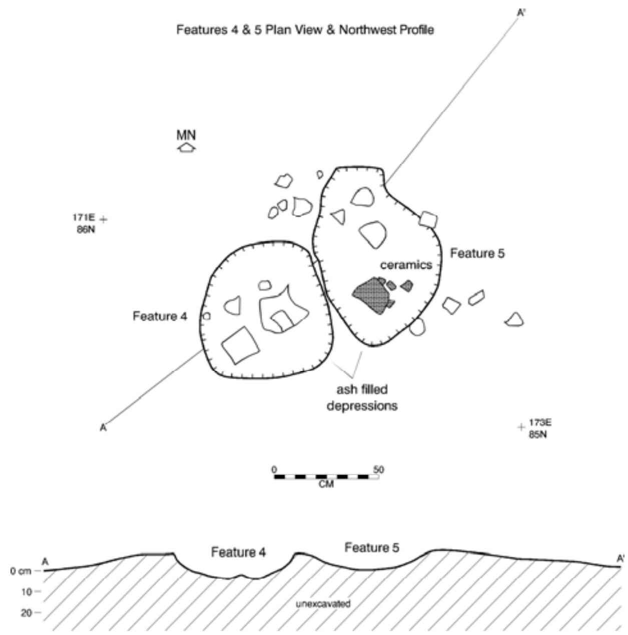


Figure 7.11. Plan view of Study Unit 7 with excavated features, fire-cracked rock and piece-plotted artifacts



a

b

c

Figure 7.12. Features 4 and 5: (a) plan view and profile; (b) pre-excavation (view to northwest); (c) post-excavation (view to northwest).

Feature 5

Feature 5 was located just northeast of Feature 4 (Figure 7.12). It was not as well defined as Feature 4 and initially appeared as an irregular ash stain measuring roughly 70 by 32 cm. Again the southeast half of the fill was removed and bagged for flotation to bisect the feature. In cross-section, the fill was a lens of ash-stained light gray loamy sand flecked with very small pieces of charcoal and thermally altered rock. After removal of the remaining fill, the fully excavated pit was 95 cm long (north-south), 60 cm wide (east-west), and 5–8 cm deep. It was oval to kidney-shaped in plan with a shallow, basin-shaped cross-section. Because no signs of oxidation were observed on the sides or bottom of the feature, it may not have been used as a hearth but instead served as an ash or warming pit used in conjunction with Feature 4.

The macrobotanical analysis revealed the presence of charred wood fragments of cholla, juniper, and an indeterminate plant part. In addition, several Red Mesa Black-on-white bowl sherds were recovered from the fill of Feature 5 and around the perimeter of the pit. Most of the sherds refit into a single ceramic piece which makes up about 20% of the original bowl. It is likely the bowl was used during the food preparation or consumption. Fourteen pieces of angular debris, all unburned, were also recovered during the excavation of this feature.

Feature 6

Feature 6, the last feature excavated in SU 7, was a small oval pit filled with ash-stained sediments that was located about 2 m northwest of Features 4 and 5 (Figure 7.13). As with Features 4 and 5, the pit fill was bisected northeast-southwest with the southeast side removed first and collected for flotation processing. The fill was a brown (7.5 YR 4/3) loamy sand mixed with ash. A profile drawing was made of the northwest side and then other half of the feature fill was then removed and collected. There was a white calcium carbonate stain on the northern edge of the feature that might be lime used in cooking. Such material could have been obtained from the calcic horizon which is less than 20 cm beneath the occupation layer. Upon the completion of the excavation, Feature 6 appeared oval in plan and measured 38 cm north-south by 32 cm east-west. In cross-sectional view, it was a shallow basin about 7 cm deep.

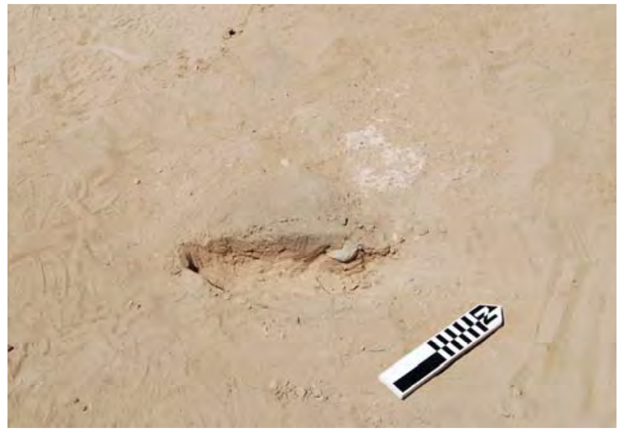
Nine pieces of angular debris were recovered from flotation processing of the Feature 6 matrix. A single burned cholla seed also was recovered from the fill. Burned wood in the fill was identified as juniper and cholla. It is not clear if Feature 6 functioned as a thermal feature since no traces of oxidation were documented along the pit walls or its perimeter edge. The presence of ashy fill with charcoal could imply light use as a hearth or the pit may have been used for ash disposal.

Discussion

Seventeen ceramics were recovered in SU 7, both from the modern ground surface (*n*=8) and from excavation contexts (*n*=9). Most of the latter sherds were clustered in and around Feature 5. There were 13 Red Mesa Black-on-white bowl sherds and four indeterminate Cibola Whiteware sherds, all of which may be fragments of a single Red Mesa Black-on-white bowl. Based on these ceramics, the occupation is dated sometime between about AD 900 and 1100, the Pueblo II or Late Developmental period.

A total of 64 lithic artifacts were recovered during the excavations in SU 7 (Table 7.4). The total includes 2 flakes and 39 angular debris fragments recovered from the fill of the features, and 16 flakes, 5 angular debris fragments, and 1 tested rock found on the occupation surface. Forty of these artifacts (87%) are chalcedony and 6 (13%) are local cherts, which indicates that the occupants were collecting and reducing lithic materials found in the immediate vicinity of the site. Analysis of the debitage (Chapter 10) suggests that core reduction was directed toward the production of flakes for use as expedient tools. No utilized flakes were identified in the assemblage, however, which could indicate either that the tools were removed by the occupants or that they received light use that left no perceptible traces. Although none of the artifacts from the features were burned, seven of the flakes found on the occupation surface showed heat alteration that could be accidental or the result of intentional heat treatment to improve the flaking quality of the raw material.

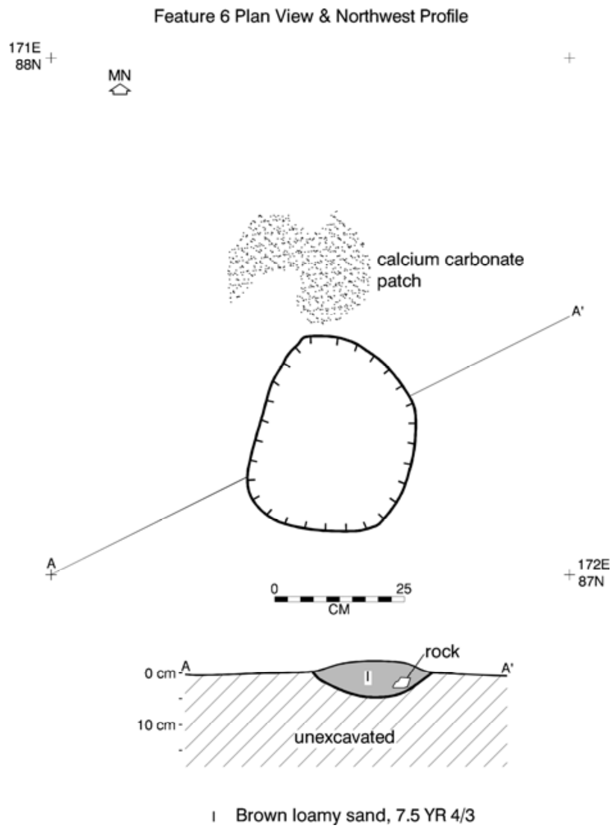
a



b

c

Figure 7.13. Feature 6: (a) pre-excavation; (b) profile; (c) post-excavation, note the calcium carbonate patch north of feature (all views to northwest), and (d) plan view with profile sketch.



d

A basin metate was found laying upside down on the occupation surface about 1.5 m south of Features 4 and 5. This metate is 59 cm long, 36 cm wide, and 14 cm thick, and was made from sandstone. Its close proximity to Features 4 and 5 suggests that seeds or other plant resources were prepared and consumed at the site. Based on the charred plant embryo from Feature 4 and charred seed from Feature 6, cholla seeds appear to have been one of those food resources. The metate was likely left at the site in anticipation of future use. It may have been brought to the site by the Pueblo II inhabitants or it could have been scavenged from the Basketmaker occupation area. A mano was found on the surface approximately 7 m east of SU 7 but its association with this occupation is uncertain.

Table 7.4. Lithic Artifacts Recovered from Study Unit 7 at LA 158640.

Feature No.	Artifact Type				
	Angular Debris	Flake	Metate, Basin	Tested Rock	Total
SU 7 grid	5	16	1	1	23
4	2	2	-	-	4
5	28	-	-	-	28
6	9	-	-	-	9
Total	**44**	**18**	**1**	**1**	**64**

All of the artifacts recovered during the excavations, including the fire-cracked rock fragments (Figure 7.14), were clustered within 2–3 m of Features 4 and 5, a pattern consistent with Binford's (1983:149–160) model of a hearth-centered activity area. The area south of the hearth is relatively clear of debris, and the presence of the metate suggests that it may have been a food preparation area. A second, relatively clear area northwest of the hearth may have been a second work area. Although the types of features and small size and low diversity of the artifact assemblage indicate a short-term occupation, the artifacts in the feature fill reflect some clean-up effort. As site maintenance activities tend to be proportional to the duration of the occupation, the Pueblo II occupation at LA 158640 appears to have been at least a few days longer in duration than the Basketmaker occupations in Area 1.

SUMMARY

Eight study units totaling at 81 sq m were excavated during the archeological data recovery at LA 158640. Additionally, 294 auger holes were dug to systematically probe another 694 sq m adjacent to three of the excavation units. Three components were identified at the site.

The earliest occupations were short-term residential camps, marked by two hearths on top of the low ridge in the north-central part of the site. Radiocarbon dates from these features (Feature 2 in Study Unit 4 and Feature 3 in Study Unit 8) have two standard deviation calibrated ranges of AD 120 to 330 and AD 260 to 520, respectively. The difference in the dates is statistically significant, indicating that the hearths are likely the remnants of two separate occupations during the Basketmaker II to early Basketmaker III period. The quantities of fire-cracked rock associated with these features was probably employed in stone boiling as they are too small to have been used for pit roasting. This evidence, together with the presence of milling stones, suggests that the groups were procuring and processing seeds or some other plant resource. Other than fuel wood, no plant macrofossils were recovered from the hearths, however, so no more specific identification of the subsistence resources was possible.

The small flaked stone assemblage associated with these occupations consisted of largely of debitage with a few cores and tested rocks. There were no identifiable flaked stone tools. Analysis of the assemblage suggests that local lithic raw materials were brought to the site as partially worked cobbles that were further reduced at the camp to remove waste material from the cores. The relatively high flake to core ratio for the assemblage further suggests that the groups carried away some cores when they left the site. The pattern therefore appears consistent with an embedded lithic procurement strategy.

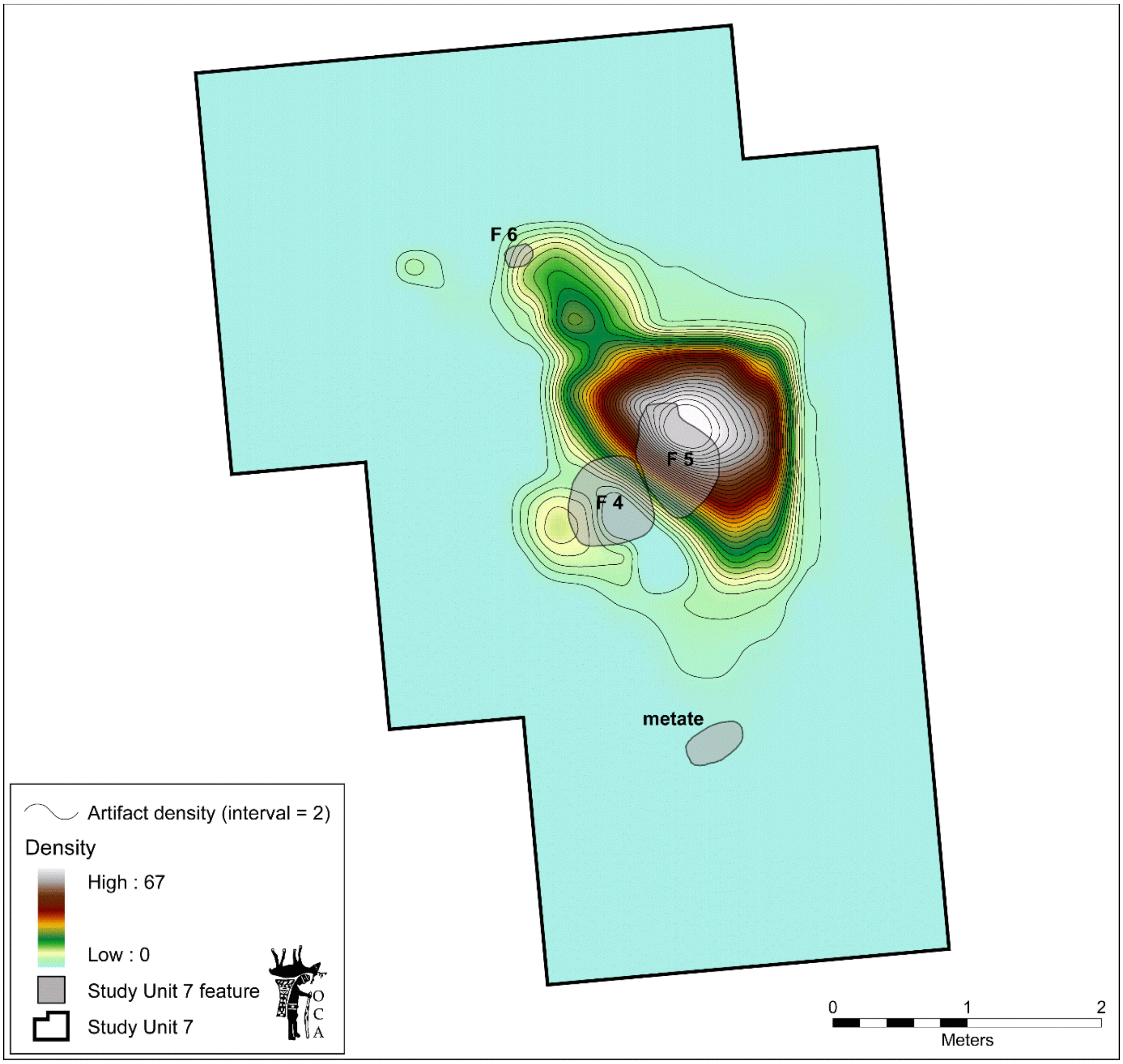


Figure 7.14. Artifact density map showing possible activity areas in Study Unit 7 at LA 158640.

The small number of flaked lithic artifacts found in and around Study Unit 5 evidence the procurement of lithic raw materials from a lag gravel deposit exposed at the base of the slope below SUs 4 and 8. These artifacts may be associated with the Basketmaker component, or they could represent unrelated episodes of lithic procurement. The character of Feature 1 in SU 5 is also uncertain. It might be a deflated hearth or a chance concentration of cobbles within the lag gravel deposit. It is also possible that the cobbles are the remnants of an agricultural terrace or water-diversion feature. The swale seems an ideal setting for an agricultural plot positioned to utilize surface runoff from the surrounding slopes. If Feature 1 was an agricultural feature, then it was most likely associated with the Classic period component at the site, as similar features dating to this period have been documented elsewhere on the West Mesa (Chapman and Estes 2004; Huckell 2002c), on La Bajada Mesa (Gerow and Doleman 2002), and in the Galisteo Basin (Doleman and Brown 2000; Cordero 2007, Kurota 2006c).

The second component at LA 158640 is the occupation marked by the three features uncovered in Study Unit 7 in the eastern end of the site. Based on the associated Red Mesa Black-on-white ceramics, this occupation probably dates to the Pueblo II or Late Developmental period. Feature 4 appears to be a hearth, while the adjacent Feature 5 was likely an associated ash and warming pit. The function of Feature 6 is less certain; it may have been a secondary hearth or a small storage pit subsequently used for refuse disposal. Based on the distribution of artifacts, the area south of Features 4 and 5 appears to have been used for food preparation while the area immediately to the north was used for lithic reduction. The nature of the features and small artifact assemblage suggests a short-term residential occupation but, given the evidence for site maintenance, the occupation may have been of a slightly longer duration than the Basketmaker occupation. The presence of milling stones indicates that plant processing was conducted at the site, and the scant macrobotanical remains recovered from Features 5 and 6 suggest that cholla seeds were one of the subsistence resources that were processed.

The flaked lithic artifacts associated with this component include the debris from early and late stage core reduction, which suggests that cobbles of knappable material were brought to the camp, and that reduction was directed toward the production of flakes for use as expedient tools. No identifiable tools were recovered, however, which could result either from light use of the flake tools or from transport of the flake blanks away from the site. Consequently, it is unclear whether the assemblage reflects an embedded lithic procurement or the production of expedient tools for tasks conducted at the camp.

The third component at the site consists of glazeware sherds from Study Unit 6, which represent an ephemeral use episode dating to the Pueblo IV or Classic period. No features were uncovered during excavations in this area, and the few flaked lithic artifacts found in this area are not necessarily associated with the glazeware ceramics. The sherds may simply mark a pot drop by an individual engaged in the collection of wild food resources or possibly agricultural activities at an outlying farm field.

In summary, the cultural deposits at LA 158640 were more extensive than anticipated and reflect a more varied use of the area than the limited lithic procurement activities suggested by the surface artifacts. Short term residential camps were found dating to the Basketmaker II/III and Pueblo II periods, as well as an ephemeral use episode dating to the Pueblo IV period. The collection of wild plant resources appears to have been the primary subsistence activity at the camps, although the evidence is not conclusive. No direct evidence was found for agricultural activities but the Pueblo II and Classic period components were located at the edge of a broad swale that appears an ideal field location. In any case, lithic procurement was most likely embedded in routine subsistence activities at the site. Lithic reduction during the Basketmaker occupations seems to have been directed toward the removal of cortex and waste material from cores that were carried away from the site, while cores were reduced to produce flakes during the Pueblo II occupation. It is unclear if the flakes were produced for immediate use as expedient tools, or as flake blanks that were transported.

Chapter 8

EXCAVATIONS AT LA 158641

by Brian Cribbin and Patrick F. Hogan

LA 158641 is situated on University of New Mexico land near the southwest corner of the CNM Rio Rancho campus. It initially appeared that the site would not be affected by Phase I construction but, in May 2009, the construction plans were modified to add a temporary overflow parking area on the adjacent UNM land. Construction of this parking area would directly impact LA 158641, so the data recovery plan was amended to include excavations at the site.

The site was recorded by OCA in February 2008 (Kurota and Chapman 2008) as a small surface scatter consisting of 13 flaked stone artifacts and two indented corrugated grayware jar body sherds, the latter suggesting an occupation dating to the Coalition-Classic period. The artifacts were scattered over an area measuring 35 m (north-south) by 15 m (east-west) on the lower, north-facing slope of a broad east-west trending dune ridge (Figure 8.1). Auger probes made during the survey indicate that there were at least 80 cm of unconsolidated sediments in the site area, so there was a possibility that buried cultural materials were present. Vegetation on the site includes cholla (*Cylindropuntia* spp.), sand dropseed (*Sporobolus cryptandrus*), galleta (*Pleuraphis* spp.), snakeweed (*Gutierrezia* spp.), and narrowleaf yucca (*Yucca angustissima*); there is also a solitary one-seed juniper tree (*Juniperus monosperma*) within 50 m of the site. Soils in the project area are mapped as Grieta fine sandy loam.

The site overlooks a broad grassy swale and beyond it, the dune ridge on which LA 158640 and LA 158642 are situated. The swale is an undissected drainage that joins Arroyo de las Baranca roughly 0.5 km east of the site. It seems a likely location for an agricultural field since the deep soils in the drainage receive occasional runoff from the small drainage basin between the two dune ridges.

Work at the site began with the crew walking the area to redefine the site boundaries and to mark the surface artifacts. Next, a skeleton grid was established over the site area using a theodolite and tapes to provide horizontal provenience control for the excavation. Elevation controls were also established. The surface artifacts were point-provenienced, then collected. The theodolite was also used to prepare a topographic map of the site. Grid points, the site boundaries, and the surface artifact locations were added to this map and, as the excavations progressed, the locations of all excavation units were added.

Because there were no surface features or artifact concentrations, the excavations were designed to systematically probe the site area for buried cultural materials. Fifteen 1 by 1 m test pits were dug at 5 m intervals centered on the datum and within the area where most of the surface artifacts had been found (Figure 8.2). One of these units (N100 E110) was subsequently expanded to 1 by 2 m to investigate Feature 1. Concurrently, 159 auger holes were dug to investigate the area between the 1 by 1 m test pits. The auger holes were positioned in a staggered grid (i.e. alternating lines of holes on the even and odd grid corners). This configuration gives a spacing of 2 m between the auger holes in each row and 1.41 m between the auger holes in adjacent rows. The rationale for this excavation strategy was that the 1 by 1 m test pits would enhance the recovery of subsurface artifacts, while the more closely spaced auger probes would have a higher probability of locating smaller buried features.

Figure 8.1. LA 158641 overview facing southwest.

Subsurface artifacts were recovered from half of the 1 by 1 m test pits, two units yielded isolated charcoal fragments, and one unit uncovered ash-stained sediments in a rodent burrow (Feature 1). No evidence of features was observed in the auger holes and no artifacts were recovered. When the site area was bladed during construction, however, four additional features (Features 2–5) were uncovered and subsequently excavated by the monitoring crew. Those features evidence one or more short-term occupational episodes during the Coalition period that may have been associated with agricultural activities.

REVIEW OF SUBSURFACE SAMPLING METHODS

A number of simulation studies (Kintigh 1988; Krakker et al. 1983; Nance and Ball 1986; Shott 1985; Welch 2013) have demonstrated that the intensity of subsurface testing required to discover all of the buried features at a site tends to be cost prohibitive. This realization has led some archaeologists working in the region to abandon manual testing and adopt mechanical stripping as a more cost-effective discovery method. Mechanical scraping is inarguably an efficient method for uncovering shallowly buried features but it has the disadvantage of removing any artifacts on use surfaces associated with those features – data that are critical for understanding site structure, and the character and probable duration of the occupation(s). To minimize this data loss, we elected to first complete manual excavations at the site and then to monitor the initial phases of construction to ensure that any features missed during the excavations were discovered and investigated.

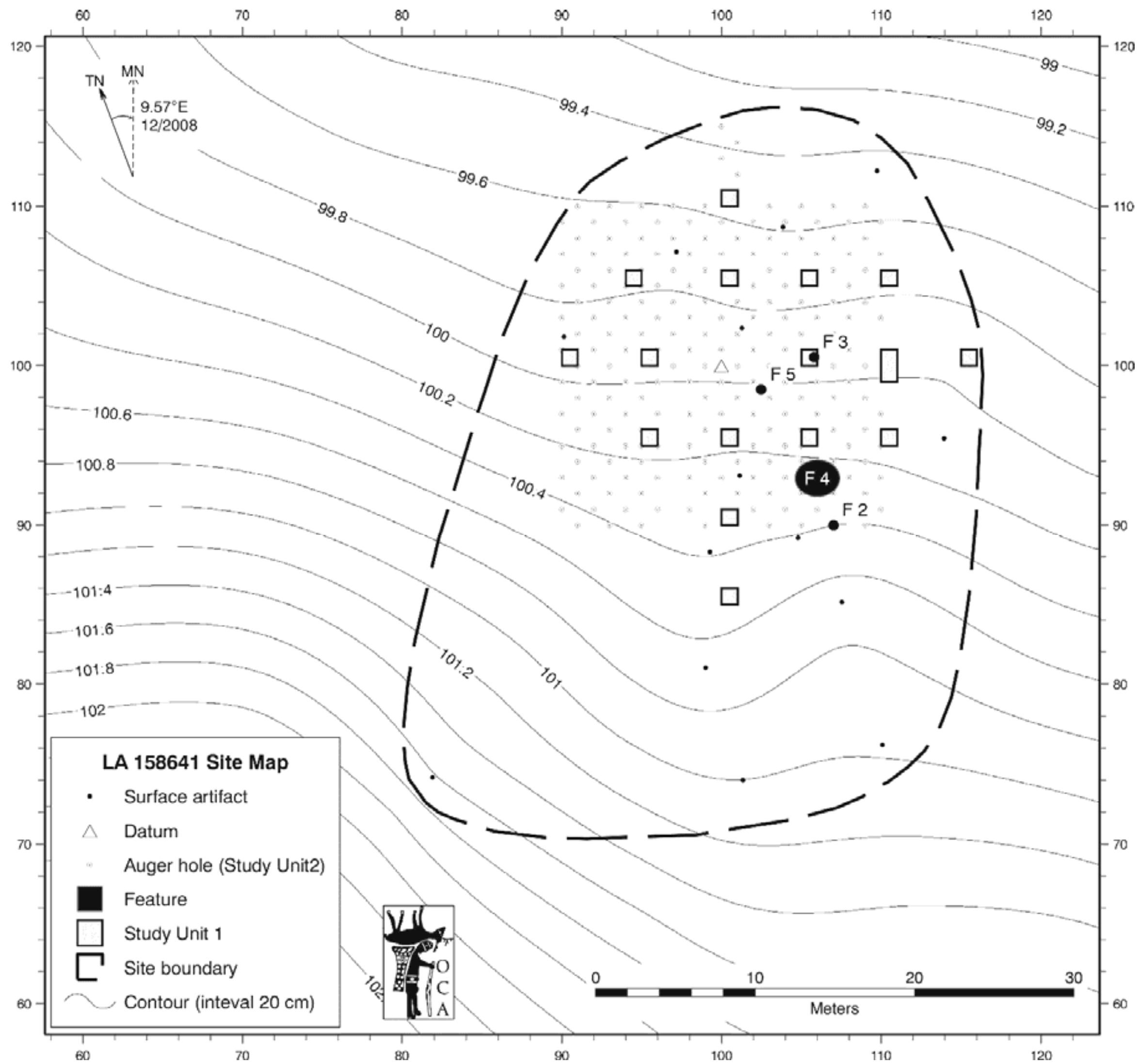


Figure 8.2. LA 158641 site map.

The patterning of auger tests at LA 15841 was necessarily a compromise between the ideal configuration and what could actually be accomplished with a reasonable labor effort. Following Welch (2013), the probabilities that our staggered (isosceles) grid of the 159 auger tests would locate ash stains that were 2 m, 1 m, and 0.5 m in diameter were estimated at 78.54%, 19.63%, and 4.91%, respectively. Given these estimates, it was not surprising that we missed the smaller features at the site but our failure to locate Feature 4 prompted a review of our testing methods.

By the time the features at LA 158641 were found by the monitors, construction had eradicated the site grid, so the precise locations of the features relative to the excavation units could not be determined. Using the GPS coordinates recorded for key grid points, however, we were able to plot the locations of the newly discovered features on the site map with sub-meter accuracy; that is, to within a meter of the actual feature locations (Figure 8.2). Thus Feature 3 is plotted within N100 E105, although its actual location must have been just beyond the boundaries of the test pit. Locations relative to the auger tests are less certain. Feature 5 appears to have been between the auger tests, while the plotted location of Feature 2 suggests that it may have been hit by one of the auger holes. Because of its larger size, we can be certain that Feature 4 was hit by one or more of the auger holes. It therefore appears that the problem was not that the test units missed all of the features but that the excavators were unable to distinguish the light ash-stained fill of the features in the loose sand brought up by the bucket auger. Our excavation procedures were modified to correct this deficiency, and shovel test pits rather than auger tests were employed during the subsequent test excavations at LA 160886.

RESULTS OF THE EXCAVATION

The first five 1 by 1 m test pits excavated at the site were arrayed along the E100 grid line to define the slope stratigraphy and establish the geomorphological context of the site. The profiles in these excavation units show an upper stratum (Stratum 1) of loose brown (7.5 YR 5/4 dry) sandy loam with a massive structure overlying a more compact deposit of brown (7.5 YR 5/4 dry) silty clay loam with a moderate sub-angular blocky structure (Stratum 2). Although both strata are moderately to strongly effervescent, no carbonate filaments or nodules are present in the upper unit while the lower stratum exhibits carbonate development approaching Stage I.

The sequence is similar to that documented by Worman in Study Unit 1 at LA 158640 (Chapter 7, this volume), which was also located near the base of a dune ridge hillslope. Specifically, Stratum 1 at LA 158641 appears analogous to Worman's ABtj(k?) horizon, although Stratum 1 at LA 158641 lacked evidence of soil development and so is more properly designated as a C horizon. Worman argues that this unit is an aeolian deposit consisting of older, reworked dune sediments intermixed with recent wind-blown sediments that has accumulated within the last few hundred years. Stratum 2 at LA 158641 is equivalent to the Btk horizon documented at LA 158640, and is a Pleistocene age dune deposit.

Stratum 1 at LA 158641 ranges from 10 to 20 cm in thickness, which is somewhat greater than the accumulation of surface sediments in Study Unit 1 at LA 158640. This difference probably results from the site's position on the leeward side of the dune ridge where the accumulation of aeolian sediments is greater and less subject to subsequent deflation. Based on Worman's analysis of soil catena at LA 158640, it is likely that slope wash erosion also has contributed the accumulations of sediments at LA 158641. This periodic influx of sediments could explain the absence of soil development in Stratum 1. The boundary separating Stratum 1 and Stratum 2 at LA 158641 is gradual rather than abrupt, so the erosional boundary separating the Pleistocene and recent sediments is not as marked as at LA 158640. This difference appears to be the result of bioturbation. Rodent burrows, insect crotovina, and root casts were common throughout the deposit, indicating that Pleistocene and Holocene deposit near the discontinuity have been thoroughly mixed.

The only feature encountered during the manual excavations was Feature 1, a small oval area of ash-stained sediments, which was uncovered in N100 E110 at a depth of 19 cm below modern ground surface (BMGS). The excavation was expanded into N99 E110 to better define this feature, which proved to be a rodent burrow. These ashy sediments are clearly in a secondary depositional context and could not be traced back to their original source. Nevertheless, their stratigraphic position provides weak evidence that the ground surface was at or near the base of Stratum 1 when the site was occupied.

Because of the mechanical stripping, levels of origin could not be determined for the four features discovered by the monitors. All were cut into the top of Stratum 2, however, which again suggests that the aboriginal ground surface was at or near the base of Stratum 1. These features were clustered in an 8 by 12 m area in the east-central part of the site (Figure 8.2). The largest, Feature 4, is centered at about N93 E106. Feature 2 was located 3 meters south of Feature 4. Feature 3 and 5 were located 6 to 7 m to the north of Feature 4 and were about 4 m from each other.

Features 2, 3, and 5 are small roughly circular pits that most likely functioned as hearths or ash pits. Feature 2 was 30 cm in diameter and at least 29 cm deep (Figure 8.3); Feature 3 was 13 cm in diameter and at least 8 cm deep; and Feature 5 was 35 cm in diameter and at least 10 cm deep. The fill in all three pits consisted of ash-stained sediments with dispersed flecks of charcoal. Root casts and insect and rodent burrows were common, evidencing extensive bioturbation. The interior surfaces of the pits were not oxidized, so use of the features was not prolonged or intensive.

Figure 8.3. Feature 2 profile facing west.

Wood charcoal from these features consisted predominantly of saltbush/greasewood with lesser amounts of juniper and cholla. This contrasts with the features from LA 158640 and LA 158642 in which juniper was the predominant fuelwood. In addition, a charred purslane seed was recovered from the fill Feature 2, and a charred goosefoot seed was recovered from Feature 5. These seeds ripen in the spring and fall, respectively, so the two hearths may represent separate seasonal occupations. Charred juniper berries also were recovered from all three hearths. These could have been introduced incidentally with the firewood but, given the paucity of juniper in the fuelwood, it is more likely that they were a food resource.

Feature 4 was a large oval depression approximately 2.8 m long (east-west), 2.3 m wide (north-south), and at least 28 cm deep (Figure 8.4). As with the smaller features, the initial stain was larger than the actual depression, indicating some degree of post-occupational erosion. Fill in the depression consisted of light, ash-stained loamy sand flecked with charcoal. Unlike the smaller features, juniper was the predominant wood identified in the flotation samples but there were also significant quantities of cholla and saltbush/greasewood. Based on its size and relatively shallow depth, Feature 4 is most likely the remnant of a brush shelter intended for short-term use, although the possibility that it is a large roasting pit cannot be totally discounted. If it is a structure, then the informal nature of the construction and absence of internal features is suggestive of a warm-season occupation.

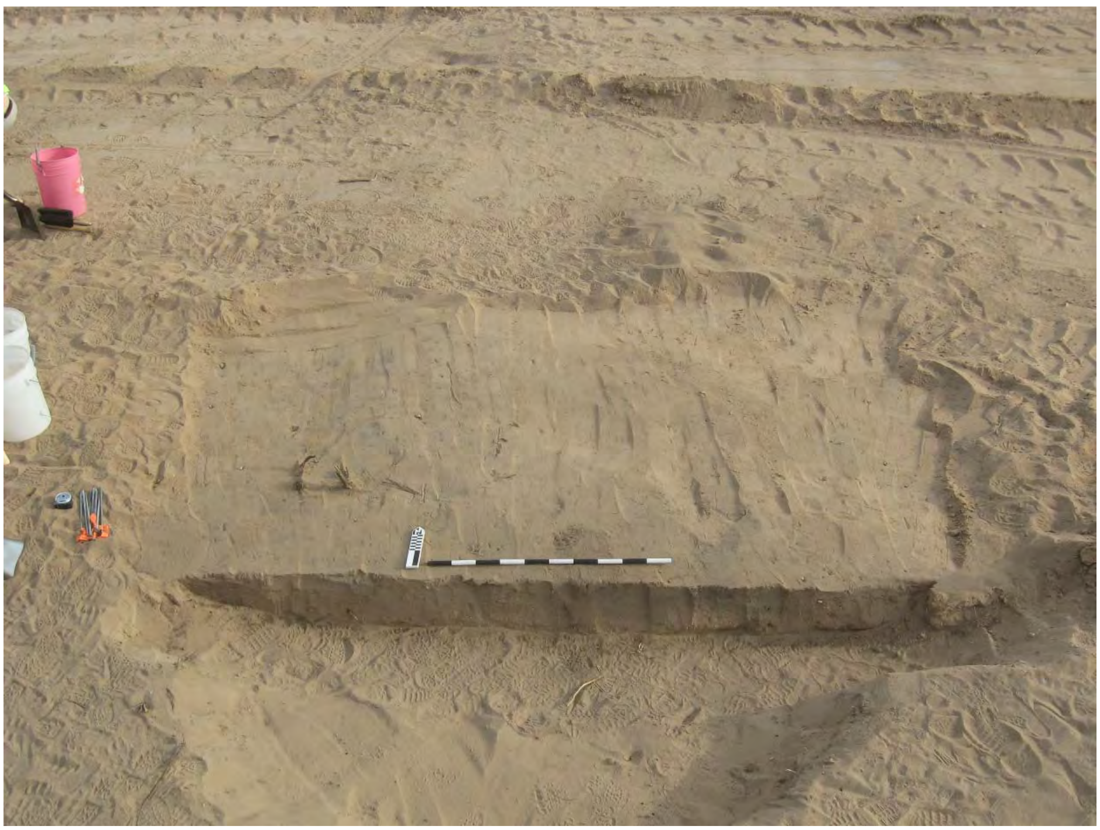


Figure 8.4. Feature 4 plan profile facing north-down.

Saltbush/greasewood charcoal from Feature 4 yielded a radiocarbon date of 820±40 BP (Beta No. 265704), which has a calibrated two standard deviation range of cal AD 1160 to 1270. This date is consistent with the Wiyo Black-on-white and Rio Grande Plain sherds recovered from the fill of Feature 4 and the Indented Corrugated sherds recovered from elsewhere on the site. Collectively, the evidence indicates that the primary occupation at LA 158641 occurred during the Rio Grande Coalition Period. From their spatial proximity to Feature 4, it is probable that the smaller features date to this same general period, although they could represent one or more unrelated episodes of use.

Five sherds and 48 flaked lithics were collected during the investigations at LA 158641. As mentioned, two of the sherds were from Feature 4. The assemblage also includes two indented corrugated sherds, one of which was recovered from the test pit at N105 E100 and other sherd of was collected from the surface a few meters to the south. The fifth sherd was an indeterminate whiteware found in the test pit at N95 E95. This scattered distribution of what may be sherds from as few as two vessels reflects the effects of slope erosion and bioturbation in the site area.

The lithic assemblage consists primarily of debitage but includes one tested cobble and a possible retouched flake (Table 8.1). Chalcedony is the predominant raw material (38) with lesser amounts of chert (3), quartzite (3), and carbonate (2). All of these materials are locally available from outcrops of the Santa Fe gravels. In descending order of frequency, the debitage consists of angular debris, flakes, and flake fragments. Almost three-quarters of the debitage has some cortex and nearly half have more than 50% cortex remaining. As discussed in Chapter 10 (this volume), these attributes are indicative of early stage core reduction. There is little evidence for tool manufacture or use. Such lithic assemblages are more typically associated with lithic procurement areas than logistical camps, which called into question our initial assumption that LA 158641 was an agricultural site.

Table 8.1. LA 158641 Lithic Summary.

Provenience	Angular Debris	Complete Flakes	Flake Fragments	Retouched Flake	Tested Cobble	Total
Surface	6	2	3	1	1	13
Stratum 1	16	7	2	-	-	25
Feature 2	1	-	-	-	-	1
Feature 4	5	3	1	-	-	9
Total	**28**	**12**	**6**	**1**	**1**	**48**

One possible explanation for this anomaly is that the lithic artifacts from LA 158641 constitute a mixed assemblage. As noted previously, the site is situated at the base of a slope, and the depth and lack of soil development in Stratum 1 indicate that it is partly an accumulation of sediments eroded from the upper slopes of the dune ridge. There is a large lithic procurement area (LA 160886) on the ridge crest above LA 158641, and it appears likely that debitage from that site was carried downslope by those same erosional processes and redeposited at LA 158641. Thus the artifacts collected from the surface and those recovered from Stratum 1, about three quarters of the assemblage, may not be related to the occupation of LA 158641. This leaves only the 10 artifacts recovered from Features 2 and 4, which is too small a sample to evaluate independently.

Alternatively, if we assume that all of the lithics from LA 158641 were associated with the Coalition period occupation, then the most probable explanation is that the site's inhabitants were collecting nodules of lithic raw material and removing some of the cortex before transporting the resulting cores back to their primary residence. This kind of lithic procurement was generally embedded in some sort of subsistence activities but, in this case, those activities apparently did not involve extensive use of stone tools. Indeed, the features provide the only indication that other activities may have been conducted at the site.

Our preliminary interpretation of LA 158641 as an agricultural site was based on its environmental setting and the probable date of the occupation as indicated by sherds found on the surface. The features uncovered at the site also seem consistent with that interpretation. In her review of the ethnographic literature on Pueblo farming, Sebastian (1983) noted that fieldhouses range from seasonal habitations to simple shelters where workers rested in the shade during day-long visits to their fields. LA 158641 seems to fall at the latter end of this spectrum. The structure appears to have been little more than a windbreak and probably served as much to mark the field as to provide shelter. The three hearths show minimal use and evidence multiple, short-term occupational episodes through the growing season.

SUMMARY

Sixteen 1 by 1 m test units and 159 auger holes were dug to systematically probe for buried cultural deposits at LA 158641. Subsurface artifacts were recovered from half of the test units but no cultural features were found. Four features were uncovered during initial construction, however, the remnants of a small structure and three hearths. A radiocarbon date of cal AD 1160 to 1270 was obtained from the structure that, together with the ceramics from the site, dates the occupation to the Rio Grande Coalition period. Given their spatial patterning relative to the structure, the three hearths probably date to this same occupation.

The small lithic assemblage recovered from the site consisted almost entirely of debitage and evidences the procurement and early stage core reduction of locally available lithic raw materials. At least some of these artifacts may have been redeposited at the site by slope erosion, however, so it is unclear if lithic procurement activities were actually associated with the occupation. In the absence of tools or other direct evidence of the activities conducted at the site, LA 158641 was tentatively interpreted as a fieldhouse based on the site's age, environmental setting, and indications that the features represent multiple, short-term occupations during the growing season that are consistent with ethnographic descriptions of Pueblo field facilities.

Chapter 9

TEST EXCAVATIONS AT LA 160886

by Patrick F. Hogan and Brian Cribbin

LA 160886 is located in the northwest corner of the proposed University of New Mexico West campus, approximately 50 m to the south of LA 158641. The site is outside the construction zone for the CNM Rio Rancho campus but the drainage plan for the facility will require some slope re-contouring on UNM land that could impinge on the site area. Consequently, test excavations were conducted at the site to determine its eligibility for the National Register of Historic Places.

LA 150886 is an extensive lithic scatter of unknown age and cultural affiliation. It was first recorded by OCA during a cultural resources survey of the proposed UNM West campus (Kurota and Hogan 2009). The site is situated on a north-facing slope of a large dune just below the ridge crest (Figure 9.1). Soils in the site area are mapped as Grieta fine sandy loam. Vegetation consists of sand sage (*Artemesia filifolia*) and grama grass (*Bouteloua* sp.) mixed with yucca (*Yucca angustissima*), four-winged saltbush (*Atriplex canescens*), snakeweed (*Gutierrezia sarothrae*), prickly pear (*Opuntia* spp.) and cholla (*Opuntia imbricata*).

Figure 9.1. LA 160886 facing south.

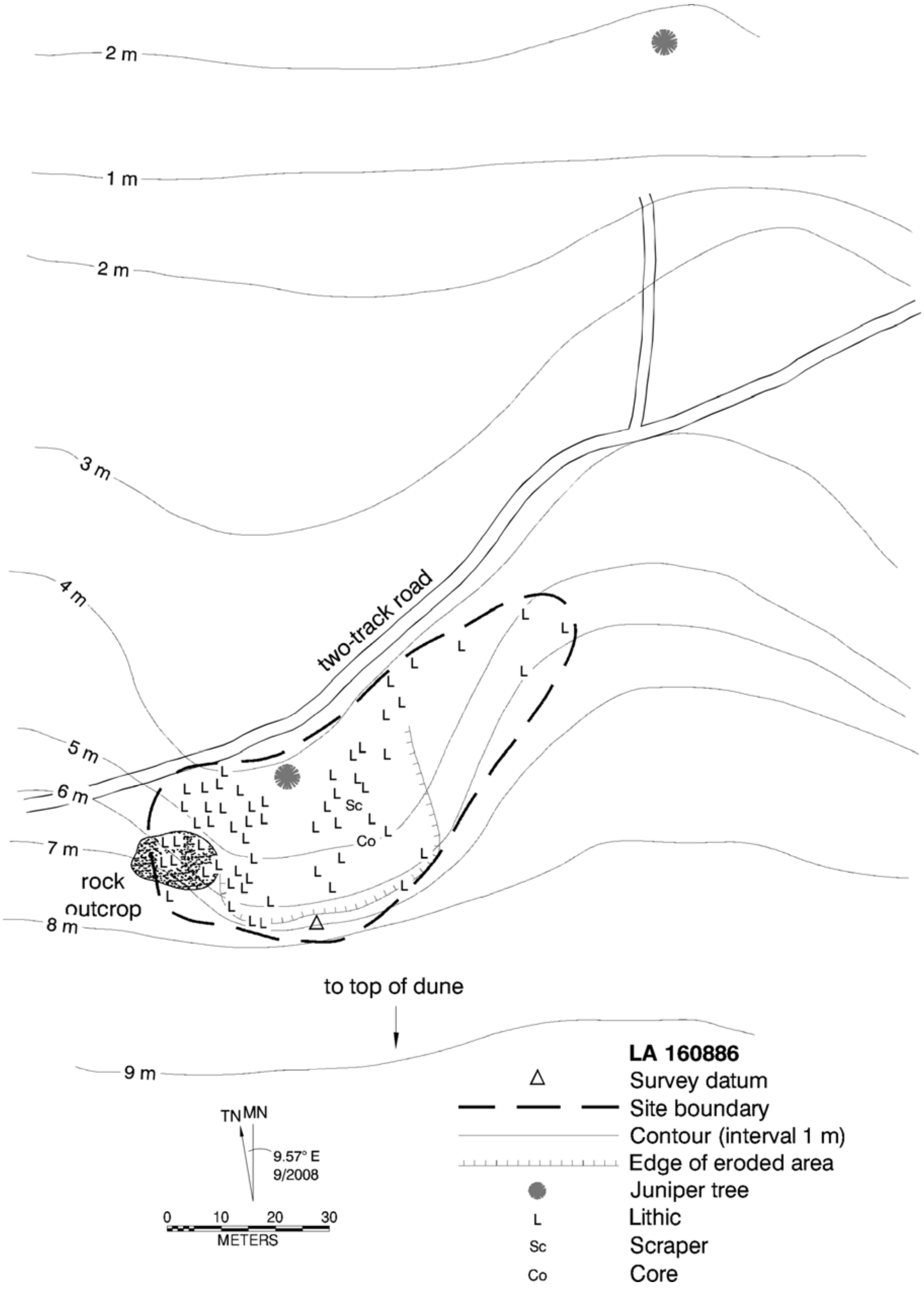


Figure 9.2. Survey map.

Most of the artifacts at LA 150886 are clustered near a Ceja gravel outcrop at the western edge of the site (Figure 9.2). Those gravels include chalcedony, quartzite, and chert cobbles up to 30 cm in diameter, which suggests that the artifact scatter was the result of lithic procurement activities. Runoff has scoured the central part of the site, creating a concave erosional scarp in the channel between two spur ridges. Most of the artifacts in this eroded area have been carried downslope from the main site area. The scatter extends downslope (north) and to the east of the outcrop, covering an area measuring about 90 m northeast to southwest by 40 m northwest to southeast. No features or temporally diagnostic artifacts were visible on the site surface.

Although the artifact scatter at LA 160886 appeared surficial, the ridge crest and spur ridges are mantled by recent wind-blown sands, so there was a possibility that buried features or other cultural deposits were present. Consequently, the information potential of the site could not be fully evaluated without subsurface testing. The primary objective of the test excavations therefore was to assess the nature and integrity of the site in order to formulate a recommendation concerning eligibility for the National Register of Historic Places (NRHP). A second objective was to determine the extent of any intact cultural deposits.

TESTING METHODS AND RESULTS

Work at the site began with the crew walking the area to mark surface artifact locations and redefine the site boundaries. A grid was then established over the site using a theodolite and tapes, and a topographic map was prepared. Next, the artifacts on the surface were collected.

The surface artifacts were concentrated on the eroded part of the slope where the Holocene sediments had been stripped away exposing Pleistocene age deposits. Test excavations therefore focused on three areas at the margins of the scatter where intact cultural deposits were more likely to be preserved beneath the mantle of recent wind-blown sand. A staggered grid of test holes (i.e. alternating lines of holes on the even and odd grid corners with a spacing of 2 m between the auger holes in each row and 1.41 m between the auger holes in adjacent rows) was used to systematically probe each of the areas. An auger was used to dig the first test holes but we subsequently switched to 30 by 30 cm shovel test pits, which made it easier to recognize buried features and increased the probability of recovering subsurface artifacts (see review of subsurface sampling methods in Chapter 8, this volume). All sediments removed from the auger holes and shovel test pits were screened through 1/8 inch hardware cloth to enhance artifact recovery.

The shovel test pits were supplemented by the excavation of scattered 1 by 1 m test units to obtain a better estimate of subsurface artifact density and to recover a representative sample of those materials. Some of these units were excavated in areas where the shovel test pits had yielded one or more artifacts. Others were located judgmentally in areas outside the shovel test grid that seemed likely to have subsurface materials. Again, all excavated sediments were screened using 1/8 inch hardware cloth. Recovered artifacts were provenienced to the 1 by 1 m grid and natural stratigraphic unit.

Excavations began in Study Unit 2, which encompassed the ridge crest along the southern edge of the site between the two spur ridges (Figure 9.3). A staggered grid of 123 test holes was laid out in four rows (N97, N98, N99, and N100) between the E70 and E130 grid lines. Tests along the eastern half of the N99 line were made with an auger; all others were shovel test pits (STPs). No features were found but subsurface artifacts were recovered from four of the STPs (N100 E77, N100 E85, N100 E93, and N110 E107). A 1 by 1 m test unit was then opened in N99 E84 to determine the density and integrity of the subsurface material. This excavation was eventually expanded to 8 sq m and 44 flake and angular debris fragments were recovered.

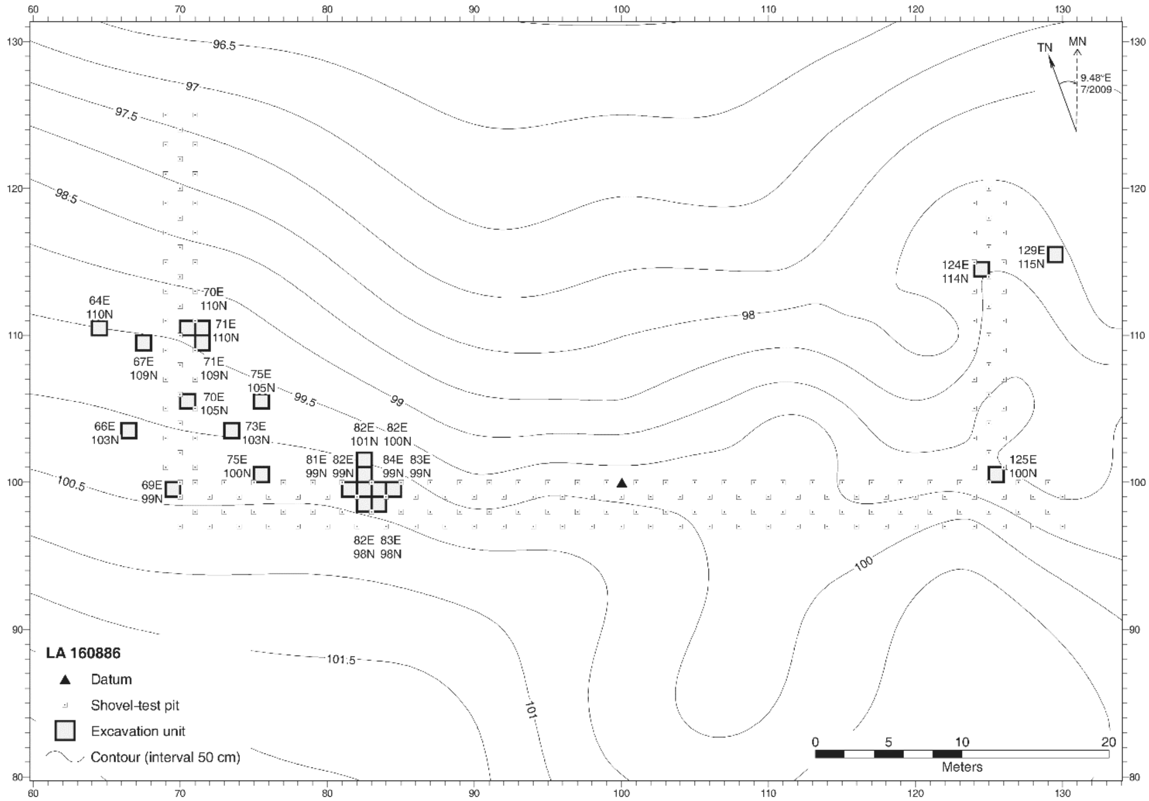


Figure 9.3 LA 160886 excavation site map.

The tests in SU 2 demonstrated that the recent wind-blown deposits (Stratum 1) in this part of the site are shallow, generally less than 10 cm thick, and rest directly on Pleistocene age sediments. It therefore appears that any Holocene deposits have been stripped away from the upper slope of the dune ridge, leaving the artifacts as a lag deposit that was subsequently incorporated into Stratum 1. Consequently, there is little chance that any intact cultural deposits are present in this part of the site, although the artifacts may retain some spatial integrity at a coarse scale.

Study Unit 1 encompassed the low spur ridge at the western edge of the site near the outcropping Ceja gravels. In this area, 35 STPs were dug in three staggered rows along the E69, E70, and E71 grid lines between N100 and N125. As in SU 2, the recent sediments on the spur ridge were shallow and directly overlay Pleistocene deposits. Although it was doubtful that any intact cultural deposits would be present, this relatively level area immediately adjacent to the outcrop appeared an ideal location in which to process lithic raw materials collected from the gravels. Consequently, we were surprised that none of the 35 STP yielded subsurface artifacts. For that reason, eleven 1 by 1 m test units were excavated across the southern part of SU 1. Single artifacts were recovered from only two of these units, and no evidence of features was found.

Study Unit 3 was located on the spur ridge along the eastern margins of the site. Thirty (30) STPs were dug in this area in three rows extending from N100 to N120, along the E124, E125, and E126 grid lines. Three 1 by 1 m test pits were also dug in areas where the recent aeolian deposits were deepest. No features or subsurface artifacts were found in this part of the site.

The results of the subsurface testing suggest that lithic procurement activities at LA 160886 were restricted to a relatively small area in the immediate vicinity of the gravel outcrop, and that the more extensive surface scatter is a function of slope erosion. The only concentration of subsurface artifacts was found on the slope just above the outcrop. Most of the lithic reduction at the site appears to have taken place in this area, and it is probably the source of most of the material now scattered further downslope.

The lithic assemblage from LA 160886 comprises 125 artifacts (Table 9.1). The majority (62%) were collected from the surface, and 90% of the subsurface artifacts were recovered from the excavations in Study Unit 2. As both the surface and subsurface artifacts are in a secondary depositional context, there is little rationale for splitting the assemblage. Taken together, the artifacts reflect the expected emphasis on lithic procurement activities. Other than a few tested cobbles and cores, it consists entirely of debitage. Nearly three-quarters of the debitage (73%) has some remaining cortex and, on roughly a third of the fragments (31%), the proportion of cortex is greater than 50%. Flake platforms are predominantly cortical and single facet. This profile is consistent with the debris produced by early stage reduction of cortex-covered nodules like those found in the Ceja gravels.

Table 9.1. LA 160886 Lithic Assemblage.

Provenience	Angular Debris	Complete Flakes	Flake Fragments	Cores	Tested Cobbles	Total
Surface	40	14	11	7	5	77
Stratum 1	37	6	5	-	-	48
Total	**77**	**20**	**16**	**7**	**5**	**125**

The intended product of that core reduction is uncertain. One possibility is that waste material (cortex) was being removed from the nodules to produce trimmed cores that were transported to some other location. This is probably the most common interpretation of the debris from lithic procurement sites on Ceja Mesa. Alternatively, reduction may have been directed toward the production of flakes useable as tools, in which case, the amount of cortex remaining on the debitage would indicate that core reduction was not particularly intensive. O'Brien's observation that the intensity of reduction on the cores from the site seemed to be positively correlated with the quality of the raw material (Chapter 10, this volume) provides some support for this alternative interpretation.

The size of the lithic assemblage further suggests that surprisingly little lithic reduction actually occurred at LA 160886. Although the assemblage is only a sample, these 125 lithics include all of the surface artifacts and a substantial part of the only concentration of subsurface material identified during our investigations. Given the small number of test units that yielded artifacts, it seems unlikely that full excavation would more than double or triple the number of artifacts recovered. Allowances also need to be made for the probability that erosion has removed some artifacts from the site area, so a guesstimate of 600 artifacts for the total assemblage does not seem unreasonable. Even this figure works out to an average of only 0.25 lithics per year over the 2500 years of sporadic occupations documented by our excavations at the other CNM sites.

The low intensity of lithic reduction at LA 160886 does not necessarily equate with a low intensity of lithic procurement activities, however. Analysis of the lithic materials from the late Archaic occupation at LA 158642 and the Late Developmental occupation in Area 2 at LA 158640 (Chapter 10, this volume) suggests that the inhabitants brought largely unworked nodules back to the camps for reduction. Only in the early Developmental component in Area 1 at LA 158640 was there evidence that initial reduction of the nodules had occurred before the cores were brought back to the camp. The data obtained from LA 160886 reinforces the varying patterns of lithic procurement observed at the other sites excavated during this project.

SUMMARY AND MANAGEMENT RECOMMENDATIONS

During subsurface testing at LA 160886, 188 shovel test pits and auger holes were dug to systematically probe the less eroded eastern, western, and southern site margins of the site. No evidence of features was found and only four of the STPs yielded subsurface artifacts. Twenty-two 1 by 1 m test units were then excavated to supplement the STPs. These units were positioned in areas where subsurface artifacts had been found, where surface artifacts were concentrated, and in areas where the surface sediments were deeper. Subsurface artifacts were recovered from nine of these units, seven of which were in Study Unit 2. Those units were contiguous and were dug to determine the extent of a subsurface artifact concentration located near the ridge crest and just above an outcrop of Ceja gravels. In all, approximately 4 cu m of sediment were excavated from a 39 sq m area, which is about 1.4% of the site area defined by the surface artifact scatter.

Geomorphological observations at the site suggest that, at some indeterminate time in the past, erosion stripped away the Holocene from the hillslope leaving the artifacts as a lag deposit resting on the Pleistocene age deposits that form the dune ridge. Continued erosion has transported artifacts in the central part of the site further downslope and has probably removed some material from the site area. Artifacts on the more level areas near the ridge crest and on the two spur ridges were subsequently reburied by recent wind-blown sediments and incorporated into those deposits as a result of pedoturbation. They therefore are in a secondary depositional context but appear to retain some spatial integrity.

Analysis of the collected artifacts indicates that LA 160886 was primarily a lithic procurement area at which nodules of lithic raw material were collected and tested for quality. In some cases, part of the cortex was removed from suitable nodules but, based on our estimate of the total amount of debitage at the site, this behavior was not common. No charcoal or temporally-sensitive artifacts were recovered during testing, so the site is undated. However, it was probably used as a source of lithic raw materials throughout the 2500 years of intermittent occupations documented at other sites in the immediate vicinity.

After consulting with the staff of the New Mexico Historic Preservation Division, it was decided that LA 160886 should be recommended as eligible for the NRHP under criterion *d* of 36 CFR 60.4 despite its relative lack of integrity. The test excavations demonstrated that buried artifacts were present in at least one area of the site that could yield additional information about the nature of lithic procurement activities. Further, given the spacing of the test units, there was only about a 20% probability of locating a feature measuring 1 m in diameter. Consequently, there could be buried features at the site that might yield charcoal for radiocarbon dating. No additional data recovery was required, however, since only the lower, eroded portion of the site would be affected by the proposed slope re-contouring. The areas with potential subsurface materials are outside of this area and could be avoided. Monitoring of the construction was recommended to avoid inadvertent damage to that part of LA 160886.

Chapter 10

FLAKED LITHIC ANALYSIS

by Matthew O'Brien

Excavations were conducted at four separate sites on the proposed CNM Rio Rancho campus, each of which recovered a sizable quantity of lithic artifacts. The site lithic assemblages are presented independently to highlight general patterns and interpretations of the lithic technological organization. When possible additional analyses focusing on the lithic spatial distribution is discussed and interpreted in conjunction with site features and other artifact classes.

The lithic assemblage from the entire project is dominated by over 1,100 pieces of debitage with only six tools. The absence of lithic tools limits this analysis to predominately a discussion of differences in the debitage assemblage and worked nodules. The primary interpretative framework employed for this analysis is technological organization, which provides a link between lithic attributes and intentional human behavior through experimental and archaeological case studies (i.e. Dibble 1995; Frison 1968; Jelinek 1971; Nelson 1991; Sullivan and Rozen 1985).

METHODS FOR THE LITHIC ANALYSIS

The site assemblages were analyzed using the standard OCA lithic methods (Herhahn 2008). Given the emphasis on bulk sediment samples in addition to traditional shovel scraping, the lithic assemblage provides a robust sample with which to interpret lithic technological organization. To account for the differing excavation strategies, the debitage collected from the sediment samples were size sorted to filter out flakes measuring less than 3.2 mm in maximum dimension. This threshold separates out the flakes that would have passed through the 1/8" screens that were used for the shovel scraping. Any flake measuring 3.2 mm or greater would technically have been collected from the screening process, and therefore would have been collected from traditional excavation techniques. The lithic analysis separates out those smaller pieces of debitage independent of the screened and larger debitage fraction to avoid skewing the lithic representation.

Laboratory analysis recorded the raw material type, macroscopic variation per raw material type, artifact type, flake portion (condition), dorsal cortex, and platform morphology. Flake portion (condition) has five possible classifications: complete, proximal, medial, lateral, and unknown. The definitions of these classifications adhere to those established by Dibble (1995) and Andrefsky (2005). Platform types include single and multifaceted, cortical, prepared, and collapsed. Prepared platforms include any platform exhibiting extensive grinding or dorsal stepping. Flake size followed the metric standards established by Andrefsky (2005) with a few noted alterations. For complete flakes, length, width, and thickness were recorded. Length was measured from the platform to the flake termination. Width was measured perpendicular to length at the midpoint of the length measurement. Thickness was recorded at the intersection of length and width. Maximum length and thickness was recorded for fragmented flakes (proximal, medial, and lateral) and angular debris. In the case of medial flake fragments, the width was measured at its maximum distance. If lateral flake fragments possessed a portion of the platform and termination point, platform type and flake length were recorded.

In addition to the basic lithic information recorded for all debitage, edge angle and use wear were recorded for formal and expedient flaked tools. For those tools exhibiting usewear, the number of edges, edge shape, and length and depth of the utilized edge were documented. Finally, projectile points, and point fragments when possible, included documentation of the proposed projectile point type, hafting type, base type and shape, and presence of notching. When applicable, points were analyzed to determine if breakage was the result of manufacturing error or impact damage. Additional metrics were recorded on neck width, neck thickness, stem length, basal width, and shoulder width.

RAW MATERIALS

The lithic raw materials recovered from the surface survey and subsequent excavations indicate extensive use of Santa Fe (Ceja) Formation gravels that exist within the Arroyo de la Barranca drainage. All four sites reflect this procurement strategy, which indicates a dominant localized lithic industry. This procurement pattern mirrors previous cultural inventories and data recovery projects in the local area (Hogan 1986; Kennedy et al. 1998; Kurota 2006; Kurota and Hogan 2009; Raymond et al. 2008; Seymour et. al. 1997). The primary raw material types include chalcedony, chert, quartzite, and silicified wood. To a lesser degree, obsidian, jasper, siltstone, and limestone were also present, but in low frequencies.

The chalcedony recovered exhibits characteristics found within the overarching classification of Rio Grande Chalcedony. Rio Grande Chalcedony is mostly a clear semi-translucent material with white circular inclusions, but it can also have colored inclusions that include red, black, and brown. The only known outcrop that feeds the Rio Grande drainage basin is Pedernal Chert, located at the northwestern edge of the Jemez Mountains. A thick band of chalcedony bedding is known from Cerro Pedernal located southwest of Abiquiu Reservoir. The outcrop possesses significant color and transparency variation throughout the bedded material. Colors range from white, yellow, red, and black. The majority of the Pedernal chert is transparent, but there is a more opaque white version that appears in lower frequency. Pedernal chert enters the Rio Puerco to the west and Rio Chama to the east through alluvial processes, and is then transported into the Albuquerque Basin. For the purposes of classification, the Pedernal chert classification is reserved for the procurement directly from the outcrop, while the more generalized classification Rio Grande Chalcedony refers to the secondary deposits found in the alluvial cobbles that transport the material down stream.

The cherts from the project area are opaque fine crypto-crystalline with color variations ranging from tan, brown, and red. The tan and brown cherts are common in the drainages within the Albuquerque Basin, which LeTourneau (2000) calls Abiquiu chert. Secondary deposits of the chert are present in conjunction with the primary outcrops of Pedernal chert and are transported in a similar manner to Pedernal, but the primary outcrop of the material is unknown. The red chert is an unknown variety. The quartzite found also is a common member of the alluvial cobbles found in the Albuquerque Basin. They range from purple to white in color and have differing degrees of grain size. As a whole, the chert, chalcedony, and quartzites are all members of the geologic Santa Fe Group. The cobbles within the unconsolidated conglomerate average fist size, but can also be significantly larger. Overall, the raw materials at sites on the CNM Rio Rancho campus are locally procured. These raw materials can be found within a kilometer of the excavated sites, and the general lithic characteristics support this local classification.

SITE DESCRIPTIONS AND INTERPRETATIONS

LA 158640

The flaked lithic assemblage from LA 158640 consists of 165 pieces of debitage, 4 cores, 6 tested cobbles, and one hammerstone. Lithics within the bulk sediment floats account for 85 flakes, of which 44 measured less than 3.2 mm. The other 41 flakes recovered from the bulk sediment samples were larger than 3.2 mm and were analyzed as part of the general lithic assemblage (Table 10.1). Generally, the site is dominated by angular debris (77.5%) and cortex bearing flakes (40.8%). The lithic assemblage also has 13 heat altered pieces of debitage. Twelve of these are characterized by crazing, and one shows waxy luster on the ventral and dorsal surfaces. While cherts (11%) and quartzites (5%) are present, the most frequent raw material utilized at LA 158640 is chalcedony (83%). As discussed in above, the source of all these tool stones are assumed alluvial cobbles in the gravel facies of the Santa Fe Group, which are locally available throughout the Albuquerque Basin. The proximal and complete flakes have 15 single-facet, 4 cortical, 3 multifaceted, and 2 collapsed platforms (Table 10.2). Absent from the assemblage are discarded tools.

Table 10.1. LA 158640 Lithic Summary (excludes debitage <3.2 mm).

Debitage Attributes					
Raw Material	**N**	**Cortex**	**>50% Cortex**	**Heat Alteration**	**Angular Debris**
Chalcedony	101	39	13	10	73
Chert	13	8	3	2	13
Quartzite	6	1	-	1	6
Silicified Wood	-	-	-	-	-
Other	1	1	-	-	1
Total	**121**	**49**	**16**	**13**	**93**
Percentage		**40.5%**	**13.2%**	**10.7%**	**76.9%**

Flakes/Flake Fragments						
Raw Material	**Complete**	**Distal**	**Lateral**	**Medial**	**Proximal**	**Unknown**
Chalcedony	14	3	-	2	8	1
Chert	-	-	-	-	-	-
Quartzite	-	-	-	-	-	-
Silicified Wood	-	-	-	-	-	-
Other	-	-	-	-	-	-
Total	**14**	**3**	**0**	**2**	**8**	**1**
Percentage	**11.6%**	**2.5%**	**0.0%**	**1.7%**	**6.6%**	**0.8%**

Non-Debitage				
Raw Material	**Cores**	**Tested Cobbles**	**Hammerstone**	**Total**
Chalcedony	4	3	-	108
Chert	-	1	1	15
Quartzite	-	1	-	7
Silicified Wood	-	-	-	-
Other	-	1	-	2
Total	**4**	**6**	**1**	**132**
Percentage				

Table 10.2. LA 158640 Platform Types.

	Platforms					
Raw Material	**N**	**Collapsed**	**Cortical**	**Single**	**Faceted**	**Prepared**
Chalcedony	22	2	3	14	3	-
Quartzite	2	-	1	1	-	-
Other	-	-	-	-	-	-
Total	**24**	**2**	**4**	**15**	**3**	**0**

The four cores and six tested cobbles from LA 158640 suggest that the site functioned as a procurement area (Figure 10.1). The four chalcedony cores show varying degrees of multi-directional reduction that seems to hinge on the quality of the nodule - those cores that exhibit interior flaws have fewer flake scars. Each of the complete and fragmented cores still possess cortex in varying quantities. These cortical surfaces exhibit rounding that is indicative of alluvial transport. Only one core (FS 40) still possesses acute angles capable of producing additional flakes. The tested cobbles consist of one chert, one quartzite, one “other,” and three chalcedony nodules. Two of the chalcedony nodules are similar to the cores but are smaller in size. The third is a large nodule of poor quality. There are six similar pieces of debitage (two refit to the nodule) that likely indicate an isolated reduction area. The chert nodule is an alluvial cobble found in the Santa Fe Formation gravels. It has a chalky white to tan exterior with a brown interior, which is considered characteristic of Abiquiu chert. The nodule has 70% cortex, which looks to have compromised the high quality chert within. Two flake scars are visible, but the majority of the remaining nodule remains unused. The red to tan quartzite tested cobble has a portion that transitions into fine-grained material with high luster. It is on this surface that flake removal occurred. The “other” tested cobble is a transitional material that is predominately limestone with portions exhibiting crypto-crystallization replacement.

Spatial Analysis of LA 158640

The spatial distribution of lithic artifacts at LA 158640 suggests that the site consists of multiple occupations or distinctive activity areas. The lithics recovered from the eastern portion of the site (Area 2) are associated with the diagnostic Pueblo II ceramic sherds, but less is known about the western portion of the site (Area 1). Both areas cover a large space, but the primary focus of the spatial analysis focuses on lithic artifacts associated with Study Units 4 and 8 from Area 1 and Study Unit 7 from Area 2. Hearths were exposed in both areas, which suggest both occupations are associated with campsite activities. Initial analysis attempted to subdivide Area 1 into artifacts recovered from the surface and excavated cultural materials located between the N120 and N138 gridlines and between the E90 and E116 gridlines (Area 1A). The remainder of Area 1 (Area 1B) was lumped together to isolate these data from the denser concentration of lithics in Area 1A. This subdivision of Area 1 was ignored when burned artifacts were mapped in association with thermal features.

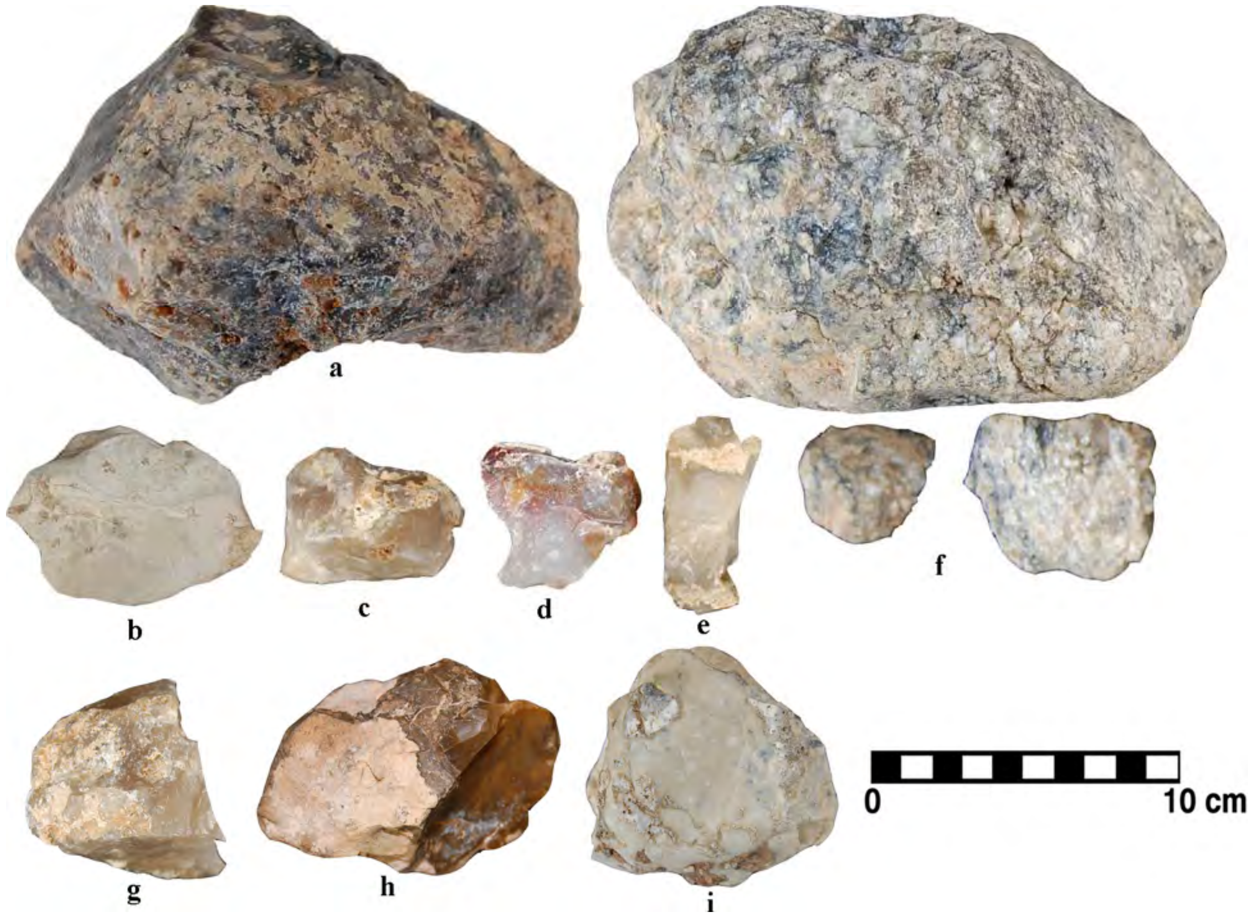


Figure 10.1. LA 158640 sample of raw materials from cores and tested cobbles: a-g and i are Rio Grande Chalcedony, and h is Abiquiu Chert.

The distribution of heat altered material is suggestive of differences in post depositional processes. Artifacts recovered within the hearths do not show any degree of heat alteration, but two burned artifacts were found adjacent to Feature 2. Both burned pieces of debitage show obvious crazing, which suggests that heat alteration was not intentional. The remaining burned debitage found in Area 1 are down slope to the south of Features 2 and 3, which suggests post depositional displacement of the artifacts. Given the geomorphological analysis presented in Chapter 7, it is likely that most of the cultural material found south of Study Units 4 and 8 have been redistributed through erosional processes. This evidence raises questions regarding the division of Area 1A from Area 1B. If burned artifacts are used as a proxy for translocated material from Features 2 and 3, then Study Units 1, 2, and 3 are linked to Study Units 4 and 8. The exception is the tight cluster of debitage and a tested cobble (FS 101), which do not relate with the remainder of Area 1 in terms of lithic characteristics. This lithic reduction outlier may be the result of a separate occupation distinct from the one centered around Study Unit 4 and 8. Therefore, these artifacts were removed from the spatial analysis of LA 158640.

The distribution of burned artifacts from Area 2 is predominately located to the southwest of Features 4 and 5. There seems to be some post depositional disturbance of the cultural material, but most of the burned artifacts are within two meters of the hearth features. Despite the potential differences in cultural affiliation between Study Units 6 and 7, the small lithic sample size from Area 2 prevented further subdivision.

The lithic assemblage broken down along these parameters provides ample subsamples of 78 flakes from Area 1 and 56 flakes from Area 2. One obstacle in comparing the two areas is the uneven distribution of excavation units. Area 1 has significantly more test units, while the lithics from Area 2 consist of primarily surface artifacts. This results in skewed representation of flake size – Area 1A reflects the complete range of debitage size, while Area 2 tends to have larger, more visible, flakes. For this reason, the metric data are not discussed in this analysis of sub-site patterns. Each subsample will be discussed independently, and then a summary will highlight potential patterns of site use.

Area 1. The assemblage from Area 1 consists of 72 pieces of debitage, 1 hammerstone, 5 tested cobbles, and 1 core (Table 10.3). The debitage is dominated by clear to opaque white chalcedony chipped stone (91.9%) combined with low percentages of pink/red (4.8%) and black (3.2%) variations. The cherts include Abiquiu chert (5.8%), and an unknown gray chert (2.9%). Approximately 5% of the debitage has more than 50 percent cortex, and 24 pieces of debitage (28.2%) have some percentage of dorsal cortex. Area 1 has two chalcedony flakes and four angular debris fragments that have crazing on their ventral and dorsal surfaces evidencing burning. One burned piece of angular debris and one flake also have cortex present, but it only covers ten percent of the dorsal surface. Area 1 has a high percentage of angular debris (70.5%) followed by a notable number of complete flakes (9%). Of the 12 flakes with platforms, there are 1 collapsed, 9 single faceted, and 2 multi-faceted types (Table 10.4).

Table 10.3. LA 158640 Area 1 Lithic Summary.

Debitage Attributes					
Raw Material	**N**	**Cortex**	**>50% Cortex**	**Heat Alteration**	**Angular Debris**
Chalcedony	62	18	3	6	45
Chert	5	2	1	-	5
Quartzite	4	1	-	-	4
Other	1	1	-	-	1
Total	**72**	**22**	**4**	**6**	**55**
Percentage		**30.6%**	**5.6%**	**8.3%**	**76.9%**

Flakes/Flake Fragments						
Raw Material	**Complete**	**Distal**	**Lateral**	**Medial**	**Proximal**	**Unknown**
Chalcedony	7	2	-	2	5	1
Chert	-	-	-	-	-	-
Quartzite	-	-	-	-	-	-
Other	-	-	-	-	-	-
Total	**7**	**2**	**0**	**2**	**5**	**1**
Percentage	**9.7%**	**2.8%**	**0.0%**	**2.8%**	**6.9%**	**1.4%**

Non-Debitage				
Raw Material	**Cores**	**Tested Cobbles**	**Hammerstone**	**Total**
Chalcedony	1	2	-	65
Chert	-	1	1	7
Quartzite	-	1	-	5
Other	-	1	-	1
Total	**1**	**5**	**1**	**79**
Percentage				

Table 10.4. LA 158640 Area 1 Platform Data.

	Platforms					
Raw Material	**N**	**Collapsed**	**Cortical**	**Single**	**Faceted**	**Prepared**
Chalcedony	12	1	-	9	2	-
Quartzite	-	-	-	-	-	-
Other	-	-	-	-	-	-
Total	**12**	**1**	**-**	**9**	**2**	**-**

A tested cobble and core were found near Features 2 and 3. The tested cobble is a limestone/chert unlike any other material found at the site. The irregular core fragment was found to the south of the dense concentration of artifacts in Area 1. It is a clear to white colored chalcedony with some embedded veins of carbonates imbedded with the chalcedony, which has caused some hinge and step terminations. The remaining surfaces of the core suggest that intensive reduction led to premature fracture of the nodule. None of the other core fragments from LA 158640 refit to this specimen. The Area 1 assemblage also included four other tested cobbles; two are chalcedony, the third is Abiquiu chert, and the fourth is quartzite. The hammerstone was found in proximity to Feature 1 in Study Unit 5. It is a mottled grayish brown and white chert cobble with 80% of its cortex remaining. It shows battering use-wear at one end, suggesting use as a hammerstone Absent from this portion of the site are any flake tools.

Area 2. The lithic assemblage from Area 2 consists of 56 pieces of debitage, 3 cores, and 1 tested cobble (Table 10.5). Chalcedony (78.6%) is the most common raw material, which is followed by chert (17.8%) and quartzite (3.5%). All of the chalcedony falls into the clear translucent to white opaque variation that is common in the Rio Grande alluvium. The most common chert is Abiquiu with a less frequent white chert variety. The debitage condition mirrors that of Area 1 with angular debris and complete flakes accounting for 66 and 16 percent of the debitage, respectively. There are six flakes (10%) with 50 percent or greater cortex, and 45% of the debitage has some amount of cortex. Heat alteration occurs on nearly 20% of the assemblage, which is characterized by eight crazed and four waxy luster flakes. Area 2 has the highest frequency of platform bearing flakes, and single facet and collapsed platforms are predominant (Table 10.6). The platform type distribution indicates earlier stage reduction.

The three chalcedony cores from this area exhibit multi-directional reduction patterns. The irregular shape and size indicates intensive core use of these materials for flake production. Further reduction of the cores was possible, but each is near exhaustion. There is no indication that the cores were heat treated prior to reduction. The single tested rock is a translucent chalcedony nodule with two visible flake scars. The invasive nature of the calcium carbonate parent material limited the utility of the nodule.

Comparison and Interpretation. The spatial division of the lithic assemblage from LA 158640 provides a useful approach for interpreting localized site activities, post depositional processes, and, possibly, the duration of site occupation. The radiocarbon dates from the hearth features of Area 1 fall within the Late Archaic to Early Developmental periods, while the Pueblo II (Late Developmental) ceramics from Area 2 are indicative of a later occupation of the eastern part of the site. Thus the site has two or more occupations separated by a substantial period of time. Looking at the lithic assemblages from the two areas suggests that lithic technological organization are distinct. Comparisons focused on procurement strategies, reduction strategies, and discard patterns.

Table 10.5. LA 158640 Area 2 Lithic Summary.

Debitage Attributes					
Raw Material	**N**	**Cortex**	**>50% Cortex**	**Heat Alteration**	**Angular Debris**
Chalcedony	44	18	4	9	26
Chert	10	7	2	2	9
Quartzite	2	-	-	-	2
Other	-	-	-	-	-
Total	**56**	**25**	**6**	**11**	**37**
Percentage		**44.6%**	**10.7%**	**19.6%**	**66.1%**

Flakes/Flake Fragments						
Raw Material	**Complete**	**Distal**	**Lateral**	**Medial**	**Proximal**	**Unknown**
Chalcedony	9	1	3	-	5	-
Chert	-	1	-	-	-	-
Quartzite	-	-	-	-	-	-
Other	-	-	-	-	-	-
Total	**9**	**2**	**3**	**0**	**5**	**0**
Percentage	**16.1%**	**3.6%**	**5.4%**	**0.0%**	**8.9%**	**0.0%**

Non-Debitage			
Raw Material	**Cores**	**Tested Cobbles**	**Totals**
Chalcedony	3	1	48
Chert	-	-	10
Quartzite	-	-	2
Other	-	-	-
Total	**3**	**1**	**60**
Percentage			

Table 10.6. LA 158640 Area 2 Platform Data.

	Platforms					
Raw Material	**N**	**Collapsed**	**Cortical**	**Single**	**Faceted**	**Prepared**
Chalcedony	14	2	4	7	1	-
Quartzite	-	-	-	-	-	-
Other	-	-	-	-	-	-
Total	**14**	**2**	**4**	**7**	**1**	**-**

In terms of procurement, both areas utilized the same raw materials. Chalcedony and chert are consistently the most frequent tool stones with minor use of quartzite and petrified wood. All of the materials derive from the Santa Fe Formation gravels, which is locally available. The immediate accessibility of these tool stones can be seen in the high frequency of tested cobbles and cortex bearing flakes. Tool stone quality varies greatly among the chalcedony artifacts, which hinges on the degree of chalcedony replacement of the carbonates. The size of the cores mattered less to the occupants, as many of the tested cobbles could, at best, produce a few usable flakes.

The assemblages from both areas of LA 158640 consist mostly angular debris with a high percentage of cortex bearing flakes. Combining these general flake characteristics with the presence of cores and tested cobbles provides a strong case for classifying LA 158640 as a lithic procurement site. Yet, when debitage characteristics are analyzed by their respective subsample, greater distinctions in the lithic organization appear. Technological organization analysis focuses on cortex frequencies, flake conditions, and platform characteristics to highlight similarities and differences between the subsamples.

If one assumes that the flint knappers first focus on removing cortex from the margins of a fresh nodule, then cortical platforms should occur in the location of initial reduction or cobble testing. This assumption does not imply that the removal of all cortex is the goal in primary reduction. Instead, cortex may remain on a late stage core, or biface, as long as it does not interfere with the knappable edges. In the case of biface manufacture, the eventual removal of cortex may occur as late as bifacial thinning. Area 1 and 2 show a divergence in the amount of cortex and cortical platforms. Area 2 has more cortical platforms and a greater frequency of flakes with 50% or more dorsal cortex. Area 2 also has a ratio of 18 flakes to every core, while Area 1 has 36 flakes to every core.[1] The absence of cortical platforms and flakes with high percentages of cortex suggests that Area 1 occupants did not initially reduce nodules within this area. Based on the existing lithics characteristics, Area 1 occupants were shaping the cores through further reduction at the site. The high ratio of flakes to cores at Area 1 does suggest that some of these reduced nodules were more likely transported off site than at Area 2. The absence of bifacial debitage and the dominance of single faceted platforms suggest that occupants were focused on producing flakes for immediate utilization.

Unlike Area 1, debitage traits from the entire core reduction sequence are present in Area 2. Early stage reduction is represented by four cortical platforms (28%) and six flakes with 50% or greater cortex (10.7%). Exhausted cores and core fragments are suggestive of on-site late stage reduction. Interestingly, there is only one tested cobble from the area, which indicates occupants did not perform initial cobble testing on-site. Instead, cobbles were likely selected off-site, and then transported to the campsite for further reduction. This suggests that Area 2 occupants were collecting their tool stone away from the site as opposed to Area 1 occupants who brought untested cobbles to the site for examination. Area 1 occupants may have also tested cobbles that were naturally deposited within the boundaries of the site. The absence of bifacial debitage, the irregular core reduction, and absence of formal tools suggests that Area 2 occupants were focused on producing flakes for utilization. A lithic industry centered on utilized flakes, or expedient technology, is a reasonable conclusion in the absence of formal tools. The absence of these flake tools suggests that they were taken with the occupants when the site was abandoned.

Ethnoarchaeological studies have shown that occupants residing at a campsite for longer periods of time will attempt to clear debris away from activity areas (Bartram et al. 1991; Gamble 1991). The swept up debris are commonly deposited in the hearth or in refuse piles. If redeposited debitage is dumped in hearths, then we would expect a greater frequency of thermal alteration – especially crazing and potlidding. Short occupations differ, because these do not experience activity area cleaning. Area 1 has an equally dense concentration of lithics as Area 2, but does not have similar thermal alteration frequencies. If these ethnographic observations are considered a general trend in determining occupation span, then Area 2 was occupied for a longer period of time than Area 1.

[1] FS 26, Item 2 is included in this data for Area 1, but it cannot be linked to the erosional processes that distributed artifacts to the south of the site. This core is located approximately 12 m west of the majority of the eroded cultural material.

Summary

LA 158640 is a multicomponent site exhibiting distinctive lithic assemblages that suggest differing technological organization. Based on the provenience of hearth features and burned artifacts, the site shows differing post depositional processes across the site. In Area 1, artifacts originated around Features 2 and 3 with some of this material eroding down slope to the south. Area 2 also shows some artifact displacement, but this is less pronounced. The frequency of heat altered debitage also suggests that Area 1 was a shorter occupation then Area 2.

The technological organization of the two areas indicates local procurement of alluvial cobbles and a focus on flake production. What differs between the areas is the representation of the lithic reduction sequence. Area 1 shows intermediate stages of lithic reduction. The area lacks primary reduction debitage, which suggests initial reduction occurred outside of the site boundaries. This pattern differs from Area 2, which possesses debitage associated with all stages of lithic reduction. This evidence suggests that occupants of the site utilized the area for different purposes and/or duration.

Turning to the ratios of debitage to cores and tools, there is little difference between the two areas, but isolating the ratios of tested cobbles to cores shows a distinction. Area 1, which is associated with the Archaic occupation has a two to one ratio of tested cobbles to cores, while the Puebloan occupation in Area 2 has a ratio of one tested cobble to three cores. This supplements the debitage interpretation by suggesting that occupants of Area 1 removed prepared cores from the site and left behind tested cobbles that exhibited poor flint knapping potential. Area 2 occupants produced debitage from the procured cores until exhaustion, and discarded these artifacts on-site. The Archaic period tested cobble to core ratio is also visible at LA 158642, which will be discussed later.

LA 158641

The lithic assemblage from LA 158641 includes 46 pieces of debitage, a retouched flake, and a tested cobble (Table 10.7). While sediment samples were taken at this site, there were no lithics extracted from the heavy fraction. The raw material frequency is skewed toward chalcedony (82.6%) with lesser contributions from chert (6.5%) and quartzite (6.5%). Cortex is present on 73.9% of the assemblage and 45.7%t of the assemblage has 50% or greater amounts of cortex. None of the observed debitage exhibits heat alteration. In terms of debitage condition, angular debris is the most frequent class (60.9%) followed by complete flakes (26.1%). Laboratory analysis identified 14 flakes with intact striking platforms among the debitage assemblage, the majority of which are single facet (Table 10.8). The one prepared platform had indications of grinding on the exterior surface prior to detachment. Based on the platform lipping and preparation, it looks to be a pressure flake.

The non-debitage assemblage consists of a tested cobble and a retouched flake. The tested cobble is a clear to white chalcedony with as many as three flake scars. Cortex remains on 70% of the exterior surface. The quality of the tool stone is adequate, but the nodule size limits its functionality. The chalcedony retouched flake shows three adjacent flake scars along the ventral surface of the lateral margin. While this could be considered retouch, the edge in question measures only 3.8 mm and has an edge angle of 80 degrees. The remainder of the margin shows no indication of use and an average edge angle of 85 degrees.

Table 10.7. LA 158641 Lithic Summary.

Debitage Attributes					
Raw Material	**N**	**Cortex**	**>50% Cortex**	**Heat Alteration**	**Angular Debris**
Chalcedony	38	28	15	-	23
Chert	3	1	1	-	2
Quartzite	3	3	3	-	2
Other	2	2	2	-	1
Total	**46**	**34**	**21**	**0**	**28**
Percentage		**73.9%**	**45.7%**	**0.0%**	**60.9%**

Flakes/Flake Fragments						
Raw Material	**Complete**	**Distal**	**Lateral**	**Medial**	**Proximal**	**Unknown**
Chalcedony	9	2	-	2	2	-
Chert	1	-	-	-	-	-
Quartzite	1	-	-	-	-	-
Other	1	-	-	-	-	-
Total	**12**	**2**	**0**	**2**	**2**	**0**
Percentage	**26.1%**	**4.3%**	**0.0%**	**4.3%**	**4.3%**	**0.0%**

Non-Debitage			
Raw Material	**Retouched Flake**	**Tested Cobbles**	**Totals**
Chalcedony	1	1	40
Chert	-	-	3
Quartzite	-	-	3
Other	-	-	2
Total	**1**	**1**	**48**
Percentage			

Table 10.8. LA 158641 Platform Data.

	Platforms					
Raw Material	**N**	**Collapsed**	**Cortical**	**Single**	**Faceted**	**Prepared**
Chalcedony	11	1	2	5	2	1
Chert	1	-	1	-	-	-
Quartzite	1	-	-	1	-	-
Other	1	-	-	1	-	-
Total	**14**	**1**	**3**	**7**	**2**	**1**

LA 158641 was initially interpreted as a small agricultural camp with minimal lithic discard around a shallow pit structure. However, the lithic analysis suggests that the debitage from the site may represent a mixture of *in situ* artifacts and erosionally redeposited cultural materials from up slope. The *in situ* artifacts include the lithics found in two of the hearts, Features 2 and 3, although the debitage from nearby show no indications of thermal alteration. This may indicate that the debitage was swept into the extinct features. Based on flake condition and cortex, the nine pieces of debitage from the structure, Feature 4, are similar to the remainder of the site assemblage. Feature 4 debitage is distinct in the platform type frequencies, which include one cortical and two single faceted platforms. This difference could indicate that the artifacts found within Feature 4 are also associated within the site's occupation but is far from conclusive.

Another interpretation of the spatial data from LA 158641 is that all the material is redeposited from up slope. The geomorphological interpretation of the surface sediments indicate that this surface is highly mixed from erosional/depositional cycles and various forms of site formation processes. Overall, the artifacts from the features do not show distinctions from the entire lithic assemblage, and any differences cannot be substantiated due to the small sample sizes. The secondary deposition of nine artifacts into Feature 4 is possible if this feature was a low spot in the topography, which acted as a trap for eroding cultural material.

Overall, the debitage assemblage reflects a dispersed intensive core reduction area. The debitage assemblage shows no evidence of tool manufacture and a lack of discarded tools indicates that LA 158641 was not an activity area centered on tool production or prolonged use. The raw material frequencies indicate a local reliance on knappable members of the Santa Fe Group alluvial cobbles.

LA 158642

Of the four sites investigated during this project, LA 158642 has by far the densest concentration of lithic artifacts. Surface collections and excavation recovered 755 pieces of debitage, 4 tested cobbles, 1 biface fragment, 1 utilized flake, 1 chopper, and 1 projectile point (Table 10.9). Of the 755 chipped stone, 39 measured less than 3.2 mm and were separated out from the general assemblage. Among the general lithic assemblage, angular debris (55%) is the most common flake condition. Cortex bearing flakes are common (38%) but LA 158642 has the lowest percentage among the four sites investigated. Approximately 15% of the debitage assemblage has heat alteration, which is dominated by 58 pieces exhibiting crazing and/or potlidding. Three of the 13 bifacial thinning flakes have evidence of heat alteration in the form of a waxy ventral and dorsal surface. None of the bifacial thinning flakes have more extreme signs of burning (i.e. crazing or potlidding). The 139 complete, 4 longitudinally split, and 30 proximal flakes provide a robust dataset for platform preparation. Among the identified platforms, there are 101 single faceted, 34 cortical, 21 collapsed, 13 multi-faceted, and 4 prepared platforms (Table 10.10). The identifiable raw materials utilized at LA 158642 are chalcedony (78.8%), chert (11.1%), obsidian (0.3%), quartzite (7.6%), and silicified wood (1.7%). LA 158642 shows a greater variety of procured tool stones, but the relative frequencies of each raw material are similar to the other assemblages.

The tested cobbles from LA 158642 are generally small alluvial nodules exhibiting minimal utilization (Figure 10.2). Three of the four tested cobbles are partially crystallized chalcedony deposits forming around the parent carbonate material. Due to the incomplete crystallization, these nodules have numerous flaws that compromise the predictability of flaking patterns. One pure chalcedony cobble exhibits minor flaking, but it small size (maximum length: 44.8 mm) likely limited its functional utility.

The tool assemblage from LA 158642 is limited to a biface fragment, a utilized flake, and a large chopper. The biface fragment was made on a white to black chalcedony with faint banding (Figure 10.3). Based on the flake scar patterning and its thickness to width ratio, the flint knapper was in the process of thinning the biface when a longitudinal fracture occurred (Dockall 1997). There is no evidence that this broken biface was utilized. A single clear chalcedony utilized flake was recovered from the heavy fraction of the sediment sample. The flake tool also exhibited a waxy luster on the exposed surfaces. The chopper recovered from the surface is a fine-grained tan quartzite (Figure 10.4). With the exception of the utilized edge, the nodule has a single smooth surface with rounded edges derived from alluvial transport. The utilized edge differs with a semi-serrated edge that measures 68 mm in length. Impact damage resulted in the removal of the cortical surface opposite of the smooth side.

Table 10.9. LA 158642 Lithic Summary (excludes debitage <3.2mm)

Debitage Attributes					
Raw Material	**N**	**Cortex**	**>50% Cortex**	**Heat Alteration**	**Angular Debris**
Chalcedony	565	226	85	68	311
Chert	79	25	8	8	45
Obsidian	2	-	-	-	-
Quartzite	24	8	5	-	10
Quartzite Coarse	30	6	4	-	19
Silicified Wood	12	3	2	-	8
Other	4	2	1	-	2
Total	**716**	**270**	**76**	**76**	**395**
Percentage		**37.7%**	**10.6%**	**10.6%**	**55.2%**

Flakes/Flake Fragments						
Raw Material	**Complete**	**Distal**	**Lateral**	**Medial**	**Proximal**	**Unknown**
Chalcedony	110	53	22	10	21	38
Chert	13	4	6	-	6	5
Obsidian	2	-	-	-	-	-
Quartzite	6	4	-	1	-	3
Quartzite Coarse	7	2	-	-	2	-
Silicified Wood	1	2	-	-	-	1
Other	-	2	1	-	1	-
Total	**139**	**65**	**29**	**11**	**30**	**47**
Percentage	**19.4%**	**9.1%**	**4.1%**	**1.5%**	**4.2%**	**6.6%**

Non-Debitage				
Raw Material	**Cores**	**Tested Cobbles**	**Tools**	**Total**
Chalcedony	-	4	2	571
Chert	-	-	-	79
Obsidian	-	-	1	3
Quartzite	-	-	1	25
Quartzite Coarse	-	-	-	30
Silicified Wood	-	-	-	12
Other	-	-	-	4
Total	**-**	**4**	**4**	**724**
Percentage				

Table 10.10. LA 158642 Platform Data.

	Platforms					
Raw Material	**N**	**Collapsed**	**Cortical**	**Single**	**Faceted**	**Prepared**
Chalcedony	131	15	27	77	9	3
Chert	21	4	2	12	3	-
Obsidian	2	1	-	1	-	-
Quartzite	6	-	3	3	-	-
Quartzite Coarse	9	1	1	5	1	1
Silicified Wood	1	-	-	1	-	-
Other	3	-	1	2	-	-
Total	**173**	**21**	**34**	**101**	**13**	**4**

Figure 10.2. LA 158642 sample of Rio Grande Chalcedony tested cobbles recovered from excavations

Figure 10.3. Biface fragment from LA 158642.

Figure 10.4. LA 158642 chopper made from gray quartzite.

The projectile point recovered has a unique morphology that does not fall nicely within any existing point typology (Figure 10.5). The point has corner notches with a flat base. The interesting features are the three deeply incised notches along the lateral margins. Justice's (2002) typological classification places this point tentatively within the San Pedro type based on the converging lateral margins, base shape, and notching. According to Chapin (2005), the point resembles an En Medio Corner Notched point, which has a temporal range of 1700 to 2100 cal BP. The later date falls within the upper range of the radiocarbon dates taken from thermal features. The notching located on the margins may indicate subsequent recycling of the point by later culturally affiliated groups. The point may represent a weapon lost by its original owner during hunting, which was later discovered by later occupants of the area. While purely speculation, the point may have been reused for hunting, used as an emblematic symbol, or as jewelry. If this is the case, it will be difficult to associate this point with a particular cultural classification.

Figure 10.5. Projectile point of unknown typology from LA 158642.

The point's gray obsidian material has been sourced using XRF analysis, which indicates its origin within the Cerro Toledo Rhyolite (Shackley 2009). Testing of Rio Grande obsidian alluvium indicates that Cerro Toledo Rhyolite enters the drainage system and is transported downstream. Studies focused on knappable alluvium transported by the Rio Grande indicate that obsidian pieces remain relatively large, which provides an alternative to procurement from the primary source. The relative size (max. length = 30 mm) and the general dominance of alluvial cobbles within the lithic assemblage suggest that the nodule that produced this projectile point was procured from the Rio Grande drainage system.

Interpretation

The lithic assemblage from LA 140642 resembles that of a primary reduction area with minor evidence of tool production and use. The debitage is dominated by angular debris, platforms characteristic of early stage reduction, and high frequency of cortex bearing flaked stone. The poor quality of tool stone for the tested cobbles and cores compared to finer quality debitage suggests that many of the higher quality cores are absent from the site. In addition, the high ratio of debitage to cores/tools suggests that occupants were removing the worked nodules from the site. The lithic assemblage is concentrated around a series of thermal features. The provenience of burned debitage overlaps with the locations of the thermal features, which suggests the debitage and features are coeval. This situation is compounded by radiocarbon dates obtained from the thermal Features 2 and 5, which indicate non-contemporaneous, but overlapping, campsite occupations. Feature 2 radiocarbon dates span from cal BC 1750 to 1600, and the Feature 5 radiocarbon date ranges from cal BC 1400 to 1190.

Spatial analysis does not show a break in the lithic distribution to distinguish debitage from the separate occupations. One exception is a concentration of tool manufacturing debris that occurred around Feature 2. All of the multi faceted and prepared platforms are located with a 5 m by 7 m area (between N129 and N136 and between E56 and E62 gridlines) that encompasses Feature 2. This pattern parallels the presence of all the bifacial thinning flakes within the same cluster. In addition, the single biface fragment is also located at the eastern margin of this artifact cluster. The presence of one burned multi-faceted flake provides a tenable link between occupants of Feature 2 and the activities that produced these platforms exhibiting greater preparation. While it is possible that these flakes were the product of the later occupation, the burned multi-faceted platform flake makes it a less likely association. This suggests that occupants of Feature 2 were performing limited tool production, which is not seen anywhere else on the site.

While the flaked lithic assemblage suggests a primary lithic reduction area, the other artifacts and features suggest that LA 158642 was a campsite. In addition, thermal altered debitage is found within close proximity of the thermal features, which suggests that post-depositional processes had minimal impact on the integrity of the site. This indicates that the distribution of artifacts is real and that there were overlapping occupations. The close proximity of the features suggests that the site was reoccupied successively by the groups, but there are no means of determining the affiliation of these temporally different groups

For every tool or core at LA 158642, there are 143 flakes. This ratio is far above the ratios observed at the other three sites. Where are all the cores if this is a procurement site? One possible explanation may be that the occupants were focusing on identifying higher quality nodules from the abundant alluvial cobbles. The high quality nodules would be procured and taken with the flint knappers when they abandoned the site. Ideally, this would translate into a lithic assemblage rich in tested cobbles and poor in cores. This is, in fact, what we see at LA 158642, which has four tested cobbles and no cores. This behavioral interpretation does not conflict with the determined site function of a camp site, but acts as a complement.

The presented argument contradicts more basic interpretations based on the size of the lithic assemblage to indicate length of occupation. Compared to the other sites, LA 158642 should represent a longer occupation based on the significantly larger lithic concentration. Yet, the combination of the lithic attributes and the radiocarbon dates suggest that the site represents a series of short overlapping occupations.

LA 160886

The lithic assemblage of LA 160886 consists of 113 pieces of debitage, a retouched flake, 7 cores, and 5 tested cobbles (Table 10.11). According to the raw material distribution, occupants favored chalcedony (86.7%) and chert (8.8%) as their primary tool stone. Over 70% of the assemblage possesses some traces of cortex and 31% has cortex covering more than half of the dorsal flake surface. Macroscopic observations of the lithic material show no visible evidence of thermal alteration. As with all the sites from this project, angular debris (68.1%) is the most abundant debitage condition, which is followed by complete flakes (17.7%) and proximal flakes (7.1%). The proximal and complete flakes have a total of 29 platforms, more than half of which are single faceted (Table 10.12). A single retouched piece of angular debris encompasses the entirety of the tool assemblage. The specimen has minor retouch on its dorsal surface, but there is no visible usewear pattern. Its classification as a tool is precarious given the characteristics found within the rest of the lithic assemblage. The rest of the non-debitage assemblage consists of an even mixture of tested cobbles and cores (Figure 10.6). The tested cobbles are all chalcedony nodules with minimal flake scars that occur around flaws in the material. There are six

Table 10.11. LA 160886 Lithic Summary.

Debitage Attributes					
Raw Material	**N**	**Cortex**	**>50% Cortex**	**Heat Alteration**	**Angular Debris**
Chalcedony	98	71	26	-	65
Chert	10	7	6	-	10
Quartzite	3	3	2	-	1
Silicified Wood	1	1	1	-	1
Other	1	-	-	-	-
Total	**113**	**82**	**35**	**0**	**77**
Percentage		**72.6%**	**31.0%**	**0.0%**	**68.1%**

Flakes/Flake Fragments						
Raw Material	**Complete**	**Distal**	**Lateral**	**Medial**	**Proximal**	**Unknown**
Chalcedony	19	2	1	1	7	3
Chert	-	-	-	-	-	-
Quartzite	1	-	-	-	1	-
Silicified Wood	-	-	-	-	-	-
Other	-	-	-	1	-	-
Total	**20**	**2**	**1**	**2**	**8**	**3**
Percentage	**17.7%**	**1.8%**	**0.9%**	**1.8%**	**7.1%**	**2.7%**

Non-Debitage			
Raw Material	**Cores**	**Tested Cobbles**	**Totals**
Chalcedony	7	5	110
Chert	-	-	10
Quartzite	-	-	3
Silicified Wood	-	-	1
Other	-	-	1
Total	**7**	**5**	**125**
Percentage			

Table 10.12. Platform Data for LA 160886.

	Platforms					
Raw Material	**N**	**Collapsed**	**Cortical**	**Single**	**Faceted**	**Prepared**
Chalcedony	27	4	10	10	2	1
Quartzite	2	-	1	1	-	-
Other	-	-	-	-	-	-
Total	**29**	**4**	**11**	**11**	**2**	**1**

irregular cores and one bifacially reduced core. Like the tested cobbles, the cores are all chalcedony. The intensity of reduction varies from nodule to nodule, but there seems to be a positive correlation between the quality of the stone and the degree of reduction.

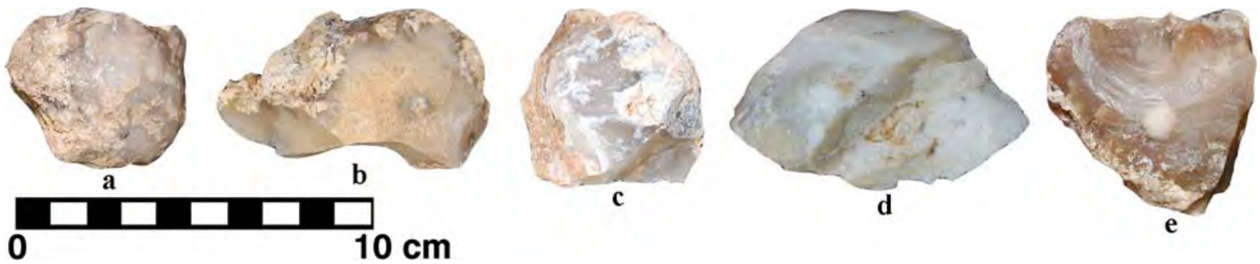


Figure 10.6. LA 160886 sample of Rio Grande Chalcedony cores and tested cobbles.

The main concentration of lithics lies on a low scarp of an anchored dune. While the greatest concentration of debitage is located southwest of the exposed outcrop of Santa Fe Formation, a moderate amount of debitage was recovered from down slope. In the case of the tested cobbles and cores, all of them are found on the north-facing slope. This indicates that weathering continued to erode the low scarp inwards, which is exposing more cultural material for transport down slope. It is safe to assume that all the material found *in situ* and down slope are coeval, and can be considered part of the same lithic assemblage. One concern is why all the cores and tested cobbles are only found on the slope? One possibility is that LA 160886 had two activity areas, but only one is still intact. The southern portion of the block excavation possesses trends that can be equated with more intensive core reduction. This includes a high percentage of angular debris mixed with decreasing amounts of cortex per piece of debitage. In addition, the average size of debitage is diminishing relative to the rest of the site. Unfortunately, a quantitative comparison between this area and the rest of the site cannot be accomplished due to the erosion of northern portion of the lithic concentration. While there was substantial lithics found on the northern slope, there is no way of tracing its origin.

The lithic assemblage indicates that LA 160886 was a lithic procurement and primary reduction site. The macroscopic analysis of the tool stones matches with the comparative samples from the Santa Fe Group. This material can be found in the exposed outcrop of the Santa Fe Group at the northwestern boundary of the site. Due to erosion, many artifacts have been redeposited down slope, which hampers comparative spatial analysis. The intact deposits located within the southern portion of the excavation block suggest that occupants used this area for more intensive core reduction. The northern portion of the block and cultural material located closer to the Santa Fe outcrop indicate that initial nodule testing occurred where the tool stone was procured. The lack of non-local raw materials and the absence of thermal features suggest that occupants did not use this area as a camp site. Instead, it is likely that occupants used this area as a logistical lithic procurement area.

SMALL DEBITAGE FROM SEDIMENT SAMPLES

The data recovery at LA 158640 and LA 158642 emphasized the collection of bulk sediment samples from features and midden deposits. Debitage was recovered from the heavy fraction of many of those samples after flotation. As discussed previously, much of this material was analyzed with the general lithic assemblage but items smaller than 3.2 mm (i.e., material that would have passed through the 1/8 in screens used by the excavators) were analyzed separately. These debitage subsamples were obtained almost exclusively from features associated with the aceramic components of the sites, so the following discussion can be couched within the general discussion of the Archaic occupations at LA 158640 and LA 158642. Examination of the subsamples focused on comparing assemblage characteristics from the general assemblage with the debitage measuring less than 3.2 mm in maximum length.

The LA 158640 subsample from the sediment samples consists of 44 pieces of debitage (Table 10.13). This subsample accounts for over 26% of the lithic recovered from the site. The debitage is overwhelmingly dominated by chalcedony debitage (84.1%) and angular debris (93.2%). There are six chert lithics with only a single proximal flake fragment among the five pieces of angular debris. A single gray translucent obsidian flake fragment was also collected from the coarse fraction of the sediment sample, but it is too small for potential XRF sourcing. Over 38% of the debitage had cortex, which mirrors the rest of LA 158640's lithic assemblage. The absence of heat alteration within the sediment subsample differs from the general assemblage.

Table 10.13. LA 158640 Subsample of Debitage <3.2 mm Recovered from Flotation Samples.

Raw Material	N	Cortex	Heat Alteration	Angular Debris
Chalcedony	37	13	-	36
Chert	6	4	-	5
Obsidian	1	-	-	-
Total	**44**	**17**	**0**	**41**
Percentage		**38.6%**	**0.0%**	**93.2%**

	Flakes/Flake Fragments					
Raw Material	**Complete**	**Distal**	**Lateral**	**Medial**	**Proximal**	**Unknown**
Chalcedony	-	1	-	-	-	-
Chert	-	-	-	-	1	-
Obsidian	-	-	-	-	-	1
Total	**0**	**1**	**0**	**0**	**1**	**1**
Percentage	**0.0%**	**2.3%**	**0.0%**	**0.0%**	**2.3%**	**2.3%**

LA 158642's subsample consisted of 39 pieces of debitage, which accounted for only about 5% of the entire lithic assemblage (Table 10.14). The raw material counts are 36 chalcedony (92.3%) and 3 chert (7.7%) pieces of debitage. In terms of flake condition, the debitage is mostly angular debris (59%). While obsidian and quartzite occur in the general lithic assemblage, they are absent from the sediment samples. Another distinction is the relatively low number of cortex bearing flakes in the subsample (10%) compared to LA 158642's general assemblage (37%). There is less deviation in the presence of heat alteration (subsample: 15%; general sample: 10%).

Analytical Concerns

Given the high frequency of angular debris in both subsamples, it is worth exploring the possible explanations. One would expect angular debris to be the dominant flake condition for procurement sites, but the frequency is overwhelming at LA 158640 and LA 158642. It is likely that the distribution of debitage types is real, but there are two plausible explanations for this phenomenon: post-depositional processes or methodological issues. Post-depositional processes are a variable that impacts all archaeological sites (Wood and Johnson 1978). These processes can obscure behavioral patterns and spatial distributions. A thorough discussion of some of these processes has been discussed in the Geomorphology chapter.

Table 10.14. LA 158642 Subsample of Debitage <3.2 mm Recovered from Flotation Samples.

Raw Material	N	Cortex	Heat Alteration	Angular Debris
Chalcedony	36	4	5	23
Chert	3	-	1	-
Obsidian	-	-	-	-
Total	**39**	**4**	**6**	**23**
Percentage		**10.3%**	**15.4%**	**59.0%**

Flakes/Flake Fragments						
Raw Material	**Complete**	**Distal**	**Lateral**	**Medial**	**Proximal**	**Unknown**
Chalcedony	1	1	1	-	2	8
Chert	-	1	-	-	-	2
Obsidian	-	-	-	-	-	-
Total	**1**	**2**	**1**	**0**	**2**	**10**
Percentage	**2.6%**	**5.1%**	**2.6%**	**0.0%**	**5.1%**	**25.6%**

In terms of methodological issues, I am referring to concerns about the definition of angular debris and the physical analysis of individual flakes. Angular debris, as it is defined by OCA procedures (Herhahn 2008), Sullivan and Rozen (1985), and Andrefsky (2005), is debitage without a discernable ventral surface and encompasses shatter occurring from percussion manufacture. When dealing with minute assemblages, this definition may become too broad. Depending on the raw material, evidence of a ventral surface may be obscured by the lack of tight conchoidal rings, absence of dorsal flake scars, and a bulb of percussion. This leads to an overrepresentation of angular debris classifications with small debitage. The second methodological concern revolves with the physical observations of small debitage. Proper classification is difficult without the aid of magnification. In the case of this analysis, analysts used both 10 x and 30 x magnification, which provides ample resolution for macroscopic observations. Because of this, any methodological concerns more likely lie with the flake condition classification scheme than with analytical approaches.

Subsample Interpretation

Despite concerns about the validity of the subsample representation, it is still possible to offer generalizations for each site's lithic assemblages of less than 3.2 mm. In the case of LA 158640, the assemblage reflects initial core reduction. The abundance of chalcedony in the subsample reflects occupants' general focus on this fine grained material for lithic procurement. The absence of heat alteration indicates that subsample reflects lithic reduction occurring prior to intentional heat treatment and/or the practice of sweeping debris into nearby hearths. This suggests that occupants were not concerned with clearing their workspaces of sharp debris from the lithic work areas. Another explanation for the lack of heat alteration of the subsample at LA 158640 relates to the geomorphological interpretation of site formation. If the lithics represent a lag deposit from erosional processes that removed sediment from the area, the subsample may be associated with subsequent occupations that postdate the adjacent hearth features. The presence of burned flakes suggests this second explanation is less likely.

LA 158642 provides a similar raw material and flake condition distribution that was seen at LA 158640. The subsample shows a consist pattern of cortical flake frequency and heat alteration. Using the same range of possibilities mentioned for LA 158640, the heat altered debitage from LA 158642 could have occurred from intentional heat treatment of debitage or secondary deposition of small debitage into nearby hearths. Given the proximity of the hearths to the subsample provenience and the amount of potlidded/crazed flakes (50%), it is more likely that the heat altered debitage resulted from secondary deposition as opposed to intentional heat treatment. This interpretation is difficult to substantiate given the low sample size, but it is a plausible hypothesis.

CONCLUSIONS

The lithic assemblages from the CNM Rio Rancho excavations show a high degree of similarity across all four sites. In each case, the debitage resembles expected patterns of archaeological sites found within close proximity of raw material sources. This pattern of land use is similar to previous data recovery projects within the local area (Kennedy et al. 1998; Raymond et al. 2008; Seymour et. al. 1997). Despite comparable lithic characteristics, the sites can be distinguished by a combination of feature-artifact association and technological organization.

In the case of LA 158640 and LA 158642, thermally altered debitage reveal occupations of the flint knapping events with the use of the thermal features. This suggests that these two sites are more likely campsites as opposed to primary reduction areas. Based on this evidence, these sites are campsites that had a lithic technology centered on reducing locally derived nodules of Santa Fe Group tool stones. Although low in frequency relative to the entire assemblage, LA 158642 shows clear evidence of isolated tool production that is visible from the types of flakes, platforms, and tools located around Feature 2, which helps distinguish the range of activities at different times despite overlapping occupations. LA 158641 differs from LA 158640 and LA 158642, in that it has no burned debitage, but thermal features. This raises doubt regarding contemporaneous discard of the lithics and the use of the thermal feature. At this time, the lithic assemblage from LA 158641 is interpreted as redeposited cultural material washing down slope from the south. The exact origin of this material is unknown. LA 160886 appears to be a primary lithic reduction area centered on an outcrop of Santa Fe Group bedrock located within the defined site boundaries. Despite extensive testing, there were no thermal features observed, which suggests that the site served a logistical tool stone procurement function. Flint knappers used the site to test exposed nodules of chalcedony, chert, and quartzite. There seems to be spatially discrete activity areas that divided the tasks of initial nodule reduction from more intensive core reduction, but erosional processes has obscured this distinction.

One of the secondary concerns of this analysis was distinguishing Archaic occupations from later occupations where applicable. In particular, LA 158640 has an Archaic and Puebloan period occupation with spatially discrete lithic concentrations. In the case of the Archaic period lithic assemblage, the debitage reflects reduction associated with the intermediate stages. This differs from the Puebloan period assemblage that has more debitage tied with primary nodule testing and reduction. The separate occupations and their associated lithic assemblages likely reflect the changing land use patterns over time. The one identified Puebloan occupation appears to indicate longer residence than that of the Archaic occupation.

The consistency of tested cobbles to core ratios at the two Archaic occupations within the project area suggest that there is a distinct behavioral difference in land use from later occupations. While the lithic assemblages from the Archaic and Puebloan periods both focused on flake production over bifacial tool production, the Archaic lithic assemblages have only a small portion of the lithic reduction sequence present at the sites. The Archaic occupants used this area as a staging area to procure nodules of high quality to supplement their tool kits. These prepared cores were then transported off-site for further reduction. The Puebloan lithic assemblages reflect a more complete picture of the lithic reduction sequence – primary, intermediate, and late stage reduction are all present in Area 2. This lithic pattern may highlight the differing degrees of mobility and length of occupation between the cultural affiliations.

Chapter 11

GROUND STONE FROM LA 158640 AND LA 158642

by David Holtkamp

The ground stone assemblages from LA 158640 and LA 158642 consist of 20 artifacts including manos, metates, hammerstones, and fragmentary items of indeterminate function. Together, the two sites have temporal components ranging from the Late Archaic through Classic periods. Analysis of the ground stone assemblages therefore had two objectives. The first was determining artifact function and relating it to the activities associated with each occupation. The second was distinguishing any changes in the artifacts through time. Although the assemblages are small in numbers, it was hoped that the range of temporal periods represented at the sites might provide additional information on how grinding technology developed with changing regional conditions on Ceja Mesa.

ANALYSIS METHODS

Ground stone items from the CNM Rio Rancho excavations were analyzed using a combination of measurements and nominal artifact attributes following Adams (2002). The length, width, and thickness of each artifact were measured using calipers and recorded in millimeters. These measurements were recorded for both complete and fragmentary specimens. The artifact were weighed using an electronic scale, and their weight was recorded to the nearest gram. The stone from which the artifact was made was identified by referencing the OCA Lithic Type Collection. Other attributes of specific ground stone artifacts were determined using a hand lens. Those attributes include ground surfaces, striations, pecking, shaping, margins of battering, and form.

Manos and Metates

The basic grinding technology consists of two components; the handstone and the netherstone. The netherstone is the lower, stationary part of the set, which holds the material being ground and to which the grinding pressure is applied. The handstone is held in the hand and is used to apply grinding pressure and motion against the netherstone. In the American Southwest, this grinding technology set is more commonly referred to as a mano and metate.

Manos (handstones) are further classified by size, which is an indicator of whether it was used with one hand or two. Metates (netherstones) are subdivided into categories based on the shape of the grinding surfaces, which is related to the type of mano used, the predominant grinding motion, and the intensity/duration of use. Basin metates are distinctly concave in both longitudinal and cross-section, while trough metates are U-shaped in cross-section but nearly flat in longitudinal section. The flat/concave metate, though generally flat in cross section, have a slightly concave form. Flat metates, in contrast, are uniformly flat in cross section. Basin and flat/concave metates are typically used with one-hand manos, while trough and flat metates may be used with either a one-hand or two-hand mano. Most often, however, flat metates are paired with two-hand manos that are as long as the metate is wide. The mano/metate combinations in use during the Middle to Late Archaic periods are the basin and flat/concave metates and one-hand manos.

Particular grinding motions can be ascertained from striation patterns or scratches, and from high point beveling on a metate's use surface. These same patterns can be seen on the use surfaces of manos, and their cross-section shape provide additional information about particular grinding patterns. In general, two stroke patterns are associated with the different types of metates: a rotary motion, and a reciprocal or forward and backward motion. Circular, curved striations as well as parallel striations and high point beveling are characteristic to basin metates. A circular grinding motion would necessitate a large use area and, in some cases, the entire surface of the basin metate becomes concave. If a reciprocal motion were used on a basin metate, an elongated groove would be formed on the metate's use surface. A one-hand mano used on a basin metate would exhibit compatible characteristics. If a one-hand mano were used in a rotary motion, the use area would exhibit obscure or even curving striations and a convex cross section. With a reciprocal motion, the mano would have parallel striations, but still be convex. Flat/concave metates generally begin as flat grinding surfaces but, like basin metates, they begin to develop a concave cross section with extensive use. Parallel striations and high point beveling are characteristic of grinding surface. One-hand manos used with these metates are generally smaller than the width of their metate counterparts. They typically have parallel striations perpendicular to their length as well as a convex or bi-convex cross section form depending on if they have one or more ground surfaces (Adams 2002:99-106).

Because the form of manos and metates changes with use, Adams distinguishes between *extensive* and *intensive* use; that is, whether the use wear occurred as a result of one or relatively few events in a short time period (intensive) versus multiple events over a much longer period (extensive). This distinction is difficult one to make solely on the basis of use wear but clues suggesting intensive use-wear include tools retouch on the grinding surface, comfort features like finger grips, and other tool-management strategies. Another important issue in the development of grinding stone technology is the distinction between how intensely a tool was used and how efficient the user was during the grinding process. With greater efficiency, food processing time is reduced leaving more time for other activities. Alternatively, greater efficiency would allow more food to be processed in a given amount of time. This alternative possibility has a number of behavioral implications: 1) the same number of people can be fed more of the foods being processed; 2) more people can be fed; or 3) a surplus can be created if the number of people and the amount they are fed remains constant. Whether the goal of increased efficiency was to reduce processing time or to increase the amount of food being processed is a difficult distinction to make solely from analysis of the ground stone assemblage, however (Adams 2002:117-119).

Hammerstones, Handstones, and Indeterminate Ground Stone

Hammerstones are the handheld tools used in percussion activities to remove flakes from a lithic material source or to reduce the lithic material down to a desired tool form. Generally hammerstones have concentrated battered areas on their surface. Use wear can include step fracturing, extensive crushing, and ground areas for reworking the surface. In some cases hammerstones have strategically designed modifications for better holding and control of the tool as well as tool maintenance. Characteristics of these modifications include finger grips, battered surfaces for holding, and step fractured/prepared edges along the battering surface (Adams 2002:151).

The term "handstone" refers to a general category of stone tools that are handheld. Handstones include abraders, polishing stones, manos, and pestles. The term is used here when a nodule is clearly a tool but its precise function cannot be ascertained. The category of indeterminate ground stone is used for artifacts that have an identifiable grinding surface but are too fragmented to distinguish whether they came from a mano or metate. However given certain attributes of grinding technology (cross-section shape, striation patterns) a hypothesis of function can be made for the purpose of understanding grinding technology in the analysis of physical form and dimensions in different periods of time.

THE LA 158640 ASSEMBLAGE

Seven manos, one basin metate, and one flat/concave metate were recovered from LA 158640 (Table 11.1). Two of the manos were made of vesicular basalt, three were made of medium/coarse grain quartzite, and one each were made of sandstone and tuff. Both the basin metate and flat/concave metate are made of sandstone. The manos were classified by relative size and their corresponding metate type. Two one-hand basin mano fragments, one of quartzite (FS 12) and one of sandstone (FS 106-1), have light high point beveling; the sandstone mano also has striations in a circular pattern indicating a circular grinding motion. There are also three one-hand flat/convex one-hand manos. Two of these manos are complete, while the third is nearly complete but broken in two pieces. They are each a different material; tuff (Figure 11.1a), quartzite (Figure 11.1b), and vesicular basalt (FS 106-2). All of these manos have parallel striations and a slight convex or bi-convex form indicating reciprocal motions with a slightly concave flat metate. The two remaining manos are indeterminate fragments; one is a large piece of vesicular basalt (FS 61) and the second is a small fragment of medium/coarse grain quartzite (FS 9). The mano fragment of basalt has high point beveling, but not across its entire use area. It is likely that this fragment was used as a hand held grinding stone for a short period of time and then discarded. The quartzite fragment has a heavily polished ground surface, but is not large enough to determine a cross section shape nor does it have striations.

Table 11.1. LA 158640 Ground Stone Artifacts by Type and Material.

Ground Stone Type	Basalt, Vesicular	Chalce dony	Quartzite, Med/Coarse	Sandstone	Tuff	Total
Ground stone, nfs	1	-	-	-	-	1
Hammerstone	-	1	-	-	-	1
Mano, basin	-	-	1	1	-	2
Mano, flat/convex	1	-	1*	-	1*	3
Mano, nfs	1	-	1	-	-	2
Metate, basin	-	-	-	1*	-	1
Metate, flat/concave	-	-	-	1	-	1
Total	**3**	**1**	**3**	**3**	**1**	**11**

nfs - no function specified; asterisk (*) indicates artifacts from Pueblo II component

The flat/concave metate is made of sandstone (Figure 11.2a) and has parallel striations along the length of its grinding surface as well as shaped margins from pecking. The basin metate (Figure 11.2b), also made of sandstone, has an elongated basin use area with slight trough borders. It has characteristics similar to that of an open-ended trough metate, one end being open and the other is not present. However the edges of the metate are not flat and vertical enough to be considered a distinct trough metate. There is pecking on the use area indicating that the metates surface was reworked for further use.

The hammerstone from LA 158640 is made of chalcedony (Figure 11.1c). It has three areas of use, all of which have step fracturing and extensive battering. This kind of use wear generally indicates that the stone was used as a percussor to strike flakes from a core. In this instance, however, it is equally likely that the battering represents a failed attempt to remove flakes from the nodule itself. That is, the artifact may be a tested cobble rather than a hammerstone. It was tentatively classified as a hammerstone because the battering was more extensive than that observed on other tested cobbles at the site. Finally, the indeterminate fragment from LA 158640 is vesicular basalt (FS 105) and has some light grinding on its use surface. Its ground surface is slightly concave whereas the exterior surface of the fragment is generally convex. There are no additional data to indicate further to its function.

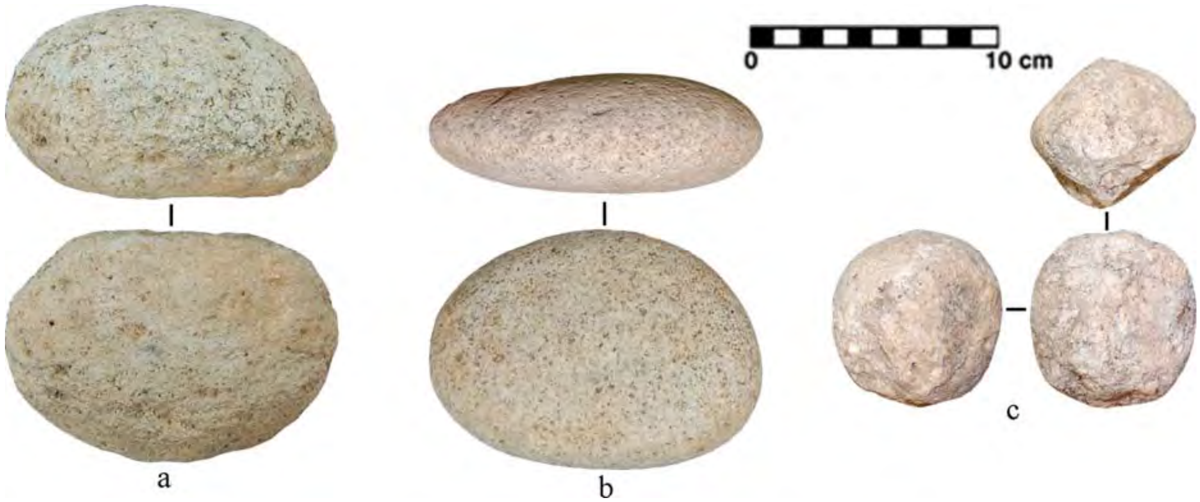


Figure 11.1. LA 158640 manos and hammerstones: (a) one-hand mano of tuff, (b) one-hand mano of quartzite, (c) hammerstone of chalcedony.

Figure 11.2. LA158640 metates: (a) flat/concave metate of sandstone, (b) basin metate of sandstone.

LA 158640 has three spatially segregated temporal components. Area 1 in the western part of the site encompasses the Basketmaker (Early Developmental) period component. Specifically, Feature 2 in Study Unit (SU) 4 yielded a radiocarbon date between cal AD 120 and 330, while Feature 3 in SU 8 yielded a date between cal AD 260 and 520. Eight of the 11 ground stone artifacts from LA 158640 are associated with this component. Three manos, the flat/concave metate, and the hammerstone were found within a six by eight meter area surrounding Feature 2. Two additional manos are located in a drainage 40 meters south of these thermal features. The drainage also has several thermally altered lithics associated with it, which suggests that the artifacts were eroded downslope from the occupation area in SUs 4 and 8.

Area 2 in the eastern part of the site includes the two later components, a Pueblo II (Late Developmental) occupation uncovered in SU 7 and an ephemeral Classic period occupation in SU 6. Both of these components were dated on the basis of ceramics. Only the Pueblo II component yielded ground stone, however. Two flat/convex manos, one quartzite and one tuff, and a sandstone basin metate were associated with that occupation.

THE LA 158642 ASSEMBLAGE

Six manos and a basin metate were found at LA 158642 (Table 11.2). Two of the manos were made of medium/coarse grain quartzite and one each were made of fine grain quartzite, quartzitic sandstone, sandstone, and granite. One of the medium/coarse grain quartzite specimens (FS 74) is a one-hand mano fragment, which has high point beveling and parallel striations perpendicular to the its length. Though fragmentary, the mano is very convex in its use area. Because this mano is highly convex with parallel striations, it is most likely that it was used with a basin metate. Two of the manos are complete flat/convex one-hand manos. One is made of sandstone (FS 79) and the other of granite (Figure 11.3a). The sandstone mano has been completely covered in soot from nearby Features 2 and 4, and has slight parallel striations. The granite mano has four ground surfaces, two of which are the primary grinding surfaces against a metate. The other two ground surfaces are along opposite margins, a ground highly polished surface and a pecked area that could be considered a finger grip. This mano has parallel striations and pecking indicating retouch of the ground surface as well as a bi-convex form. The three indeterminate mano fragments do not have a specific mano function associated to them. They are made of fine grain quartzite (FS 49-1), medium coarse grain quartzite (FS 49-2), and quartzitic sandstone (FS 92). Their function is indeterminate due to a lack of striation patterns and complete cross sections. The only metate from LA 158642 is an incomplete basin metate consisting of 3 fragments of basalt (Figure 11.3b). A relatively small section of the concave ground surface is still present, having high point beveling but no striation patterns.

Table 11.2. LA 158642 Ground Stone Artifacts by Type and Material.

Ground Stone	Material							
Type	Basalt	Basalt, Vesicular	Granite	Quartzitic Sandstone	Quartzite, Fine Grain	Quartzite, Med/Coarse	Sandstone	Total
Ground stone, nfs	-	-	1	-	-	-	-	**1**
Handstone, indeterminate	-	1	-	-	-	-	-	**1**
Mano, basin	-	-	-	-	-	1	-	**1**
Mano, flat/convex	-	-	1	-	-	-	1	**2**
Mano, nfs	-	-	-	1	1	1	-	**3**
Metate, basin	1	-	-	-	-	-	-	**1**
Total	**1**	**1**	**2**	**1**	**1**	**2**	**1**	**9**

nfs – no function specified

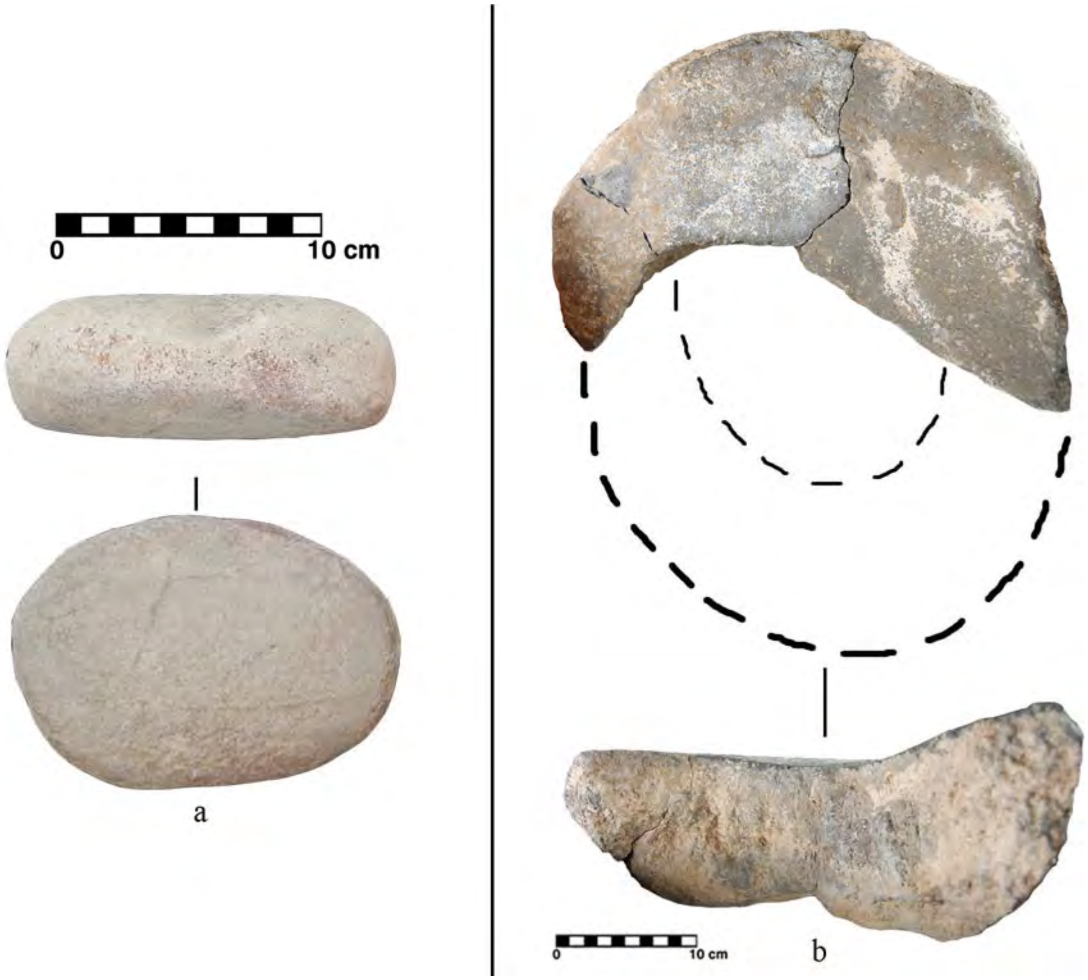


Figure 11.3. LA 158642 ground stone: (a) one-hand mano of granite, (b) basin metate of basalt with hypothesized maximum dimensions and ground surface.

LA 158642 has one handstone with an indeterminate function. It is a large fragment of vesicular basalt with a convex ground surface (FS 8). The ground surface has high point beveling and is incomplete. Though fragmentary, because of its convex cross section, this artifact is considered a handstone likely attributed to grinding activities. It is possible that it was a large convex mano, possibly two-handed, that was used with a basin or flat/concave metate. The indeterminate ground stone fragment (FS 45) is granite and has a ground surface that is slightly concave with some high point beveling. The overall shape suggests that it may be a netherstone fragment.

Most of the ground stone of LA 158642 was recovered during excavations in SU 2. Radiocarbon dates were obtained from two of the features uncovered in this study unit. Feature 2, a roasting pit, was dated between cal 1750 and 1600 BC) and Feature 5, a residential structure, was dated between cal 1400 and 1140 BC. These dates indicate occupations dating to the Late Archaic period. Almost all of the ground stone recovered from SU 2 and can be directed associated with this occupation. The only artifact without a clear stratigraphic context is the indeterminate handstone, possibly a large mano, which was found on the surface within a small drainage rill leading towards the adjacent arroyo. Its location suggests that it was eroded from the in situ cultural deposits uncovered during the excavation.

DIMENSIONAL ATTRIBUTES

Dimensions of ground stone items including length, width, thickness, and weight was recorded for all items in this assemblage. Only ten of the artifacts are complete or nearly complete, however (Table 11.3). The measurements of the nearly complete items were included in this study for two reasons. First, if the mano or metate had a small piece missing, but grinding surfaces were intact, then the entire dimensions were included. Second, the most important characteristics of these grinding tools are 1) the area and extent of the grinding surface, and 2) the degree to which the thickness of the artifact was reduced as a result of use. The incomplete basalt basin metate (FS 33 from LA 158642) was included for the latter reason. While length and width cannot be measured, the thickness of the metate and the depth of the basin can be estimated, as can the area of the grinding surface.

Table 11.3. Dimensions of Complete and near Complete Ground Stone Artifacts from LA 158640 and 158642.

LA 158640									
FS #	**Type**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Weight (g)**	**Ground Surface Length (mm)**	**Ground Surface Width (mm)**	**Ground Surface Depth (mm)**	**Second Ground Surface (mm)**
106-2	Mano, basin	109	94	43	554	85	75	-	-
44*	Mano, flat/convex	128	91	45	746	90	85	-	100(L) 75(W)
104*	Mano, flat/convex	118	83	69	830	74	35	-	
106-1	Mano, flat/convex	132	86	66	828	105	70	-	80(L) 30(W)
62	Metate, flat/concave	225	174	56	4500	200	169	-	-
107*	Metate, basin	586	364	144	29483	480	241	18	
LA 158642									
8	Handstone	102	145	86	1488	-	120	-	-
74	Mano, basin	104	87	60	691	-	65	-	-
79	Mano, flat/convex	138	87	68	969	85	57	-	-
91	Mano, flat/convex	138	96	48	1086	123	92	-	104(L) 79(W)
33	Metate, basin	-	-	101	6804	-	300	47	-

Asterisk (*) indicates artifacts from Pueblo II component

The manos from the two sites of these two sites show similar patterns of grinding use, and have similar dimensions for thickness and grinding area. This suggests that the grinding technology employed on Ceja Mesa changed little through time, although the apparent similarities could be a function of the small sample size. There is some evidence for differing levels of use intensity between the sites, however. Most of the manos from the Late Archaic component at LA 158642 have one grinding surface and low to moderate use-wear. The Basketmaker and Pueblo II components at LA 158640 have more bi-convex manos with two grinding surfaces and somewhat higher levels of use-wear (Table 11.4). This difference suggests either more intensive or extensive use of grinding stones during the Formative period. The fact that LA 158640 has proportionately more manos and metates than LA 158642 also supports the hypothesis that the later Basketmaker and Pueblo II occupations were on processing plant material as a means of subsistence.

Table 11.4. Manos by Site, Functional Type, and Grinding Use Attributes.

		Mano Cross-Section Shape				
Site No.	**Functional Type**	**Convex**	**Plano-Convex**	**Biconvex**	**Indeterminate**	**Total**
LA 158640	Mano, basin	-	-	1	1	2
	Mano, flat/convex	-	1	2	-	3
	Mano, nfs	-	-	-	2	2
LA 158642	Mano, basin	1	-	-	-	1
	Mano, flat/convex	-	1	1	-	2
	Mano, nfs	-	2	-	-	2
Total		**1**	**4**	**4**	**3**	**12**

		Mano Use-Wear Levels				
Site No.	**Functional Type**	**Light**	**Moderate**	**Extensive**	**Indeterminate**	**Total**
LA 158640	Mano, basin	1	-	1	-	2
	Mano, flat/convex	1	2	-	-	3
	Mano, nfs	-	1	1	-	2
LA 158642	Mano, basin	-	1	-	-	1
	Mano, flat/convex	-	-	1	1	2
	Mano, nfs	-	1	-	1	2
Total		**2**	**5**	**3**	**2**	**12**

		Mano Striation Patterns			
Site No.	**Functional Type**	**Circular/Curved**	**Parallel**	**Indeterminate**	**Total**
LA 158640	Mano, basin	-	-	2	2
	Mano, flat/convex	-	2	1	3
	Mano, nfs	-	-	2	2
LA 158642	Mano, basin	-	1	-	1
	Mano, flat/convex	-	2	-	2
	Mano, nfs	-	-	2	2
Total		**-**	**5**	**7**	**12**

COMPARISON WITH OTHER SITES

Two other excavated sites on Ceja Mesa were examined to determine if they reflected the same trends in ground stone technology observed at LA 158640 and LA 158642. En Medio Shelter (Irwin-Williams and Tompkins 1968) is a stratified rockshelter with dates ranging from late San Jose to Basketmaker III (1600–10 BC). Lru-Kish Kachreu (Seymour et al 1997) is a multi-component open site dating primarily to the Archaic period.

En Medio Shelter, LA 9380, is located near the northwestern edge of Ceja Mesa and was recorded in 1966. Excavations at the site documented a stratigraphic sequence of occupations ranging from the Late San Jose Phase to Basketmaker II (1600 BC to 10 BC), and a surface occupation dating to Pueblo I (AD 820). The ground stone from En Medio Shelter is part of larger assemblage that shows little change in form and function over time, the only significant variation being in the projectile point forms. This consistency suggests that the successive occupations of the site occurred during an interval of stable ecological conditions for food processing. The site's ground stone assemblage includes of seven metates, 14 manos, a mortar, and three pestles. The distribution of these artifacts by temporal component is shown in Table 11.5.

Table 11.5. Distribution of Grinding Stones from En Medio Shelter by Temporal Period (Irwin-Williams and Tompkins: 1968).

Temporal Periods	Metates	Manos	Mortar	Pestles
Late San Jose (1600–1400 BC)	1	-	-	-
Armijo Phase (1400 to 1000 BC)	-	-	-	-
Proto-Basketmaker (1000–800 BC)	1	2	-	-
Basketmaker II (800–10 BC)	4	8	1	1
Basketmaker III to Pueblo I(10 BC to 810 AD)	1	4	-	2

The date ranges given for the Late San Jose (1600-1400 BC) and Armijo levels (1400–1000 BC) at En Medio Shelter overlap with the radiocarbon dates from the Archaic occupation at LA 158642. Only a single metate was recovered from those levels, however, so there is little basis for comparison with the ground stone artifacts from LA 158642. The date ranges given for the Proto-Basketmaker (1000–800 BC) and the Basketmaker II (800–10 BC) levels, from which most of the ground stone artifacts were obtained, are later than the Archaic component at LA 158642 but predate the Basketmaker component at LA 158640. The date range for the Basketmaker III–Pueblo I occupation at En Medio (10 BC to AD 810) overlaps the Basketmaker component at LA 158640 and predates the Pueblo II component.

Three of the metates from the Proto-Basketmaker and Basketmaker II levels at LA 9380 are described as having shallow, oval-shaped grinding surfaces, and can probably be classified as basin metates. There are also two trough-like, open-ended metates; one with a rotary motion on its ground surface. Nine of the 10 manos are made of quartzite and one of basalt. All have convex grinding surfaces with little to moderate use wear. The mortar is also affiliated with the Basketmaker II Period. It has a 5 cm diameter depression that is highly smoothed and evidences a rotary grinding motion. It is hypothesized that it was used with a small pebble pestle, which exhibits similar ground surfaces on both ends.

The Basketmaker III/Pueblo I affiliated ground stone shows the transition towards more flat grinding surfaces on metates and manos. The metate is a flat grinding slab that is heavily worn and very thin with a slight depression in the center. There are three one-hand manos and one two-hand mano. The one-hand manos still have convex form and little use wear, but the two-hand mano is almost completely flat on its use surface because of reciprocal motions conducted by its user. The two remaining pestles are also affiliated with this Basketmaker III/Pueblo I setting (Irwin-Williams and Tompkins 1968:1–20).

Apart from the mortar and pestle, the ground stone from the Proto-Basketmaker and Basketmaker levels closely resemble the assemblages from both the Archaic component at LA 158642 and the Basketmaker component at LA 158640. Generally, the assemblages are made of local materials and are largely unshaped except for the grinding surfaces. Basin metates and one-hand manos are predominant; the latter tend to be unshaped cobbles with a single grinding surface that exhibits light to moderate use wear.

The transition toward flat grinding surfaces evident in the Basketmaker III/Pueblo I occupation at En Medio Shelter is echoed by the flat/concave metate from the Basketmaker component at LA 15840. There are no two-hand manos, however. Interestingly, this trend is not apparent in the small ground stone assemblage from the Pueblo II component at LA 158640, which appears similar to Archaic/Basketmaker grinding technology.

Excavations at several sites were completed by Lone Mountain Archaeological Services (Seymour et al: 1997) prior to construction of the Sandoval County dump, which is located about 5 km east of the CNM Rio Rancho campus. Most of the ground stone from those excavations were recovered from Archaic components at the Lru-Kish Kachreu site (LA 107577). Those components were situated in three areas scatter along a large dune ridge in a setting very similar to that of the CNM Rio Rancho sites.

Locus A at LA 107577 consists of four thermal features and an activity surface within a ca. 6 by 10 m area near the northern edge of the site. Radiocarbon dates from two of the features had ranges of cal 1530–1260 BC and cal 1510–1260 BC. Three one-hand manos and two indeterminate ground stone fragments were recovered from this locus. The manos show heavy use but are not refurbished. All of the ground stone artifacts were burned indicating secondary use as heating elements or hearth accessories.

Locus B, about 10 m southeast of Locus A, consists of four thermal features clustered within a 4 by 4 m area. Radiocarbon dates of cal 1735–1285 BC and cal 1765–1660 BC were obtained from two of the features in the cluster. Two one-hand manos showing light use wear were associated with the features.

Locus C is about 8 m southeast of Locus B. It encompasses a structure and associated extramural activity area covering about a 4 by 4 m area. Radiocarbon dates of cal 1390–1045 BC and cal 1415–1135 BC were obtained on charcoal from the floor of the structure. A fragmentary sandstone basin metate was found overturned on the floor of the structure. It showed heavy use and had been refurbished. Six one-hand manos were located in the extramural area immediately to the southeast of the structure. The manos all have moderate to heavy use wear and five of them have grinding surfaces on both faces. None have evidence of refurbishment, however. Most of the ground stone is burned; this may have occurred when the structure burned or it could be the result of secondary reuse.

The two radiocarbon dates from LA 158642 overlap those from Lru-Kish Kachreu, and the features in the three loci at Lru-Kish Kachreu appear similar to those in the overlapping occupations at LA 158642. Locus C in particular closely resembles the structure at LA 158642. The ground stone artifacts also share a number of similarities. Seymour et al. (1997:134–173) note that the grinding stones from LA 107577 are made from locally-available lithic materials and they exhibit little shaping other than the grinding surface. The basin metate in Locus C was heavily used and refurbished, while many of the manos show heavy use but no refurbishment. The primary differences in the two assemblage are 1) that the most of the manos from LA 158642 evidence only light to moderate use wear, and 2) that there is little evidence of burning to suggest recycling of the ground stone. These differences may relate to the season and/or the duration of the occupations. Most of the ground stone from Lru-Kish Kachreu was recovered from Locus C and the structure associated with that occupation is both larger than the one at LA 158642 and has internal features, possibly indicating a cool season occupation.

SUMMARY

The ground stone assemblages from LA 158642 and LA 158640 consist primarily of manos and a few metates, which indicate that plant processing was associated with the Archaic, Basketmaker, and Pueblo II occupations of the sites. The metates are basin or concave in form and are unshaped or minimally shaped on their margins. The manos are one-hand size cobbles with one, or rarely two, slightly flat or convex grinding surfaces. These grinding stones are made of locally available lithic materials and are mostly unshaped except for their grinding surfaces, characteristics of an expedient technology as opposed to formal tool manufacture. The metates appear to have heavy use and evidence of refurbishment. About half of the manos have moderate use wear, one-quarter have light use wear, and one quarter have heavy use wear. None appear to have been refurbished.

The trend toward flat grinding stones noted for En Medio Shelter is possibly evidenced by the flat/concave metate from the Basketmaker component at LA 158640 but is not reflected in the small ground stone assemblage associated with the Pueblo II component. That trend is largely associated with the development of corn-grinding technology, however. The persistence of one-hand manos and concave metates during the Pueblo II occupation at LA 158640 therefore suggests that wild plant resources were being processed and not cultigens.

The primary difference between the ground stone assemblages from LA 158640 and LA 158642 is less in the form of the artifacts than in the apparent intensity of use. Relative to the LA 158642 assemblage, the manos and metates from LA 158640 likely represent either longer periods of time spent grinding foods or larger amounts of plant foods being processed. The difference may be specific to these occupations, however, since the ground stone from the Archaic components at the nearby Lru-Kish Kachreu site shows predominantly heavy use wear.

Chapter 12

CERAMIC ANALYSIS

by Connie Constan

The CNM Rio Rancho excavations involved three sites with ceramics. The collected sherds are primarily from LA 158640 and LA 158641, but a single sherd was identified during survey at LA 158642. This analysis focuses on the 27 sherds from the excavations but also discusses the ceramics noted during the initial survey and recording phase (Table 12.1). Information on the pottery was gleaned from in-field recording and the collected sherds.

Table 12.1. Ceramic Types by Site.

Type	LA 158640	LA 158641	LA 158642	Total
Glaze-on-yellow	4	-	-	4
Glaze C	1	-	-	1
Red Mesa Black-on-white	13	-	-	13
Wiyo Black-on-white	-	1	-	1
Indeterminate bichrome	-	1	-	1
Whiteware	4	-	-	4
Indented Corrugated	-	2	-	2
Rio Grande Plain	-	1	1	2
Total	22	5	1	28

Ceramics at sites on Ceja Mesa and the west bank of the Rio Grande are typical of the Rio Grande Developmental, Coalition, Classic, and Historic periods. The Developmental period is the beginning of ceramic sites in the Albuquerque district. Decorated wares have a mineral paint with a black-on-white scheme. The transition from the Developmental to Coalition period is marked by a change to organic paint with a continued black-on-white scheme. The Classic period is marked by the appearance of glaze paint. The glaze paint polychromes cross into the Historic period, but eventually give way to a mineral matte-paint series.

Each time period ceramic assemblage can be generally characterized (Wendorf and Reed 1955). The Rio Grande Developmental typically has Lino Gray, San Marcial Black-on-white, trade redwares, and Mogollon brownwares in the early phase. In the late phase additional types occur: Kana'a Gray and Neck Banded, Alma Neck Banded, Kiatuthlanna Black-on-white, La Plata Black-on-red, and Abajo Black-on-orange. The La Plata and Abajo are rare in assemblages. Around the beginning of the Pueblo II period – within the Rio Grande Developmental timeframe – Red Mesa Black-on-white appears (Cordell 1978) and Kwahe'e Black-on-white is found with Wingate Black-on-red.

During the Coalition period, Santa Fe Black-on-white, Wiyo Black-on-white, and Galisteo Black-on-white are the dominant decorated types. The intrusive pottery includes St. Johns Polychrome, Tularosa Black-on-white, Chupadero Black-on-white, and Heshotauthla Polychrome. The utility wares start out corrugated over the entire vessel and transition to Indented Corrugated. Previously the culinary pottery was only corrugated on the neck of the vessel.

In the Classic period, Rio Grande Glazewares become the overwhelming decorated type. This period includes the Glaze A through Glaze D types with Glaze E crossing over into the Historic period. Chupadero Black-on-white continues to be traded in from the south and Biscuit A and B come in from the north. The Indented Corrugated become more smeared and finish with a Rio Grande Plain smooth exterior surface. A micaceous utility ware also appears at this time.

The Historic period coincides with the Spanish colonization of New Mexico and finishes out the Rio Grande Glazeware series with the Glaze E and Glaze F types. The Historic matte-paint tradition emerges to replace the glazewares. Puname Polychrome is one of the earliest of the matte-paint wares and shows the typical polychrome combination of black, white, and red. The polished black and red wares, such as Kapo Black and Plain Red, also are common at this time.

RESEARCH OBJECTIVES AND METHODS

This analysis focused on answering three objectives. The first was to date the occupations. Site chronology was explored through the presence of diagnostic ceramics and their association with features that provided radiocarbon dates. The possibility of refining ceramic production dates through associations with the feature charcoal dates also was addressed. The second objective was to facilitate interpretation of activities and features at the sites by determining the vessel function of the associated ceramics. This involved examination of original vessel form (bowl, jar, etc.). Two of the collected sherds were rims, but only one was large enough for further investigation of vessel morphology. Surface treatment and location of decoration also were observed. No post-firing surface alterations were noted on the ceramics. Finally, intra-site comparisons of ceramics were done by site area, feature, and strata to look at activities and temporal components.

Attributes and Recording Methods

All of the collected ceramics for the CNM Rio Rancho data recovery come from LA 158640 and 158641. The attributes recorded in the laboratory include type; paste density and hardness; temper type, size, shape, and percent; surface color and quality; slip color and quality; and paint color and quality.

Some of the ceramic attributes, such as identification of aplastic inclusions, required use of a Cambridge Instruments binocular microscope of 10 to 70 magnification power. A 10x hand lens was used frequently for magnification in between the naked eye and the microscope. It was especially useful for looking at the paste and texturing. For the temper, predominate size was recorded following the grain size scale (Soil Survey Division Staff 1993) of very fine sand (0.05–0.10mm), fine sand (0.10–0.25mm), medium sand (0.25–0.50mm), coarse sand (0.50–1.00mm), and very coarse sand (1.00–2.00mm).

Only three rim sherds were collected, so there was not a significant sample size for rims. Two of the rims were under 2cm in length and therefore were not used to determine orifice diameter. The reconstructed Red Mesa Black-on-white bowl rim was measured and the vessel had an approximately 25cm maximum diameter.

Determination of original vessel form, i.e. bowl or jar, was based on surface finish and location of painted decoration (generally found on jar exteriors and bowl interiors). The assumption is that bowls have smoothed or polished interiors with poorly finished exteriors. Jars are the opposite with smoothed or polished exteriors and poorly finished interiors.

The surface sherd noted at LA 158642 is briefly discussed based on in-field documentation. The in-field examination was not detailed and the sherd could not be relocated during the data recovery phase. Tradition, ware, and type were noted, but it was not photographed. The sherd was consistent with the general type description for the Rio Grande grayware plain type.

Ceramic Type Descriptions

The ceramic types suggested by the initial recording work and the collected sherds are presented in this section. Specific type descriptions are presented for the identifiable decorated and utility wares. A general description of Cibola Whiteware is provided for the indeterminate whiteware ceramics.

Cibola Whiteware (AD 500–1200)

Cibola Whiteware is usually painted with mineral paint applied on white slip. Early Cibola Whiteware does not have a slip, however, and the paint is directly applied on the gray surface. They commonly have sand temper. The Late Cibola Whiteware can have a thick slip by the Pueblo III period and they tend to have crushed sherd or a sherd mixed with sand temper. The iron-based paint is the distinguishing element of this whiteware (Hays-Gilpin and van Hartesveldt 1998:67–70).

Red Mesa Black-on-White (AD 850–1125)

Red Mesa Black-on-white is commonly tempered with sherd and sand or sherd only. Its surfaces often have a thin slip with uneven polish, which gives the vessels a chalky feel. The mineral paint is black to dark brown and common design motifs include 2 to 4 mm-wide narrow lines associated with chevrons, solid triangles, interlocking scrolls, pendant dots, checkerboards, squiggle hachure, parallel hatch panel dividers or nets with fine line squares. The designs are often applied in very busy banded layouts with the rim top always painted with a solid line (Hays-Gilpin and van Hartesveldt 1998:67–70).

Rio Grande Glaze-on-Yellow (AD 1300–1490)

The glaze-on-yellow body sherds show general characteristics of Early to Middle Glazes (Glaze A–C). These glaze sherds have yellow washy slips with brown/black glaze. The glaze is not runny. The key to distinguishing early and middle glazewares is the quality of the glaze and the slip colors (McKenna and Miles 1991, Morales 1997).

Rio Grande Glaze C (AD 1450–1490)

Bowls and jars are common. Rims are slightly everted to recurved on the exterior with a bluntly to sharply rounded lip. Additionally, rims are thickened and short with the interior carina also thickened. Slips are off-white to light yellow on both bowl surfaces. Jars have red slips on the neck interior and the exterior below the shoulder and off-white slips between the shoulder and lip. Smoothed and polished but never lustrous. Completely polished on primary display surfaces. This type is well made with clear and bright colors. The glaze is brown to black and rarely runny (McKenna and Miles 1991, Morales 1997). The lustrous glaze on the light off-white slips and inwardly short beveled rims are the most important elements in identifying Glaze C sherds.

Wiyo Black-on-White (AD 1300–1400)

Forms include bowls, jars, ollas, canteens, and ladles with large bowls being the most common. The carbon paint is usually dark gray or black. The slip is thin and only applied to decorated surfaces; it is the same as the body clay ranging from gray to cream with a tendency toward olive green. Volcanic material temper is common, with some very fine sand and sherd also occurring. All decorated surfaces are polished to a silky feel (Dyer 2008, McKenna and Miles 1991). This type is part of the Tewa series.

Indented Corrugated (AD 1150–1450)

This term refers to Rio Grande grayware body sherds with indented corrugated texture on their exterior surfaces. Such a relief was produced by pressing corrugations with a fingernail or tool in a regular manner. The type is limited to jar forms with the entire exterior of the vessel showing indentation of the corrugations (Dyer 2008, McKenna and Miles 1991). Sand temper is common with crushed rock temper occurring rarely. Surface and paste color tends to be dark gray to black.

Rio Grande Plain (AD 1100–1600)

All jar forms – coiled and scraped with brownish-gray to brown color with some dark in color due to smudging or sooting. The coil joints are scraped smooth and obliterated. The sand temper may be visible. No polishing or slip is present (McKenna and Miles 1991). If it is a body sherd, it may be from a plainware jar or from a plain base of an indented corrugated jar.

CHRONOLOGY

Date ranges for ceramic types and radiocarbon results show a broad range in time for the three sites from the Rio Grande Developmental to Classic period. At LA 158640, the ceramics evidence two occupations, one during the Rio Grande Developmental based on the presence of Red Mesa Black-on-white, and the second during Classic period based on the Rio Grande glazewares (Glaze C rim). A Rio Grande Coalition/Classic occupation is suggested for LA 158641 through the presence of Wiyo Black-on-white, Indented Corrugated, and Rio Grande Plain. However, the radiocarbon date from Feature 4 at LA 158641 points to a Rio Grande Developmental/Coalition period use of the site. An explanation for this difference in dates between the ceramics and radiocarbon is presented below. The single ceramic (Rio Grande Plain) from LA 158642 spans the Rio Grande Developmental to Classic periods, but is more common in the Classic period (Boyd and Constan 2006, Wiseman 1980).

The Glazeware rim sherd from Study Unit (SU) 6 at LA 159640 is most typical of a Glaze C rim profile (Morales 1997:609-610). It is thickened high on the interior surface below the lip with a sharply rounded lip (Figure 12.1). Some confusion could arise with the rim profile of the rare Sanchez Glaze A with its low, everted rims. These rims are considered precursors to the Glaze C rim profile (Morales 1997:598-599). Based on the comparative Glazeware rim profile figures, the streaky slip, and the color and quality of the glaze paint, this rim sherd is most likely a Glaze C dating the occupational episode in SU 6 to the Rio Grande Classic period and more specifically to the late fifteenth century (McKenna and Miles 1991, Mera 1933, Morales 1997).

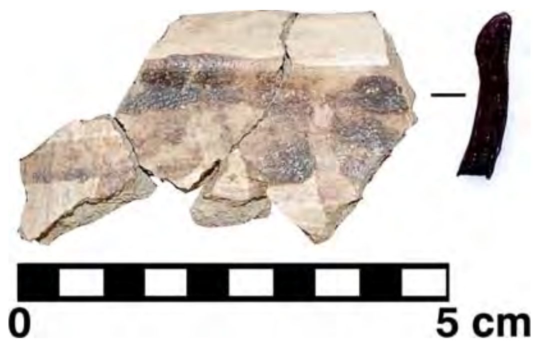


Figure 12.1. Rio Grande Glaze C rim sherd from Study Unit 6, LA 158640.

The only radiocarbon date from the CNM Rio Ranch sites that has directly associated ceramics is the date obtained from Feature 4 at LA 158641. Two ceramics were recovered from the fill of this structure – a Wiyo Black-on-white sherd, which dates between AD 1300–1400, and a Rio Grande Plain sherd, which dates from AD 1100–1600. The radiocarbon date from Feature 4 has a two sigma calibrated range of cal AD 1160–1270, which is within the date range for Rio Grande Plain but earlier than the accepted date range for Wiyo Black-on-white. However, several researchers (Dart 1980, Oakes 1979, Wiseman 1980) have noted the presence of a Santa Fe/Wiyo Black-on-white type in the Albuquerque district, and this could expand the ceramic type to AD 1200–1400. In addition, the Rio Grande Plain sherd may be from the base of a textured vessel. These factors may explain the radiocarbon date and point to a Rio Grande Coalition period assemblage, which is consistent with the Indented Corrugated ceramics also found at LA 158641.

CERAMIC VESSEL FUNCTION

Prudence Rice (1987) provides a thorough discussion of vessel function. As containers, ceramic vessels are used for storage, cooking, serving, and transport. Storage properties are affected by duration of storage, frequency of use of the contents, and the liquid or dry nature of the contents. Cooking requires efficient use of the heat from the fire or stones. Serving vessels tend to be open for ease of access or visibility of the food and may have fine finishes and decoration. Transport can be restricted by the weight of the vessel when it is full.

Functional categories for jars and bowls encompass storage vessels, cooking pots, food preparation without heat, serving, and transport containers (Rice 1987:Table 7.2). In the Southwest, jars function as storage vessels, cooking pots, and transport containers, while bowls generally are used for food preparation without heat and serving. *Storage vessels* tend to be restricted forms with orifices modified for pouring or closure. Handles for suspension or aid in tipping also occur. *Cooking pots* are rounded, conical, or globular with unrestricted orifices, and may have exterior sooting or blackening. *Transport containers* have restricted orifices and are uniform in size or multiple units of size, which facilitates stacking. They are generally lightweight and have handles. *Food preparation bowls* are unrestricted forms with simple shapes, which may show internal use wear. *Serving vessels* are unrestricted for easy access. They can have handles with flat bases or supports for stability.

Utility jars are the most common ware in ceramic assemblages in the Albuquerque district (Dart 1980). At Alameda Pueblo (LA 421), they are 28% of ceramic assemblage with most having a local sand temper, which suggests an emphasis on storage and cooking (Bargman 1997). No sooting was noted on any of the collected sherds from the CNM Rio Rancho data recovery, but this does not rule out cooking as a possible function for the jars. No modification was seen on the excavated ceramics, but fire clouding was documented on the exterior of a Red Mesa bowl sherd.

CERAMICS IN ARCHEOLOGICAL CONTEXT

Twenty-seven sherds were recovered from the excavations at LA 158640 and 158641. The surface and subsurface assemblages include similar types, although the excavations did add new types to both assemblages. The complement of types appears to fit with other recorded ceramic assemblages in the area, but low frequency tradewares, such as Chupadero Black-on-white, White Mountain Redwares, and Zuni glazewares, are absent.

Only one surfacial sherd was documented at LA 158642. Surface assemblages have been used for research since the 1970s (Lewarch and O’Brien 1981). Arid and semiarid environments lend themselves well to surface archaeology due to higher visibility. The assemblages from all three sites are discussed in this section.

LA 158640

The survey documentation for this site noted that there were three Rio Grande Glazeware body sherds on the surface, suggesting a Rio Grande Classic period occupation (Figure 12.2). A Developmental period occupation was subsequently discovered during data recovery based on the presence of Red Mesa Black-on-white sherds.

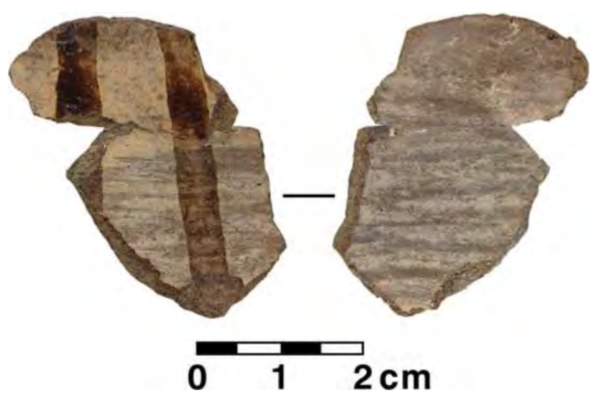


Figure 12.2. Rio Grande Glazeware body sherd from LA 158640.

A total of 22 sherds were collected during the excavations at LA 158640 (Table 12.2). All were found at two locations within Area 2. Excavations in Study Unit 6, at the southeastern edge of the site, recovered four Rio Grande glaze-on-yellow bowl body sherds and one Espinoso Glaze C bowl rim sherd. This assemblage includes the sherds observed on the surface by the survey crew. The sherds probably represent a single Rio Grande Glaze C bowl. No features were found in this area during the excavations.

Table 12.2. Ceramics From LA 158640, Area 2 by Study Unit.

Type	Study Unit 6	Study Unit 7	Total
Glaze-on-yellow	4	-	4
Glaze C	1	-	1
Red Mesa Black-on-white	-	13	13
Whiteware	-	4	4
Total	**5**	**17**	**22**

In Study Unit 7, nine Red Mesa Black-on-white bowl body sherds, two Red Mesa Black-on-white bowl rim sherds, and six general Cibola whiteware bowl body sherds were recovered. Based on the small number of sherds and limited types represented, it appears likely that the ceramics represent a single Red Mesa Black-on-white bowl. The excavations in SU 7 also uncovered an activity area with three features. Features 4 and 5 are hearths or a hearth and adjacent warming pit, while Feature 6 is a small pit with an ashy fill. Although most of the sherds were clustered near Feature 5, none are directly associated with the features, which is appropriate for serving vessels.

The Red Mesa Black-on-white bowl rim sherd was measured to approximate vessel size (Figure 12.3). The maximum rim diameter is 25 cm with an estimated vessel height of 8 cm. To investigate the design motif on the sherd, Red Mesa Black-on-white bowls in the Maxwell Museum of Anthropology whole vessel collection were examined. One of the bowls from a donated collection originating in the Jeddito, Arizona area has a similar pattern (Figure 12.4). The Maxwell Museum bowl (85.45.5) has a geometric design covering the entire area of the interior. The layout has four-fold rotational symmetry around a center point. This is a finite design with linear, squiggle hatching, solid triangles, and pendent dots elements. The design on the large Red Mesa sherd shows use of similar elements and probably had a four-fold rotational layout (Figure 12.3).

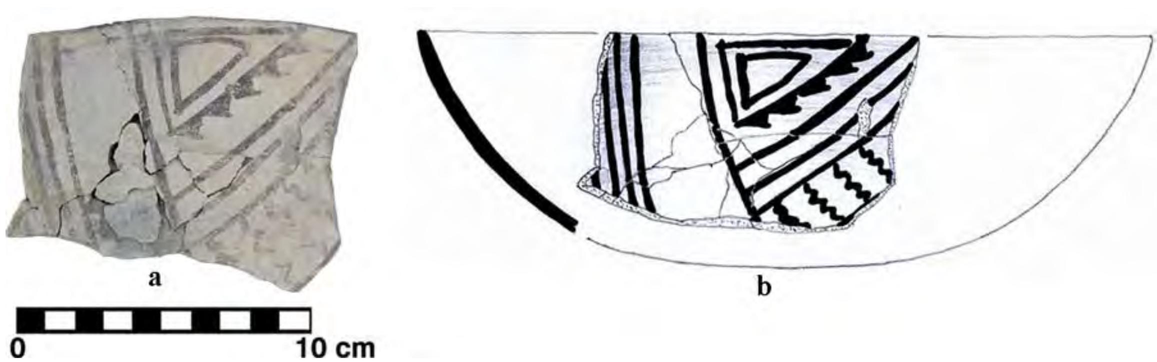


Figure 12.3. Red Mesa Black-on-White rim sherd from Study Unit 7 at LA 158640 (a) and reconstruction of vessel form and diameter (b).

Figure 12.4. Red Mesa Black-on-White bowl from Maxwell Museum collection showing designs similar to the Red Mesa Black-on-White bowl from LA 158640.

LA 158641

When LA 158641 was first recorded, the survey crew found two Indented Corrugated jar body sherds on the surface. Subsequent excavations produced another utility ware and bichrome whitewares. The final assemblage consists of five sherds – two Indented Corrugated, one Rio Grande Plain, one Wiyo Black-on-white, and one indeterminate black-on-white sherd (Table 12.3; Figure 12.5).

Table 12.3. Ceramic Types from LA 158641 by Recovery Context.

Type	Surface	Test Unit	Feature 4	Total
Indented Corrugated	1	1	-	2
Rio Grande Plain	-	-	1	1
Wiyo Black-on-white	-	-	1	1
Indeterminate bichrome	-	1	-	1
Total	**1**	**2**	**2**	**5**

Figure 12.5. Ceramics from LA 158641: (a) indented corrugated, (b) Rio Grande Plain, and (c) Santa Fe/Wiyo Black-on-white.

One of the indented corrugated sherds was recovered from the test unit at N105 E100; the other was collected from the surface a few meters to the south of that test unit. These are almost certainly the sherds recorded by the survey crew. The indeterminate bichrome is a very small sherd with caliche deposits and could not be further differentiated. It was recovered from the test unit at N95 E95. The Wiyo Black-on-white and Rio Grande Plain sherds were found in the fill of Feature 4, which appears to be a small structure. These two types do co-occur in the area. Given the radiocarbon date from Feature 4, it is likely that the decorated ceramic is a Santa Fe/Wiyo, and that the utility sherd is from the base of a textured vessel (probably Indented Corrugated). This suggests a Rio Grande Coalition period occupation.

At a minimum, the sherds from LA 158641 could represent two vessels. A Wiyo Black-on-white bowl may have included the indeterminate bichrome sherd. Similarly, the Rio Grande Plain sherd could be from the base of an Indented Corrugated jar. The indented corrugated sherds were found 10-13 m north northwest of Feature 4, however, and the indeterminate bichrome sherd was recovered from a test unit about 10 m west northwest of the structure. Erosion and bioturbation may have scattered the assemblage, or the sherds may be from more than two vessels. In any case, the presence of both bowl and jar forms at the site may indicate that combined cooking and serving occurred at this location.

LA 158642

One Rio Grande grayware utility body sherd was found on the surface in Area 1 along the north-central edge of the site. There was no texturing on the surface of the ceramic, which fits the Rio Grande Plain type. Plain ceramics have a scraped and smoothed surface generally with a coarse brownish paste. They tend to be sand tempered. The presence of the Rio Grande grayware sherd points to a transitional Coalition/Classic period occupation.

DISCUSSION

One of the complicating issues for this project with respect to ceramics is the conflation of pottery from multiple time periods into a single occupation stratum. This is a factor of the geomorphology found on Ceja Mesa. Fortunately, temporally diagnostic sherds were present at the sites with subsurface deposits.

The research questions addressed in this investigation looked at features based on vessel function of the associated ceramics, site chronology through associated diagnostic ceramics and radiocarbon dates, and intra-site differences in activities and temporal components. Only one feature, a probable structure, had associated ceramics, sherds of Wiyo Black-on-white and Rio Grande Plain. Neither showed evidence of sooting, but the utility ware was coated in caliche. The decorated bowl may have been used for serving while the plain jar could have been for either cooking or storage.

The two sites are on the West Mesa in Rio Rancho, New Mexico. Most prehistoric sites in the vicinity are either aceramic Archaic camps for seasonal procurement of plants and animals or Ancestral Puebloan agricultural field locations. The agricultural field sites seem to have temporary ramada-like structures and modest lithic and ceramic scatters associated with thermal features. As for larger sites close to the CNM Rio Rancho project, Alameda Pueblo (LA 421) and Bandelier's Puaray (LA 326) are two examples with excavation work (Brown 1997, Schaafsma 1968).

No distant tradeware ceramics were found during the CNM Rio Rancho excavations, although Rio Grande Glaze C was primarily produced at Tunque Pueblo in the Galisteo Basin (Morales 1997). The small assemblage size does not lend itself to the inclusion of low frequency tradewares, such as Chupadero Black-on-white, White Mountain Redwares, or Zuni glazewares. Micaceous utility wares also are absent from these assemblages.

All the diagnostic ceramics, which consist of Red Mesa Black-on-white, Wiyo Black-on-white, and Rio Grande Glaze C, are emblematic of different timeframes. The Red Mesa Black-on-white is typical of the later Developmental period. The Wiyo Black-on-white, which shows elements of the Santa Fe/Wiyo variant documented in the Albuquerque district, is distinctive of a Coalition occupation. The Classic period is represented by the Rio Grande Glaze C rim sherd. These three types span the pre-Hispanic occupation of the Northern Rio Grande.

At all three sites, the features and proximity to swales that are useful for agricultural fields suggest temporary camps associated with farming activities. Based on the overall assemblage and the diagnostic ceramics there were at least two uses of LA 158640, one during the Rio Grande Developmental and one during the Classic period, and a single use of LA 158641 in the Coalition period. The single sherd from LA 158642 is indicative of the Classic period, but is not enough evidence to limit the number of uses of this site. The pottery does not indicate differences in function of areas across the site.

Based on the assemblages from Alameda Pueblo (Brown 1997), work on the east side of the Sandia Mountains (Cordell 1977, Dart 1980, Oakes 1979, Wiseman 1980), and the ceramics from the three sites analyzed here, the CNM Rio Rancho project falls in line with characteristic pottery from the Rio Grande Developmental through Classic periods. The Historic period is present in the Albuquerque area, but was not represented at these sites. This may be due to modification of field location associated with the Spanish congregación policy (Jackson 1994) and Navajo raiding (Reeve 1957).

Chapter 13

FAUNAL REMAINS FROM TWO SITES AT THE CNM RIO RANCHO CAMPUS

by Robin M. Cordero

Faunal remains were recovered from two sites in the CNM Rio Rancho project area: LA 160886 and LA 158642. At LA 160886, only two bones were recovered, a small mammal tibia shaft fragment and a small mammal femur shaft fragment. Both specimens appear to be modern intrusions and will not be treated further in this chapter. From LA 58642, faunal remains were recovered from two primary contexts. The first context is from Feature 3 (Area 2, SU1), a concentration of charcoal and burnt bone in a 40 cm diameter area. An estimated 1,000 pieces of burned bone were recovered from Feature 3, which is late Historical or Modern in age. The remaining faunal remains were recovered almost entirely from SU 2 (26 bone/eggshell, 58 terrestrial snail) and are associated with the Archaic component at LA 158642.

METHODS

All remains were identified by the author to the lowest taxonomic level (i.e. family, genus or species), or size class (i.e. small bird, large mammal) using reference collections maintained at OCA. Element, portion, and side identifications were made by the author based on previous experience and, when necessary, through comparisons with reference collections. For terrestrial snails, Metcalf and Smartt's (1997) volume *Land Snails of New Mexico* was consulted. Given the immature nature of all snail shells recovered, all identifications should be considered tentative (i.e., c.f. or "compares favorably"). Quantities of bone are presented as Number of Identified Specimen (NISP). NISP, as defined here, is the number of specimens identified to a specific taxa or taxonomic category. This unit of quantification is useful in describing the faunal assemblage, but becomes problematic when performing more detailed analyses. These problems have been discussed in the general zooarchaeological literature *ad nauseam*, and these arguments are beyond the scope of this analysis. Given the small sample sizes, NISP are more than adequate for describing the assemblage.

RESULTS

Table 13.1 presents the results of the faunal identifications not including Feature 3. Feature 3, a historic thermal feature, consists of ca. 1000 individual bone fragments, all calcined, with the vast majority of fragments being under 1 cm in length. The few identifiable fragments (*n*=12) appear to be from a *Bos/Bison* (cow/bison) radius and humerus. The degree of exfoliation and surface disintegration of these remains suggests the bones were heavily weathered prior to calcination. The uniformity in which the bone was calcined further indicates there was no flesh on the bones during the heating process.

The remaining faunal assemblage contains a number of small mammal longbone shaft fragments, including several from thermal feature contexts. Roughly one-third of these fragments are burned to varying degrees. The terrestrial snail assemblage reflects three common taxonomic groups in New Mexico. All snails recovered during the excavations were immature individuals rendering taxonomic identification difficult and species identification impossible.

Table 13.1. Faunal Identifications from LA 158642 (not including Feature 3).

FS No.	Area	Study Unit	Feature	Taxa (Snails)	Taxa & Element (Vertebrates)
35	2	2	2	Succenidae (2)	small mammal longbone frag (1), burned indeterminate mammal bone (1)
36	2	2	2	Succenidae (5), *Holospira* sp. (7), *Rabdotus* sp. (2)	burned small mammal LB fragment (5)
37	2	2	5	Succenidae (6), *Holospira* sp. (2)	small mammal longbone frag (1), calcined indeterminate mammal bone (1)
41	2	2	6	Succenidae (5), *Holospira* sp. (4)	
45	2	2			indeterminate bone fragment
70	2	2			eggshell (1)
74	2	2		unidentified shell fragment	
78	2	2	10	Succenidae (3), *Holospira* sp. (2)	
79	2	2	11	Succenidae (3), *Holospira* sp. (2)	small mammal longbone shaft fragment (2)
80	2	2			calcined small mammal longbone shaft fragment (7)
81	2	2			calcined small mammal longbone shaft fragment (1)
86	2	2			Sylvilagus sp. molar (1)
94	2	2		Succenidae (2), *Holospira* sp. (5)	
96	2	2		Succenidae (2), *Holospira* sp. (1)	small rodent thoracic vert. (1), small rodent molar fragment (2)
97	2	1			calcined medium rodent tibia shaft (1) and femur shaft (1)
97/98	2	1 or 2			small rodent caudal vert. (1)
99	2	2	5	*Holospira* sp. (5)	
101					rodent rib vertebral portion (modern)
112					rodent longbone shaft fragment (acid polished, modern)

DISCUSSION

The abundance of burned bone from Feature 3 likely does not reflect subsistence use of *Bos/Bison*. Rather, the uniform calcination and surface exfoliation would appear to indicate the bone was devoid of soft tissue and weathered prior to being burned. That the remains could be assigned to only two elements further suggests a single limb was discarded into the fire, possibly for use as fuel.

The presence of multiple small mammal long-bone fragments and absence of larger mammal remains suggests a greater emphasis on small game in the Archaic diet. However, many of these remains may reflect incidental burning, in which case the dominance of small mammal remains in this assemblage reflects the abundance of small mammal bones on the landscape. Given the limited assemblage, it is not possible to adequately address either interpretation or any other alternate interpretation. The large number of immature terrestrial snails recovered from this site is unusual given their near absence at excavated sites in the surrounding area. However, this could reflect the extensive flotation sampling strategy employed at LA 156842. As no adequate comparative data are available from the surrounding area, and species identifications were not possible, interpretations of these terrestrial snail data are limited.

Chapter 14

MACROBOTANICAL REMAINS

by Pamela J. McBride

Plant remains were examined from 23 flotation samples taken from 17 features and two isolated occurrences at three sites situated on the proposed CNM Rio Rancho campus. Eleven vegetal samples from selected features were also submitted for identification prior to submittal of the samples for radiocarbon dating. The sites include a Middle-Late Archaic campsite with seven thermal features, a midden, and a possible structure at LA 158642, an Early Developmental (Basketmaker) period component with two features and a Late Developmental (Pueblo II) camp with three with three features at LA 158640, and a shallow structure with three extramural features dating to the Coalition period at LA 158641.

Vegetation in the project area is typical of Plains Grassland (Brown 1994) that has been overgrazed where snakeweed *(Gutierrezia sarothrae*) is the most conspicuous plant on the landscape. Juniper (*Juniperus monosperma*), soapweed yucca (*Yucca glauca*), rabbitbrush (*Ericameria nauseosa*), Russian thistle (*Salsola kali*), four-wing saltbush (*Atriplex canescens*), prickly pear cactus (*Platyopuntia* spp.), and cholla (*Cylindropuntia* sp.) appear sporadically, while the most common grasses are ricegrass (*Achnatherum hymenoides*), grama (*Bouteloua* spp.), sand dropseed (*Sporobolus cryptandrus*), and galleta grass (*Pleuraphis* spp.).

METHODS

Archaeobotanical analysis of material from the project involved flotation processing, full-sort analysis, and quantification as described below. Identification was aided by the use of a modern comparative collection and comparison to photographs in seed identification manuals (Martin and Barkley 1961 and Delorit 1970). Scientific nomenclature and common names followed those presented in Martin and Hutchins (1980). Identifications were made to different taxonomic levels: subclass (monocotyledonae), families (e.g., Chenopodiaceae), genus (e.g., *Cylindropuntia*), and artificial categories (e.g., cheno-am). The cheno-am category refers to seeds that could be either in the genus *Chenopodium* spp. or *Amaranthus* spp. This category is used when the condition of a seed prohibits a more specific identification. Plant remains designated as “indeterminate” are unidentifiable due to erosion or fragmentation.

The Latin and common name, plant part, and plant category (annuals, perennials, etc.) of all charred plants recovered from the project are listed in Table 14.1. For ease of reporting, taxa in all other tables except the comparative tables are recorded using the common name only. Taxa in comparative tables are recorded using the Latin name only to avoid confusion where more than one common name is in general use.

Flotation Processing

The 23 flotation samples were processed by Office of Contract Archaeology personnel using a standard decant flotation system as described by Hammett and McBride (1993). Soil samples ranged from 1.0 to 142.95 liters in volume. Each flotation sample was poured into a bucket of water, agitated gently until the botanical material floated to the surface, and then decanted onto a clean piece of chiffon material to dry.

Table 14.1. Charred Plant Taxa Recovered from Flotation and Vegetal Samples at LA 158640,LA 158641, and LA 158642.

Scientific Name	Common Name	Plant Part
Annuals		
Chenopodium	Goosefoot	Seed
Chenopodium/Amaranthus	Cheno-am	Seed
Portulaca	Purslane	Seed
	Other	
Chenopodiaceae	Goosefoot family	Seed
Monocotyledonae	Monocot	Stem
Physalis	Groundcherry	Seed
-	Indeterminate	Seed, unknown plant part
	Perennials	
Artemisia	Sagebrush	Wood
Atriplex/Sarcobatus	Saltbush/greasewood	Wood
Cylindropuntia	Cholla	Seed
cf. *Cylindropuntia*	Cholla	Embryo, seed, wood
Juniperus	Juniper	♀ cone, seed, wood
Opuntia	Cholla/ prickly pear cactus	Embryo
Pinus	Pine	Wood
Pinus edulis	Piñon	Wood
cf. *PlatyOpuntia*	Prickly pear cactus	Embryo
-	Unknown conifer	Seed
-	Unknown non-conifer	Wood

cf. compares favorably.

The residue at the bottom of the bucket (called the heavy fraction) was rinsed to eliminate soil matrix, dried, and examined in order to recover lithic, ceramic, and bone artifacts.

Modified Scan/Charcoal Analysis

The floated material was passed through a series of graduated screens (U.S. Standard Sieves with 4mm, 2mm, 1mm, and .5mm mesh sizes). The material from each screen size was then examined using a binocular microscope at a magnification of 7x to 45x. Two samples from large roasting pits at LA 158640 (FS 94 and FS 96) were too large to completely analyze, so five of the 15 bags of floated material from FS 94 were examined and six of the 23 bags from FS 96 were analyzed.

Charred plant material found during a standard scan analysis is usually quantified as an estimate of abundance/sample. During this analysis, by request, charred reproductive plant parts like seeds were identified and counted, while charred non-reproductive plant parts (stems) were identified and quantified as an estimate of abundance/sample. Uncharred plant parts were noted, but not quantified.

If more than 20 pieces of wood charcoal were present in a sample, then 20 pieces (selected randomly from the 4mm and 2mm screens) were identified, separated by taxon, counted, and weighed. Then the remainder of each fraction was scanned to identify any taxa that might have been missed. Otherwise, all identifiable wood charcoal from a sample was analyzed.

One problem that arises consistently during wood identification in the Southwest was solved by placing specimens of the Chenopodiaceae (goosefoot) family into a more general category. Several species of shrubs in the goosefoot family are impossible to distinguish from each other – four-wing saltbush (Atriplex *canescens)*, greasewood (*Sarcobatus* sp.), winterfat (*Krascheninnikovia lanata)*, and others. For this reason, identification to species is impossible and specimens were placed in the combined saltbush/greasewood taxon.

Quantification

Two forms of quantification were used during flotation analysis: abundance and minimum number of individuals (MNIs). Each of these is described below.

Abundance

To determine the approximate abundance of non-reproductive plant parts in a sample, an estimate of the number of these materials per sample was recorded. This allows for an estimation of burned taxa represented solely by non-reproductive plant parts.

Absolute Counts and MNIs

During the modified scan analysis, absolute counts and minimum number of individuals (MNI) were recorded for charred seeds and indeterminate plant parts. The absolute count includes fragments as well as whole plant parts. The MNI count was used effectively by Hammett and McBride (1993) on the Transwestern Pipeline Project. This is a quantification measure borrowed from faunal analysts and osteologists, which allows the archaeobotanist to clearly distinguish between the presence of whole or fragmented remains when reporting results. In tables, there are two numbers for reproductive or indeterminate plant parts. The first number is the total number including fragments encountered in a sample, while the number in parentheses represents the MNI value. An MNI value of 1 was given to a seed or plant part if more than one half of that unit was present.

All wood and burned plant parts that were identified from each sample were placed in polypropylene capsules or plastic bags and labeled for future reference. Roots and insect parts were observed in every sample during flotation analysis and rodent feces were noted in three samples, providing evidence for three sources of disturbance. Sample volumes (before flotation) and sample weights (after flotation) are recorded in Table 14.2 along with comments concerning absence of charred plant remains and presence of rodent feces and bone.

RESULTS OF FLOTATION ANALYSIS

The majority of plant material observed in flotation samples consisted of uncharred grass (ricegrass, *Achnatherum hymenoides;* dropseed grass, *Sporobolus* spp.*)*, weedy seeds like goosefoot (*Chenopodium* spp.) and purslane (*Portulaca* spp.), a few hedgehog cactus (*Echinocereus* sp.) seeds, and other plants that thrive in disturbed habitats like globemallow (*Sphaeralcea* spp.), doveweed (*Croton* sp.), and hidden flower (*Cryptantha* sp.). Various studies have addressed the origins and difficulty of interpreting uncharred plant remains found in open-air sites (Minnis 1981; Keepax 1977). Therefore, uncharred remains were considered to be more of a representation of the local vegetation than a reflection of cultural activities. Indeed, unburned taxa recovered in flotation samples commonly occur in the Plains Grassland biotic community (Brown 1994) where the sites are located, indicating deposition by insects, wind, or water.

Table 14.2. LA 158640, LA 158641, and LA 158642, Flotation Sample Summary Information.

Site	FS No.	Feature No.	Sample Volume (liters)	Sample Weight (grams)	Comments
158640	63	Mixed Stratum I/II, Study Unit 4	1.0	8.4	Rodent feces; unburned only
	94	2	77.0	57.5	5 of 15 bags analyzed; unburned only
	96	3	142.95	203.2	6 of 23 bags analyzed; rodent feces; unburned only
	97	4	9.25	19.8	
	98	5	?	27.7	
	99	6	5.25	8.4	
158641	25	1	4.0	9.1	Unburned only
	29	IO 29	1.8	21.2	Unburned only
	30	IO 30	2.0	7.0	Unburned only
	33	2	10.9	50.6	
	34	3	45.25	148.3	
	35	4	28.1	150.1	
	36	4	12.0	42.9	Unburned only
	37	5	5.7	21.7	
158642	34	4	7.05	15.9	
	35	2	51.65	102.6	1 bone
	36	2	47.95	80.6	1 lithic
	37	5	25.0	53.5	
	40	7	9.8	19.6	
	41	6	2.64	13.1	
	61	-	3.5	1.7	No plant remains
	78	10	19.4	27.3	
	79	11	65.5	71.8	Rodent feces

LA 158640

Bulk soil samples for flotation were taken from five features at LA 158640. Features 2 and 3 are roasting pits associated with the Basketmaker component at the site, while Features 4, 5, and 6 are related to the Pueblo II occupation. Flotation plant remains from these thermal features were restricted to two indeterminate plant part fragments from Features 4 and 5, a plant part fragment that resembles a cholla embryo from Feature 4, and a cholla seed from Feature 6 (Table 14.3). Juniper was the most common wood charcoal taxon encountered in flotation samples; cholla wood was identified in the two roasting pits (Features 2 and 3) and a trace from a mixed stratum I/II sample from the use surface surrounding Feature 2 in SU (Table 14.4). In contrast, vegetal wood samples examined from the Feature 2 hearth were entirely juniper (Table 14.5).

Table 14.3. LA 158640 and LA 158641, Flotation Scan Charred Plant Remains.

Site	158640			158641			
Context	Feature 4 Hearth	Feature 5 Ash Pit or Hearth	Feature 6 Ash Pit/ Thermal Feature	Feature 2 XM Hearth/ Ash Dump	Feature 3 XM Hearth/ Ash Dump	Feature 4 Shallow structure	Feature 5 XM Hearth/ Ash Dump
FS No.	97	98	99	33	34	35	37
Annuals: Goosefoot							1(1)
Purslane					1(1)		
Other: Indeterminate	1(0) pp	1(0) pp		1(0)		6(0) pp	2(0) pp
Perennials: cf. Cholla	1(0) embryo						
Cholla			1(1)				
Juniper				1(1)	3(2)		1(1)

Plant remains are seeds unless indicated otherwise.
Seeds and non-woody plant parts are recorded by count and (minimum number of individuals).
+ 1-10/sample, cf. compares favorably, pc partially charred, pp plant part.

Table 14.4. LA 158640 Flotation Wood Taxa, by Count and Weight in Grams.

Context	Mixed Stratum I/II, Study Unit 4	Feature 2 Roasting Pit	Feature 3 Roasting Pit	Feature 4 Hearth	Feature 5 Ash Pit or Hearth	Feature 6 Ash Pit/Thermal Feature
FS No.	63	94	96	97	98	99
Conifers: Juniper	2/<0.1 g	18/0.6 g	21/0.3 g	6/0.1 g	42/0.6 g	3/<0.1 g
Non-Conifers: cf. Cholla	1/<0.1 g	2/0.1 g	10/0.1 g			
Total Wood	3/<0.1 g	20/0.7 g	31/0.4 g	6/0.1 g	42/0.6 g	3/<0.1 g

LA 158641

The shallow structure at LA 158641 yielded several indeterminate plant part fragments while three extramural thermal features, in addition to more indeterminate plant parts, produced juniper, purslane, and goosefoot seeds (Table 14.3). The flotation wood assemblage was quite different than that from LA 158640. Although juniper was recovered from the six samples with wood remains, cf. cholla and saltbush/greasewood charcoal was also present in every sample (Table 14.6). In addition, a fragment of cf. sagebrush was found in the Feature 2 thermal feature. The one vegetal sample that was submitted for analysis was entirely juniper (Table 14.5).

Table 14.5. LA 158640, LA 158641, and LA 158642, Vegetal Plant Remains, by Count and Weight in Grams.

Site	**158640**		**158641**	**158642**		
Context	Feature 2 Roasting Pit		Feature 4 Shallow Structure	Feature 1 Eroded Hearth, E. Developmental	Feature 2 Roasting pit	
FS No.	94	112	31	93	35	36
Wood **Conifers:** Juniper	40/6.1 g	1/<0.1 g	16/2.7 g	22/3.1 g	23/0.4 g	17/1.5 g
Non-Conifers: cf. Cholla				3/0.7 g		
Sagebrush				6/0.6 g		
Saltbush/ greasewood				2/0.1 g		
Other cf. Cholla seed				3(0)/<0.1 g	1(0)/<0.1 g	
Cholla/Prickly pear embryo				1(1)/<0.1 g		
Juniper seed					13(0)/<0.1g	54(1)/0.1 g
cf. Prickly pear embryo				1(0)/<0.1 g		
Indeterminate seed					1(0)/<0.1 g	3(0)/<0.1 g
Total Wood	40/6.1 g	1/<0.1 g	16/2.7 g	33/4.5 g	23/0.4 g	17/1.5 g

Site	**LA 158642**					**Totals**	
Context	Feature 5 Possible Structure	Study Unit 1, Fill Around Feature 3 Hearth, Historic/Modern					
FS No.	90	27	28	29	30	Weight	%
Wood **Conifers:** Juniper	42/5.1 g	8/0.4 g	68/2.0 g	6/0.1		21.4 g	87%
Pine				6/0.1 g		0.1 g	<1%
Piñon					8/0.2 g	0.2 g	1%
Unknown conifer					6/0.2 g	0.2 g	1%
Non-Conifers: cf. Cholla						0.7 g	3%
Sagebrush			15/1.1 g			1.7 g	7%
Saltbush/ greasewood			4/0.2 g			0.3 g	1%
Total Wood	42/5.1 g	8/0.4 g	87/3.3 g	12/0.2 g	14/0.4 g	24.6 g	100%

Seeds and non-woody plant parts are recorded by count and (minimum number of individuals).
cf. compares favorably.

LA 158642

LA 158642 has three spatially-separated temporal components. The focus of the excavations was the Middle-Late Archaic component in the west-central part of the site, and all of the flotation samples from the site were from features associated with that occupation. The second component consists of a hearth (Feature 1) dating to the Early Developmental period that was exposed in the arroyo wall at the northern edge of the site. A vegetal sample from this hearth was submitted for analysis. The third component is a hearth (Feature 3), which was dated to the historic/modern period. Four vegetal samples from SU 1, the excavation unit encompassing Feature 3, also were submitted for analysis.

Table 14.6. LA 158641 Flotation Wood Taxa, by Count and Weight in Grams.

Context	Feature 1 Redeposited Cultural Fill	Feature 2 XM Hearth/ Ash Dump	Feature 3 XM Hearth/ Ash Dump	Feature 4 Shallow Structure		Feature 5 XM Hearth/ Ash Dump
FS No.	25	33	34	35	36	37
Conifers: Juniper	5/<0.1 g	4/<0.1 g	4/<0.1 g	86/5.2 g		3/0.1 g
Non-Conifers: cf. Cholla	4/<0.1 g	2/<0.1 g	2/0.1 g	40/0.9 g	14/0.2 g	2/<0.1 g
cf. Sagebrush		1/<0.1 g				
Saltbush/ greasewood	2/<0.1 g	13/0.8 g	14/1.1 g	21/0.4 g	7/0.2 g	15/0.4 g
Total Wood	11/<0.1 g	20/0.8 g	20/1.2 g	147/6.5 g	21/0.4 g	20/0.5 g

Recovery of carbonized plant material was considerably more successful at LA 158642 than at the other sites investigated during the project. Juniper remains were the most abundant, consisting of female cones (or berries) and, especially from Feature 11, a significant number of seeds (Table 14.7). Cholla seeds were also identified in the Feature 11 sample as well as goosefoot seeds. Seeds and embryos that resemble cholla were found in the Feature 2 roasting pit and the Feature 10 ash pit. Goosefoot seeds were also recovered from Feature 10 and Feature 4. Groundcherry seeds from the Feature 8 thermal pit were the only specimens of this taxon recovered from project flotation samples. The flotation wood assemblage was the most limited in taxa diversity of project assemblages, consisting of juniper and one fragment of unknown non-conifer (Table 14.8). The vegetal samples (Table 14.5), however, yielded a diverse array of wood taxa from the Early Developmental hearth (Feature 1) and from the excavation area (SU 1) surrounding the historical/modern hearth (Feature 3). In addition to juniper, taxa from Feature 1 included cf. cholla, sagebrush, and saltbush/greasewood. Cf. cholla seed fragments and embryos, which could be either cholla or prickly pear, were also identified in the sample from Feature 1. The samples from SU 1 included pine, piñon, and unknown conifer along with juniper, saltbush/greasewood, and sagebrush. The presence of pine, piñon, and unknown conifer wood this sample is unusual but, given the recent age of the occupation, it could represent fuelwood transported into the area by vehicle. Finally, the vegetal sample from the Archaic roasting pit (Feature 2) included numerous juniper seeds, one cf. cholla seed, and unidentifiable seed fragments as well as juniper wood.

DISCUSSION

The varying ages of the occupations investigated for this project offer an opportunity to look at subsistence over a time span extending from the Middle-Late Archaic through the Coalition period. Weedy annual seeds like those found at LA 158641 and LA 158642 have been recovered at archaeological sites from every region in New Mexico from all time periods. The tender young leaves of goosefoot were cooked as a potherb as were those of pigweed and purslane (Harrington 1967:57, 71, 87). The seeds were ground or parched and then used to make cakes or mush (Castetter 1935:23; Harrington 1967:89). Groundcherry fruits were crushed and used as a condiment by the Zuni (Castetter 1935:39) and after the Spanish brought onions, coriander, and chile, the fruits were ground in a mortar with the other ingredients to make a salsa (Stevenson 1993:36).

Table 14.7. LA 158642 Flotation Scan Charred Plant Remains.

Site	**LA 158642**							
Context	Feature 2 Roasting pit		Feature 4 Small Hearth	Feature 5 Possible Structure	Feature 7 Small Hearth	Feature 8 Small Hearth	Feature 10 Ash Pit	Feature 11 Hearth
FS No.	35	36	34	37	41	44	78	79
Annuals: Cheno-am							2(0)	
Goosefoot			9(4)				6(6)	1(1)
Other: Goosefoot family					1(1)			
cf. Groundcherry						2(1)		
cf. Monocot stem			+					
Indeterminate	1(1)		2(0)		1(0) pp	2(1) pp	3(0)	2(0) pp
Perennials: cf. Cholla		4(3) embryo, 1(0)					3(0)	
Cholla								1(0), 1(1) pc
Juniper	14(8)/0.1 g, cf. 11(0) ♀ cone/0.1 g	17(9)/0.1 g, 14(0) ♀ cone/0.1 g	5(0)	1(1)			8(4), 6(1) ♀ cone	59(41), 7(0) ♀ cone

Plant remains are seeds unless indicated otherwise.
Seeds and non-woody plant parts are recorded by count and (minimum number of individuals).
+ 1-10/sample, cf. compares favorably, pc partially charred, pp plant part.

Table 14.8. LA 158642 Flotation Wood Taxa, by Count and Weight in Grams.

Context	Feature 6 E, W ½ 's Hearth/ Ash Pit	Feature 7 Bell-Shaped Bottom Thermal Pit	Feature 8 Bell-Shaped Bottom Thermal Pit	Feature 10 Ash Pit	Feature 11 Bell-Shaped Bottom Thermal Pit
FS No.	41	40	44	78	79
Conifers: Juniper	5/<0.1 g	19/0.4	7/0.1 g	20/0.3 g	20/0.5 g
Non-Conifers: Unknown non-conifer		1/<0.1 g			
Total Wood	5/<0.1 g	20/0.4 g	7/0.1 g	20/0.3 g	20/0.5 g

cf. compares favorably.

Whether the juniper seeds recovered from LA 158641 and LA 158642 represent residue from preparing the resinous cones (commonly called berries) for food or from burning branches for fuel is not possible to determine. Although the mealy cones containing the seeds of the juniper were mixed with chopped meat, put into a clean deer stomach, and roasted by the Acoma and Laguna, they were more generally eaten fresh or cooked in the fall, used as an emergency food, or for seasoning meats (Castetter 1935:31). On the other hand, the fleshy cones can still be attached to branches and burn along with the wood and inadvertently become part of the record.

The presence of cholla seeds implies that the fruits were processed for food. Castetter (1935) documents that the Pima would gather the fruits of another species of cane cactus (*C. arborescens*) and roast them in a pit in a manner similar to the way in which agave hearts are prepared. Stones are heated on a fire in the bottom of a pit and as the fire dies down, the stones are taken away and a layer of herbaceous plants are placed on the embers, followed by a layer of cactus fruits, and then covered with a layer of hot stones. This layering process is repeated until the pit is filled whereupon the whole is covered with a final layer of herbaceous plants and then dirt. The fruits are then baked overnight. In the morning they are lifted out and laid out to dry, the spines are removed by stirring them with sticks in the sand, and then they are ready for storage. This is the kind of cholla fruit processing that could have occurred at all three sites, but particularly in the Archaic period roasting pit at LA 158642, where most of the cholla seeds were found.

Wood use, except for the aforementioned historic assemblage, focused on the use of locally available trees and shrubs. The present vegetation reflects the encroachment from housing developments and other construction activities and the introduction of exotic species into the landscape. The dominance of juniper in the charcoal record suggests that either juniper was more prevalent in the immediate prehistoric site environs or inhabitants travelled some distance to gather wood. From previous research on the Colorado Plateau, where we can look at thousands of samples from diverse habitats and time periods from Archaic to contemporary, it is evident that hunter-gatherers tend to limit wood collection to within a very close radius to their campsite. While hunter-gatherers living in the lower elevational reaches of juniper-piñon woodland may burn coniferous woods, those living in desert-scrub grassland have fuel assemblages consisting almost entirely of local shrubs, primarily saltbush, sage, and rabbitbrush (Toll 1983:336). Today, these three shrubs grow in the CNM project area and, if juniper was as scarce as it is today, then the majority of the wood assemblage would presumably have consisted of local shrubs rather than juniper. It therefore seems logical to assume that juniper was more abundant in the prehistoric environment than it is today.

Plant remains from sites in the middle Rio Grande Valley and the lower Jemez Valley are compared with the CNM Rio Rancho assemblage in Table 14.9. Sites dating to the Developmental and Coalition periods in the Albuquerque area are scarce or non-existent, so Developmental sites in the lower Jemez Valley were used for comparison along with River's Edge, the one Developmental site situated along the Rio Grande River. A Coalition period site (LA 110953) was excavated in the lower Jemez Valley, but deposits were mixed with historic material, so those data were not used for comparison here.

Sites or projects with the greatest taxa diversity either had the largest number of analyzed samples with charred remains (Unser Blvd. Phase II, Ceja Mesa, other Ceja Mesa sites) or were habitation sites with substantial architectural features (LA 99529, LA 25862, and River's Edge sites). A continuum of use of three taxa is indicated. Goosefoot and juniper are the two most common taxa, recovered from all time periods compared; cholla seeds were identified in all but the Coalition sites, but sample size is extremely small for this period.

Although evidence is minimal, a single charred tobacco seed recovered from a storage or thermal feature from the Archaic Ceja Mesa site, LA 99697, and another charred seed identified from the central firepit of Room 1 at LA 99529, imply at least limited use of this traditional ceremonial plant. If the whole plant was collected, it is possible that the seeds could have been accidentally charred or, incorporated with the leaves, charred during smoking, and discarded as part of the residue.

Taxa diversity may have increased during the Developmental period when land was not only disturbed by human habitation but by agricultural pursuits, creating an optimal environment for weedy annual plants like goosefoot and purslane to volunteer. These plants would have provided an ample supply of greens in the Spring, and seeds that mature in mid- Summer to early Fall. With increases in population, wild plants as well as domesticates could have been exploited to a greater extent.

Table 14.9. Charred Flotation Plant Material from Sites in the Middle Rio Grande Valley and the Lower Jemez Valley.

Time Period	Aceramic					Developmental				Coalition
Site/Project	**LA 158642**	**Unser Blvd. Phase II[1]**	**Ceja Mesa: LA 80883, 80886, 80887, 99695, 99696, 99697, 99698, 99700, 99701, 99702, 99705, 99708[2]**	**Other Ceja Mesa: LA 109100, 109105, 109108, 109109, 109110[3]**	**LA 153989, LA 153990[4]**	**LA 99529[5]**	**LA 25862[6]**	**River's Edge (LA 3128, 57019, 57020, 57022)[7]**	**LA 158640**	**LA 158641**
# of samples w/ charred remains	8	28	26	28	3	55	14	60	3	4
Annuals: *Amaranthus*		+	+	+			+	+		
Cheno-Am	+					+				
Chenopodium	+	+	+	+		+	+	+		+
Chenopodium berlandieri				+						
Cleome								+		
Corispermum		+				+	+	+		
Cycloloma			+			+	+	+		
Descurainia						+				
Helianthus				+						
Nicotiana			+			+				
Portulaca		+		+		+		+		+
Cultivars: *Cucurbita*								+		
Phaseolus							+	+		
Zea mays						+	+	+		
Grasses: *Achnatherum hymenoides*						+	+	+		
Phragmites							+ culm	+ culm		
Poaceae		+	+	+		+	+	+		
Sporobolus			+	+		+		+		
Other: Asteraceae							+			
Cucurbita							+ rind	+		
Cyperaceae							+	+		
Malvaceae								+		
Physalis	+			+				+		
Perennials: *Atriplex canescens*						+	+	+		
Boerhaavia						+		+		
Celtis										
Cylindropuntia	+	+		+	+		+	+	+	
Echinocereus				+						
Juniperus	+	+	+	+	+	+		+		+
Piñon								+		
Platyopuntia		+				+	+	+		
Rhus						+				
Vitis						+				
Yucca bacata							+			
Total taxa	5	8	7	11	2	17	16	23	1	3

Plant remains are seeds unless indicated otherwise; + present.
[1]McBride 2010; [2]McBride 2008; [3] McBride 1997 data in Dello-Russo 1999; [4]McBride 2009; [5]McBride 2000; [6]McBride 1999; [7]Brandt 1991.

Site function needs to be considered here, as River's Edge sites, LA 99529, and LA 25862 were probably year-round agricultural habitations (these three sites are the only ones with clear evidence for Spring occupation with the presence of mustard and ricegrass), while the rest of the sites in Table 14.9 most likely represent seasonal campsites, visited during late Summer and Fall, where specific plants may have been targeted, and activities such as procuring lithic materials, making tools, and hunting small game took place.

Wood data from all projects (Table 14.10) seem to lend support to the notion that juniper was far more abundant in the region than it is today, occurring at a minimum percentage of 66% by weight in flotation and vegetal samples. It is possible that by the Coalition some depletion of conifer species may have occurred with a concomitant increase in the use of local shrubby taxa, but the sample size is too small to say with any certainty.

Table 14.10. Wood Charcoal From Sites in the Middle Rio Grande Valley and the Lower Jemez Valley (percentage of total wood weight).

Time Period	Aceramic				Developmental		Coalition
Site/Project	LA 158642	Unser Blvd. Phase II[1]	Ceja Mesa: LA 80887, 99695, 99697, 99698, 99702, 99705, 99708[2]	LA 153989, LA 153990[3]	LA 99529[4]	LA 158640	LA 158641
# of samples with wood	5 F, 3 V	46 F	11 V	12 F	57 F	6 F, 2 V	6 F, 1 V
Conifers: *Juniperus*	100%	93%	97%	97%	91%	97%	66%
Pinus edulis					1%		
Unknown conifer					1%		
Non-Conifers: *Artemisia*			<1%				<1%
Asteraceae					3%		
Atriplex/Sarcobatus		4%	3%	3%	1%		24%
cf. *Cercocarpus*					<1%		
cf. *Cylindropuntia*		3%			1%	3%	10%
Ericameria nauseosa					1%		
Populus/Salix					1%		
Unknown non-conifer	<1%	<1%	<1%		<1%		

F flotation, V vegetal.
[1]McBride 2010; [2]McBride 2008; [3]McBride 2009; [4]McBride 2000.

In summary, archaeobotanical data from the CNM Rio Rancho sites contribute to our knowledge of subsistence practices of populations that utilized the west side of Albuquerque. Weedy annuals, cacti, and to some extent grasses, were the focus of plant related exploitation, and juniper was the primary wood taxon used for fuel and construction.

Chapter 15

SUMMARY AND DISCUSSION

by Patrick F. Hogan and Alexander Kurota

Excavations were completed at three archaeological sites and test excavations were conducted at a fourth site prior to construction of the CNM Rio Rancho campus. In addition, the initial ground-disturbing phase of construction was monitored to ensure that any undiscovered features were found and treated. The sites had been determined eligible for the National Register of Historic Places because of their potential to contribute information important in prehistory or history (criterion *d* of 36 CFR 60.4). Consequently, data recovery was undertaken to mitigate the loss of the sites as a result of the proposed construction.

Taken together, the four sites reflect intermittent, short-term occupation of the study area over the last 3800 years; that is, from the late Middle Archaic period to the present. The information obtained from the remnants of those occupations contributed data relating to three major research issues – chronology, settlement and subsistence, and the organization of the lithic technology. In addition, geomorphological studies in conjunction with the excavations provided a better understanding of the depositional and erosional processes affecting site preservation. The data relevant to each of these research issues is summarized below and their implications for understanding the aboriginal occupation of the Llano de Albuquerque are discussed.

CHRONOLOGY

The fundamental question for this problem area was simply when were the sites occupied. If we could answer that question, then we could also address the larger issues of how the CNM Rio Rancho sites fit into the overall demographic trends on the Llano de Albuquerque, and how those demographic trends relate to the changing environmental conditions outlined in Chapter 2. Although no chronological information was obtained from LA 160886, seven radiocarbon dates were obtained from features at the other three sites (Table 15.1). Those dates, together with the ceramics from the sites, allowed us to identify six spatially-segregated temporal components at LA 158640 and LA 158642, and one other temporal component at LA 158641. Those components rather than the sites became our basic analytical units since they represent discrete occupations of the study area during different time periods.

Summary of the Components

The earliest occupation was the Archaic component uncovered in Study Unit 2 at LA 158642. This was also the most extensive occupation investigated during the project and the best preserved. The occupation was marked by a 5–40 cm thick cultural stratum overlaid by up to 70 cm of aeolian and colluvial deposits. After a backhoe was used to remove the overburden, a 115 sq m area was excavated by hand. The excavations exposed an occupation surface with associated midden deposits and eight features – a roasting pit (Feature 2), four hearths (Features 4, 7, 8, and 11), two ash pits (Features 6 and 10), and a possible structure (Feature 5). Radiocarbon dates of cal 1750–1600 BC and cal 1400–1190 BC were obtained from Features 2 and 5, respectively. These non-overlapping date ranges indicate two occupational episodes spanning the Middle to Late Archaic transition but, given the depth of the midden deposits and number of features present, it seems likely that this component actually reflects multiple short-term occupations.

Table 15.1. Radiocarbon Results Obtained from Three Excavated Sites (all dates are AMS standard delivery).

LA No.	Feature No.	Material	Beta No.	Calibrated Date for Intercept	Radiocarbon Age	Calibrated Age 2 Sigma, 95%
158640	2	Juniperus (wood)	265700	AD 230	1800±40 BP	AD 120-330
158640	3	Cylindro opuntia (wood)	265701	AD 400	1660±40 BP	AD 260-290, AD 320–440, AD 490–520
158641	4	Atriplex (wood)	265704	AD 1220	820±40 BP	AD 1160–1270
158642	1	Artemisia (wood)	265702	AD 770	1240±40 BP	AD 670–890
158642	2	Juniperus (seed)	265703	1680 BC	3380±40 BP	1750–1600 BC, 1570–1540 BC
158642	3	Artemisia (wood)	267771	AD 1960	60±40 BP	AD 1690–1730, AD 1810–1930, AD 1950–1960
158642	5	Juniperus (seed)	265705	1300 BC	3030±40 BP	1400–1190 BC, 1140–1140 BC

The next component dates to the Basketmaker period. In Area 1 at LA 158640, Feature 2 and 3 were found on the crest of the dune ridge in the north-central part of the site. Both were roughly circular pits measuring close to 1 m in diameter and 20–25 cm deep. Each of the features had an associated occupation surface with a small lithic assemblages that included ground stone and fire-cracked rock fragments. Additional artifacts eroded from these occupation areas were found downslope to the south of the features. Although the features appear identical and are only 12 m apart, the radiocarbon dates suggest that they represent two occupational episodes. The date from Feature 2 had a calibrated intercept of cal AD 230 with a two standard deviation range of cal AD 120-330, while Feature 3 dated to cal AD 400 with multiple calibrated ranges (Table 15.1).

Two other components reflect occupations during the Developmental period. The earlier of these was identified based on the cal AD 670-890 radiocarbon date from Feature 1 at LA 158642. Feature 1 was a hearth exposed in an arroyo cutbank at the extreme northern edge of the site. This part of the site was outside of the construction area, so our investigation was limited to mapping and profiling the feature, and collecting a bulk soil sample for flotation. We therefore know relatively little about this component, although the presence of an ash lens on both side of the hearth suggest that there are multiple features in the area.

The later Developmental component (Pueblo II) was located in the eastern portion of LA 158640 within the SU 7 excavation block. This occupation was represented by a use surface with a cluster of three features and an associated light scatter of flaked lithic, groundstone, and ceramic artifacts. Feature 4 was a hearth, Feature 5 was an ash pit, and Feature 6 was probably used for food processing. Based on the presence of Red Mesa Black-on-white ceramics, this occupation was dated to sometime between AD 850 and 1125.

A Coalition component at LA 158641 consisted of a probable structure (Feature 4) and three extramural hearths (Features 2, 3, and 5). Ceramics recovered from the site include Wiyo Black-on-white (AD 1300 to 1400), indented corrugated grayware (AD 1150 to 1450), and Rio Grande Plainware (AD 1100 to 1600). The date ranges for these types correspond well with the 2-sigma calibrated radiocarbon date of cal AD 1160 to 1270 from Feature 4.

A Classic phase component was identified on the basis of five Rio Grande Glazeware sherds found in the southern part of Area 2 at LA 158640. No features associated with this occupational episode were found during excavations in this area (SU 6), auger testing of the adjacent area, or the subsequent construction monitoring. A single chert angular debris fragment was recovered from the excavation unit and two chalcedony cores were found on the surface a few meters northeast of SU 6. This part of the site is located in an area where sediments eroded from the hillslope tend to accumulate, however, so the lithics are not necessarily associated with the sherds. All of the sherds appear to be from a single Espinoso Glaze-on-yellow bowl, which dates this ephemeral use episode to sometime between AD 1450 and 1500.

Similarly, a Coalition/Classic period component was identified at LA 158642 based on the presence of a single Rio Grande Plainware sherd located in the eastern part of the site. The sherd was part of a diffuse surface scatter that also included nine pieces of debitage and a chopping tool. No features were found during the excavation of two 1 x 1 m units and no other cultural deposits were discovered during the auger testing and monitoring. These artifacts may be related to the Coalition or Classic period components already described or they could represent a separate use episode.

The most recent component identified during the project consisted of a deflated hearth (Feature 3) in the south side of Area 2 at LA 158642. The hearth consisted of ash-stained sediments with a loose concentration of fire-cracked rock and charred bone identifiable only as *Bos/Bison*. The radiocarbon date from Feature 3 had a calibrated intercept of cal AD 1960. Given this date, the faunal remains are almost certainly from a cow.

Discussion

The CNM Rio Rancho data are consistent with previous research indicating relatively intensive occupation of the northeastern Llano de Albuquerque during the Late Archaic period. Survey of the proposed Venada Airport identified numerous Archaic camps clustering along the Arroyo de la Baranca (Hogan 1986:35). Late Archaic camps were also documented during excavations at the nearby Sandoval County Landfill (Seymour et al. 1997) and Paseo del Volcan corridor (Raymond et al. 2008), as well as during other surveys of nearby areas (Acklen and Bertram 1985; Brandi 1993; Hannaford 2006; Kurota and Hogan 2009; Schmader 1990a).

In an early attempt to assess demographic trends on the Llano further to the south, Schmader (1987:4) found that 20% of 370 components documented at sites on Albuquerque's west side area between Central Boulevard and the Sandoval-Bernalillo county line dated to the Archaic period. In contrast, only 3.5% of the components dated to the Paleoindian period, 0.5% to the Basketmaker period, and 2.4% to the Pueblo I–III (Developmental) period. Another 20% of the components were dated to the Coalition/Classic period, marking a second spike in human occupation of the mesa. This later demographic peak was also evident in the subsequent survey of Petroglyph National Monument (Brandi 1999). Of the 214 sites recorded during that survey, three had associated Paleoindian artifacts and 15 had Archaic points. Only small numbers of sites were dated to the Basketmaker through Pueblo III periods but 55 sites (25%) were dated to the Classic period (Brandi 1999:116–119). Although most of the Classic components within the Monument are probably associated with the petroglyphs found along the lava escarpment, recent research in the area has shown that a considerable number of Classic period sites are agricultural loci defined by fieldhouse structures (Kurota 2006b), rock pile grids (Cordero 2007), and terraced grid gardens (Camilli et al. n.d.).

These finding stand in sharp contrast to the evidence from the CNM Rio Rancho sites, which indicates only very ephemeral utilization of the northeastern Llano during the Classic period. One possible explanation for this difference is that the steep terrain, shallow soils, and small drainage catchments around the lava escarpment offer greater potential for channeling surface runoff to agricultural fields than do the gentler topography, deeper soils, and larger drainage basins that characterize the northeastern part of the Llano de Albuquerque.

In the most recent effort to assess demographic trends on the Llano de Albuquerque (also referred to as Ceja Mesa), Railey and others (2009:212) argue that the availability of water on the Llano "was probably always susceptible to even slight variations in prevailing precipitation levels …" and therefore that aboriginal use of Ceja Mesa probably fluctuated in response to climatic changes. Using radiocarbon dates as a proxy measure, they suggest that population levels on the Llano increased gradually after about 4000 BC as climatic conditions ameliorated following the Altithermal, reaching a minor peak at about 2500 BC before declining slightly with the onset of cooler conditions. With warmer, wetter conditions (Chapter 2, this volume) population levels rise sharply at about 1800 BC, reaching a peak at 1300 BC and then decline again at about 800 BC, which correlates roughly with the onset of periglacial conditions. There is another brief peak in population levels at 400 BC and a slightly lower peak at about AD 200–400, and then a sharp drop correlating with the onset of drought conditions. Population levels remain low until about AD 900, then rise again to moderate levels (Railey et al. 2009: Figure 12.2; 215–217).

The occupations at the CNM Rio Rancho sites (Figure 15.1) only partially mirror these larger demographic and climatic trends. The dates for the Archaic occupation at LA 158642 span the interval of peak occupational intensity on the Llano de Albuquerque during a period when climatic conditions were generally warm and wet. The Basketmaker component at LA 158642 also corresponds to a secondary peak in occupational intensity. While the earlier date is associated with a period of above normal precipitation, the later occupation falls with a drought that precipitated a sharp decline in the mesa's population (Dello-Russo 1999; Grissino-Mayer 1995:96; Railey et al. 2009:216). The radiocarbon date from Feature 1 at LA 158642 also falls within this demographic trough and corresponds to a protracted interval of below normal precipitation. All of the later components fall within the secondary peak in occupational intensity after AD 900. The Late Developmental component at LA 158640 and the Coalition occupation at LA 158641 occurred during the period of above normal precipitation correlating with the Medieval Warm Period, while the ephemeral Classic component at LA 158640 corresponds to the interval of cooler temperatures and below normal precipitation relating to the Little Ice Age (Grissino-Mayer 1995:132–134).

The occurrence of individual occupations running contrary to the overall demographic trends is not unexpected but raises questions about the proposed correlation between climatic conditions and occupational intensity. Railey and his colleagues begin with the premise that "the very existence of hundreds (if not thousands) of prehistoric sites on the West Mesa … provides mute testimony to the former presence of surface (or near surface) water sources on this now desiccated upland surface" (Railey et al. 2009:212). In looking at the correspondence between demographic trends and climatic conditions, they therefore stress the relationships between intervals of drought and downward trends in occupational intensity. Although hardly conclusive, the evidence from the CNM Rio Rancho sites suggests that there may be a stronger correlation between intervals of above normal precipitation and increasing occupational intensity. If so, then the water sources on which aboriginal groups depended may have been seasonal sources produced by direct rainfall – temporary ponds in playas and surface runoff in intermittent streams – which has some interesting implications for the seasonality and duration of occupations on the mesa.

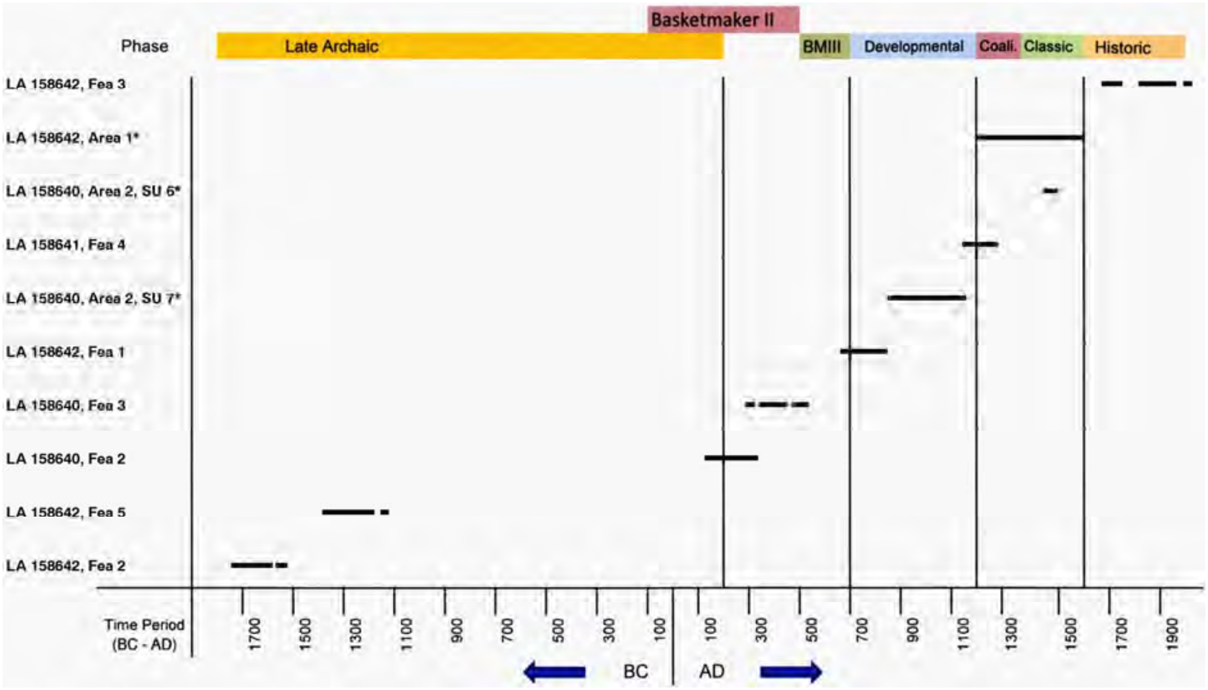


Figure 15.1. Possible ten occupations identified at four excavated sites using radiocarbon dates and ceramic manufacturing date ranges (*).

SUBSISTENCE AND SETTLEMENT

For this problem area, the basic issue was determining what activities were conducted at the sites. In the research design, this question was posed in the context of lithic procurement since all of the CNM Rio Rancho sites had been classified as lithic procurement areas during the survey. Specifically, we were concerned with ascertaining whether aboriginal groups travelled to the area specifically to collect tool stone from the gravel outcrops (i.e., direct procurement) or whether they were engaged in some type of subsistence activity and took the opportunity to collect lithic materials while they were in the vicinity of the outcrops (i.e., embedded procurement). In order to answer that question, however, we needed to address a number of subsidiary questions relating to the larger issues of the subsistence and settlement/mobility strategies employed by aboriginal groups on the Llano de Albuquerque. What subsistence resources were being exploited? What was the composition of the groups who occupied the CNM Rio Rancho sites? What was the duration of those occupations?

Because tool stone would have been the only resource collected, our expectation going into the project was that the artifact assemblages at direct procurement sites would be limited to the debris resulting from testing material quality and possibly decortication of the nodules. We further hypothesized that the sites would be devoid of features since the direct procurement most likely involved day trips to the lithic material source. Our rationale here was that groups tend to minimize the costs of transporting lithic materials (Arakawa and Nicholson 2010), so they probably would have exploited the sources nearest their residential base. Since the gravel outcrops on the CNM Rio Rancho campus are within the 10-13 km daily foraging radii of Ancestral Puebloan settlements in the adjacent Rio Grande and lower Jemez River valleys (Railey et al. 2009:218), and of known Archaic structures on the northeastern Llano (Brandi and Dilley 1998; Seymour et al. 1997; Vint and Cook 1999), day-long trips to procure tool stone from these sources would have been feasible for groups based in those areas..

If lithic procurement was embedded in subsistence activities, on the other hand, then we expected to find evidence of those activities and of occupations of a longer duration. We hoped that archeobotanical and faunal materials from the sites would provide direct evidence of the food resources being exploited, and that functional analysis of the flaked and ground stone tools would provide supporting indirect evidence of subsistence activities. Finally, the size of the artifact assemblage and variety of artifacts and features found at the sites were expected to contribute information about the duration of the occupations and the composition of the resident group.

Archaic Component

The most secure evidence for subsistence activities was obtained from the Archaic component at LA 158642. Burned animal bone fragments were recovered from the midden deposits and a few of the features. The majority consisted of small mammal long bone fragments, suggesting that rabbits and/or rodents were exploited as a food resource. In addition, seven of the eight features associated with this component yielded macrobotanical remains.

Juniper seeds were found in five of the features. These seeds are not generally counted as a subsistence resource because the cones could have been attached to juniper branches used as firewood. This seems a reasonable explanation for the seeds recovered from Feature 5 as green juniper boughs probably were used in constructing the shelter, and possibly for the seeds in Feature 2 since boughs may have been layered together with the food prepared in the roasting pit. We would expect dry wood to have been preferred for fuel, however, and it is unclear how long the cones adhere to dead branches. Consequently, given evidence that juniper cones were exploited as food resource by some ethnographic groups (Chapter 14, this volume) and indications that the caloric return rate for this resource is relatively high (Table 2.2, this volume), we cannot totally discount the possibility that juniper cones were one of the food resources exploited by aboriginal groups on the Llano.

Goosefoot and/or cheno-am seeds were recovered from four features identified as hearths or ash pits, including Feature 4 which may be associated with the structure. Ethnographically, these seeds were ground or parched and made into cakes or mush, which is consistent with their association with small hearths and with presence of grinding stones at the site. Three of the features (Features 4, 10, and 11) have associated fire-cracked rock, which could be indicative of stone boiling, but those fragments might also be rake-out from Feature 2. The fourth hearth, Feature 7, had no associated fire-cracked rock. Another small hearth, Feature 8, yielded ground cherry seeds suggesting that the fruits of this plant were also harvested.

Cholla seeds and embryos were recovered from the fill of Features 2 and 10, which indicates that cholla fruits were being collected and processed. Feature 2 was a roasting pit surrounded by an apron of fire-cracked rock that also encompassed a hearth (Feature 11) and ash pit (Feature 10) located about 50 cm south of Feature 2. From this archaeological evidence, it appears that the Archaic occupants of LA 158642 processed cholla in a manner similar to that described for the Coahuilla who "cooked or steamed [cactus fruits] with hot stones in a pit …" (Barrows 1977:67) and for the Pima who processed cactus fruits by layering them with hot stones in a pit (Chapter 14, this volume).

The indirect evidence for subsistence activities provided by the stone tools was fairly meagre. The manos and metate reflect the milling activities associated with plant processing and food preparation. The flaked tool assemblage consisted of a single projectile point, one unfinished biface, a chopper, and one utilized flake. From the point, biface, and bifacial reduction debitage, we can also infer the use and maintenance of a hunting tool kit. The context in which the chopper and utilized flake were employed could not be ascertained. Milling and food preparation are tasks generally performed by women in hunter-gatherer societies, while men do most of the hunting. Consequently, the presence of both milling stones and hunting equipment suggests that the Archaic camps were occupied by family groups rather than single-sex task groups. The near absence of formal tools further suggests that the occupations were of relatively short duration, as those items tend to be curated and carried away when the group moves to a new camp (Binford 1977, 1979).

Chenopod and amaranth seeds ripen in August and September, as do cholla fruits and juniper cones (Table 2.1), suggesting that most of the Archaic occupations at LA 158642 occurred in late summer or early fall. Ground cherry berries ripe in June, however, so the seeds recovered from Feature 8 indicate at least one early summer occupation. The features at the site also indicate a warm-season occupation. The only structure associated with this component is an insubstantial shelter that has no internal features and opens on one side to an outdoor activity area with an extramural hearth (Figure 15.2). The other features at the site appear to be associated with open air camps, which also implies that the occupations were of relatively short duration. The presence of sheet midden deposits and at least one structure indicate that some of the occupational episodes were for somewhat longer periods, however.

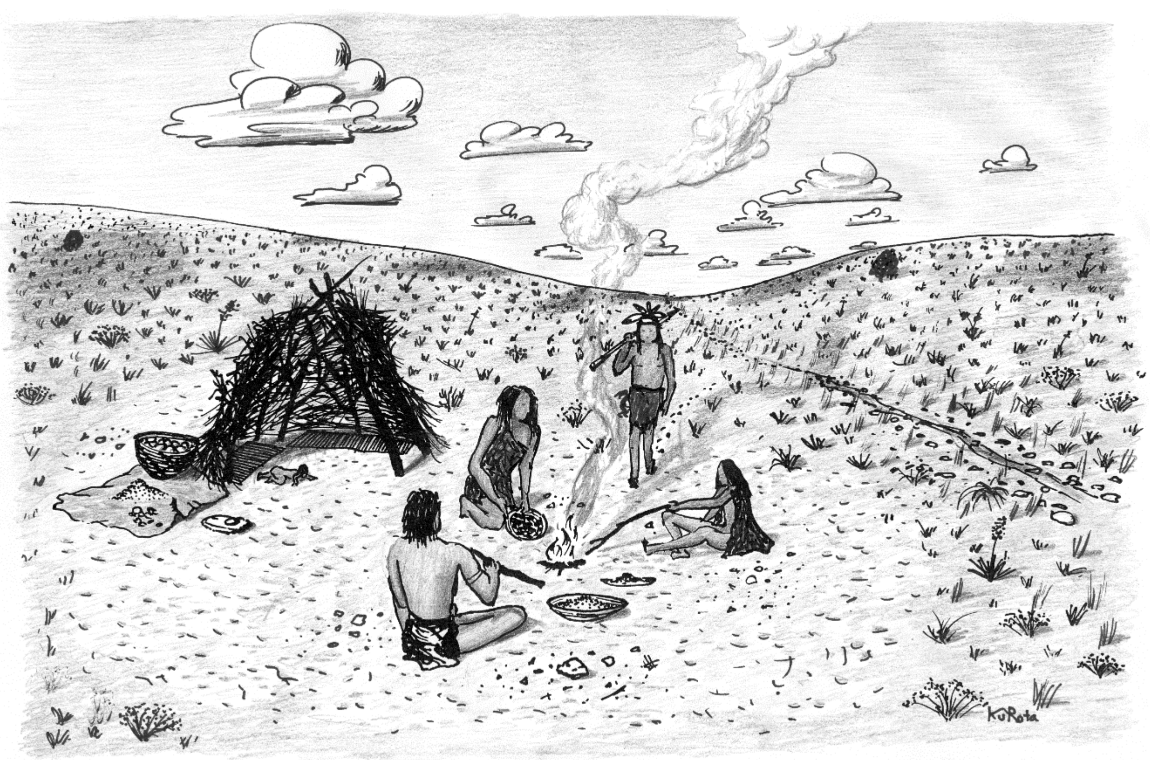


Figure 15.2. Artist's rendering of the Late Archaic camp.

The weight of evidence, then, indicates that this location was a favored camping area during the late Archaic period and that the relatively extensive cultural deposits represent the accumulated debris from repeated residential occupations of a few days to several weeks in duration. The family groups occupying the site were engaged in the collection of wild plant resources with some supplemental hunting of small game, primarily during the late summer and early fall. The procurement of lithic raw material from gravel outcrops in the vicinity of the camp therefore appears to have been embedded in those subsistence activities.

Basketmaker Component

In contrast to the Archaic component, the Basketmaker component at LA 158640 yielded no faunal remains or macrobotanical materials other than fuel wood. The manos and metate fragment associated with this component provide indirect evidence for plant processing and food preparation but there were no identifiable tools in the flaked lithic assemblage. From the radiocarbon dates, the component comprises two separate occupations, each marked by a large fire pit (Features 2 and 3). Although the size of these features suggests that they served as roasting pits, the small quantity of associated fire-cracked rock is more consistent with stone boiling. The presence of ground stone suggests that the features were associated with residential camps, which were probably occupied for no more than a few days given the small numbers of associated artifacts. Although the evidence for subsistence activities is tenuous, this component appears to be another example of embedded lithic procurement.

Developmental Components

For the Developmental components, Feature 1 at LA 158642 yielded seeds and embryos that could be either cholla or prickly pear. This evidence suggests that the hearth was used to process cactus fruits and that the occupation occurred sometime in late summer or early fall. Investigations in this area were limited to sampling the hearth exposed in the arroyo cut, however, so we have no other information about the nature of the occupation.

Macrobotanical remains were also recovered from the three features associated with the Late Developmental (Pueblo II) component at LA 158640. Feature 4, yielded a cholla embryo as well as indeterminate plant parts; Features 5, only indeterminate plant parts; and Feature 6, a cholla seed. A moderate amount of fire-cracked rock was found surrounding Features 4 and 5, possibly indicating that cactus fruits were roasted. A basin metate was also associated with the features and a mano was found on the surface outside of the excavation unit, suggesting that milling of seeds or other plant materials also occurred at the site. The sherds of a Red Mesa Black-on-white bowl provide further evidence for food preparation and consumption. These artifacts also imply the presence of females, which again suggests that the residents may have been a small family group.

The flaked stone assemblage associated with this component consisted of debitage and one tested cobble, and provided no additional information about subsistence activities. The debitage, however, is indicative of intensive core reduction directed toward the production of expedient flake tools. It therefore appears that lithic procurement was undertaken to satisfy an immediate tool need related to activities at the site.

The small number of artifacts and absence of formal tools implies a brief occupation, but the multiple features and cached metate could indicate more than one occupational episode. The limited evidence suggests that subsistence activities were focused on the collection of cactus fruits. By this period, the Ancestral Pueblo economy was based primarily on agriculture, however, so an alternate interpretation of this component as a “fieldhouse” also needs to be considered.

As described in the ethnographic literature, Pueblo fieldhouses exhibit considerable morphological variability, ranging from multi-room structures that are occupied more or less continuously through the growing season, to less elaborate structures occupied during spring planting and/or the fall harvest, to very simple brush shelters or naturally shaded locations where the farmers rested during sporadic or daily visits to their fields (Moore 1979; Sebastian 1983). Although agriculture was the focal subsistence activity at fieldhouses, the remains left at these locations consisted largely of varying amounts of domestic debris from food preparation and consumption. Assuming that pre-contact agricultural practices were similar to the traditional methods employed by modern Pueblo groups, there therefore seems little basis for distinguishing the lower order fieldhouses from Pueblo gathering camps.

The presence of corn or other cultigens would provide direct evidence of agricultural activities but their absence is not definitive as the harvested crops were typically carried back to the village for processing, storage, and consumption (Sebastian 1983:404). Similarly, the presence of wild food plant remains is not necessarily indicative of a gathering camp. The farmers needed to eat something while waiting for their crops to mature and, although they often brought some food with them, ethnographic groups commonly collected wild plants while residing at fieldhouses. Many wild plant resources, such as chenopod and amaranth, are weedy annuals that grow well in the disturbed ground of agricultural plots, and these weeds were often encouraged and exploited as a supplemental subsistence resources (Winter and Hogan 1986). The ripening of other taxa, such as the cactus fruits found at LA 158640, coincide with spring planting or the fall harvest, when groups were most likely in residence at the fieldhouses, and therefore could be collected opportunistically.

In the absence of architectural, archeobotanical, or artifactual attributes that could be used to identify fieldhouses, Sebastian approached the problem from the opposite direction by reviewing ethnographic descriptions of Pueblo gathering activities. She found that, with the exception of pinyon nuts, Pueblo plant gathering was generally done in day-long trips that would not produce the sherd and lithic scatters typically interpreted as "gathering camps" (Sebastian 1983:404-405). While it would be a mistake to assume that Ancestral Pueblo practices precisely mirror those of historical Pueblo groups, the ethnographic data do suggest that many of the sherd and lithic scatters on the northeastern Llano probably are fieldhouses. With respect to the Developmental component at LA 158640, however, the most that can be said is that the component is situated adjacent to a potential field location and that there is no evidence that is incompatible with interpretation of the occupation as a fieldhouse.

Coalition/Classic Components

The Coalition component at LA 158641 poses a similar interpretive problem. It consists of a small rudimentary shelter and three extramural hearths. Charred juniper seeds were recovered from all three hearths. In addition, Feature 2 had a purslane seed and Feature 5 had a goosefoot seed, both of which suggest a fall occupation or occupations. The lithic assemblage consists only of debitage; there is no ground stone. The sherds are likely from two vessels, a bowl and a jar. This component is also situated adjacent to potential agricultural land, and the features at the site are consistent with a fieldhouse occupied late in the growing season. It is less likely that the site is a gathering camp given the presence of a structure and absence of other indicators of occupational intensity.

The Classic component at LA 158640 consists of five sherds from an Espinoso Glaze-on-yellow bowl, possibly associated with a few lithics found in the same general area. This component is located adjacent to the same swale as the Late Developmental and Coalition components, and the scant remains are what we would expect to find at a day-use field facility. However, it is equally probable that the bowl was dropped by one or more individuals engaged in other activities or simply travelling through the area. The Coalition/Classic component is even more ephemeral, consisting of a single Rio Grande plainware sherd that may or may not be associated with a scatter of lithic debitage.

Discussion

The most frequently recovered macrobotanical remains from the CNM Rio Rancho sites – juniper, cholla, and chenopodium – are also the most ubiquitous at other excavated sites in the area (Table 14.9, this volume). Cholla fruits and juniper berries have moderately high caloric return rates (Table 2.2, this volume) but the return rate for chenopod seeds is low. Given the assumptions of the diet-breath model (Bettinger 1991:84-87; Kelly 1995:78-90), this suggests that aboriginal groups on the Llano de Albuquerque were exploiting a broad spectrum of wild plant resources, at least during the late Archaic period. Optimal foraging models are less applicable to the later periods when agriculture was the dominant subsistence strategy, but the macrobotanical evidence indicates that a wide variety of wild plant foods continued to be exploited. In these instances, the ubiquity of cheno-ams and other weedy species may be related to their abundance in farm fields.

Most of the identified plant remains suggest that aboriginal groups primarily exploited the plant resources of the Llano during the late summer and early fall. This evidence may be somewhat skewed by differential preservation since charred seeds are more likely to be preserved in archaeological sites than the greens, roots, and bubs that probably were targeted during the spring and early summer (Dello-Russo 1999). That potential bias, however, does not explain the comparative rarity of seeds from yucca fruits, ricegrass, groundcherry, and tansy mustard that ripen in the early summer and that have moderately high caloric return rates. As alluded to earlier, one possible explanation for the apparent predominance of late season occupations is that the availability of surface water on the Llano was directly dependent on summer rainfall. If it was, then the opportunity to exploit plant resources that ripened in the early part of growing season may have been somewhat limited. This hypothesis leaves open the question of where the population was during the remainder of the year.

The available evidence from northwestern New Mexico suggests that late Archaic hunter-gatherers in the San Juan Basin exploited an annual range extending from the piñon-juniper zone in upland areas along the margins of the basin to the grassland and shrub vegetation zones in the lowlands of the basin interior. Small family groups appear to have moved through their ranges from early spring through fall, periodically shifting their residence to exploit a successive series of plant resources that ripened at different times in the different vegetation zones – a mobility strategy termed “serial foraging” (Hogan 1994). During the winter, the groups occupied residential basecamps located on the lower fringes of the piñon-juniper zone and appear to have subsisted primarily on stored food supplemented by hunting.

Assuming unrestricted access, a serial foraging strategy would have been viable in the Albuquerque area where, owing to the greater topographic relief, the vegetation zones are in closer proximity. Unlike the San Juan Basin, however, the lowlands in the Albuquerque area also encompass extensive riverine vegetation in the Rio Grande, Rio Puerco, and Jemez River drainages. Railey and colleagues (2009:217–228) argue that late Archaic residential bases were probably located in these river valleys and not the piñon-juniper zone. They base their argument partly on limited extent of piñon-juniper woodland in the Albuquerque area and partly on the high productivity of the riverine biota itself. Moreover, the river valleys were ideally suited for small-scale farming after cultigens were introduced at the end of the second millennium BC.

Although they recognize that the Llano de Albuquerque would have been readily accessible from river-valley basecamps, Railey and his colleagues (2009:223–224) suspect that the mesa also may have been occupied on a sustained or year-round basis by marginalized Archaic groups that did not have access to the river valleys. They contend that these groups could have subsisted on by hunting large game – pronghorn, bison, and elk – which were present on the mesa, supplemented by small game and wild plant resources. They further suggest that most of the sites on the mesa represent very temporary residences or logistical camps, indicating a high degree of mobility, while the sites with structures that have internal hearths may be winter habitations. Finally, they note that the absence of storage pits at the latter sites may indicate that seed storage was not an important component of the subsistence strategy, and that groups on the mesa instead depended on dried meat products and continued hunting to see them through the winter.

The data from the CNM Rio Rancho sites are clearly too limited to fully assess these settlement-subsistence models, but we can examine how closely our component conforms to the predicted patterns. As discussed previously, the Archaic occupations at LA 158642 appear to be small residential camps occupied by family groups for periods of a few days to several weeks during the late summer or early fall. The one structure has an external hearth but no internal features indicating a warm-season occupation and not a winter encampment. Subsistence activities appear to have centered on the collection and processing of wild plant resources and hunting or trapping small game. Apart from one projectile point, there is no evidence that large game animals were being pursued. That is, the data seem inconsistent with the model of year-round settlement on the mesa in terms of both the subsistence activities and duration of the occupation. The Archaic component at LA 158642 more likely represent the residential camps of serial foragers who occupied the mesa on a seasonal basis before moving into winter camps in the river valleys.

The situation is less clear for the early Basketmaker components at LA 158640. Although tentatively identified as residential camps, which would indicate a continued residential mobility strategy, the apparently brief duration of the occupations could also be interpreted as indicating a shift to a more logistical mobility strategy by groups based in the river valleys. During the late Basketmaker and Developmental (Pueblo I-III) periods, agricultural settlements were established along the south banks of the Jemez river (Hammack et al. 1983; Brown 1999, Gerow 2008, 2010), the western margins of the Rio Grande valley (Schmader 1994), and in the Rio Puerco drainage (Elyea 1995). Task groups from these settlements probably hunted game and foraged for wild plant resources in adjacent areas of the Llano, and ephemeral occupations like the Developmental components at LA 158640 and LA 158642 could be logistical camps associated with those forays. Alternatively, the components may be fieldhouses associated with outlying agricultural plots.

During the Coalition and Classic periods, there is a marked increase in the number of sites in the east-central part of the Llano. Recent excavations by Kurota (2006), Cordero (2007) and Camilli et al. (n.d.) show that Pueblo IV fieldhouses and agricultural gridded terraces were built and used in the area of current Volcano Vista High School and around the Albuquerque volcanoes. The close proximity of some major Classic period pueblo villages, such as Piedras Marcadas (LA 290), the Alameda Pueblo (LA 421), and the Chamisal site (LA 22765), suggest that the Classic period loci on the West Mesa may have served as agricultural satellites for the main villages in the valley. Cordero et al. (2009) argue that the West Mesa field facilities may have functioned as a back-up system in case the corn fields in the immediate vicinity of the pueblos were wipe out by annual floods.

Fewer Coalition/Classic components have been found in the northeastern part of Llano. Kennedy and others (1998) excavated a fieldhouse with a mealing bin, and the corn cupule recovered from the floor of the structure is indicative of agricultural activity. The Coalition component at LA 158641 also appears to be a fieldhouse. These and other Coalition/Classic sites in the northeastern Llano de Albuquerque could mark the former locations of outlying fields established by the inhabitants of the Kuaua (LA 187) and Santiago (LA 326) pueblos.

Farming may have been feasible on the northeastern Llano during the Classic period using traditional Pueblo farming methods. Kennedy and his colleagues (1998:193) argue that runoff from summer rainstorms would provide periodic moisture to fields situated in the intermittent drainages, and the soils in the drainage bottoms would retain subsurface moisture long after the runoff events. Thus undissected drainages like the swale on the CNM Rio Rancho campus may have been favored field locations. Such fields would not require the more elaborate water-control features (check dams, grid gardens, rock piles) found further to the south, so they are not as visible in the archaeological record. Future research therefore should emphasize the careful evaluation of small Coalition/Classic artifact scatters situated near shallow drainages to more fully assess the extent of Late Pueblo agricultural activities on the northeastern Llano.

LITHIC TECHNOLOGY

Research in this problem domain focused on determining how lithic procurement activities at the CNM Rio Rancho sites were organized. The specific questions posed in the research design included: 1) were lithic raw materials obtained through direct or embedded procurement; 2) what stages of lithic reduction are represented at the sites; 3) were lithic materials being transported away from the sites and, if so, in what form; and 4) what do the lithic raw materials at the sites tell us about the prior movements of the resident groups?

The first of these questions was addressed in the previous section. The components at three of the sites – LA 158640, LA 158641, and LA 158642 – represent occupations by groups engaged in hunting, wild plant gathering, or cultivation. At these sites, lithic procurement therefore appears to have been embedded in subsistence activities. LA 160886, which encompasses the largest gravel outcrop in the project area, was the only site at which lithic procurement appears to have been the sole activity.

All of the component assemblages reflect early stage core reduction of lithic materials collected from the nearby gravel sources. There were differences in the sequencing of reduction stages and in the intended end products, however. The debitage from the Archaic component at LA 158642 evidence primary reduction of nodules brought back to the residential camps, and the high flake to core ratio suggests that trimmed cores of the better-quality materials were subsequently removed from the site. This was also the only component with bifacial reduction debris indicative of formal tool manufacture, although this activity was clearly secondary to the core reduction.

The lithic assemblage from the Basketmaker component at LA 158640, in contrast, consists largely of debitage from secondary core reduction. The absence of cortical platforms and dearth of flakes with >50% cortex suggest that initial reduction of the lithic nodules occurred before they were brought back to the camps. The flake to core ratio (1:36) suggests that secondary reduction at the camps may have been directed toward further shaping the cores before they were transported. Alternatively, the objective may have been the production of flake blanks, either for transport or use as expedient tools. The latter interpretation is suggested by O'Brien's observations that many of the tested cobbles would have produced only a few useable flakes, and that all but one of the cores associated with this component were exhausted (Chapter 10, this volume).

The debitage from the Developmental component at LA 158640 reflects the full core reduction sequence. All of the cores associated with this component are exhausted and the flake to core ratio is relatively low (1:18), which suggests that reduction was directed toward the production of expedient flake tools. Given this reduction trajectory, we would expect the assemblage to include utilized or retouch flakes since expedient tools tend to be discarded at the location of use, but none were recovered. One possible explanation for this discrepancy is that expedient tools were present but not identified. When the availability of tool stone is limited, expedient flake tools tend to be employed until the working edge is unusable, at which point the tool is either discarded or re-sharpened by retouching the working edge. If tool stone is readily available, though, then it is more efficient to discard a tool as soon as the edge begins to dull and continue the task with a new flake. In the former situation, expedient tools are generally identifiable by the use wear or retouch; in the latter situation, there is no tool retouch and the use wear may not be visible at the relatively low magnification routinely employed at OCA during analysis.

Not surprisingly, the lithic assemblage from LA 160886 reflects the initial reduction of cobbles from the gravel outcrop. Roughly three-quarters of the debitage has some cortex and a third has cortex covering >50% of the surface; there is also cortex on one-third of the flake platforms. The low debitage to core ratio (9:1) suggests that much of this reduction consisted of removing a few flakes from the nodules to assess the quality of the lithic raw material, which is consistent with evidence from the Archaic and Developmental components that selected nodules were brought back to the camps for initial reduction. It is also possible that some nodules initially reduced at LA 160886 were carried to the Basketmaker camps at LA 158640 for secondary reduction.

The reduction sequences for the remaining components could not be determined. No lithic artifacts were recovered during the limited excavations of the early Developmental component at LA 158642, and the association of surface lithics with the sherds marking the Classic and Coalition/Classic components at LA 158640 are uncertain. Similarly, the lithics from the Coalition component at LA 158641 appeared to be a mixed assemblage that included artifacts that had been carried downslope, possibly from LA 160886, and redeposited in the site area.

Judging from the small number of lithics associated with all but the Archaic component, the amount of tool stone collected and processed at the CNM Rio Rancho sites was fairly limited. This was likely due in part to the mediocre quality of the lithic materials in the local outcrops. Although the chalcedony itself is of good quality, the individual nodules often have cracks or other flaws that compromise its workability, as evidenced by the unusually high proportions of angular debris in all of the assemblages. Another factor was probably the ubiquity of lithic materials in the northern Llano de Albuquerque and the adjacent river valleys. Arakawa and Nicholson (2010) argue that Puebloan groups tended to exploit the lithic sources nearest their settlements. If they are correct, then the river valley gravels would have provided an ample supply of tool stone, and lithic from sources on the Llano would have utilized primarily to meet the immediate tool needs of groups engaged in subsistence activities on the mesa.

The Archaic lithic assemblage is much larger than those associated with later components, but it consists of the accumulated debris from multiple occupations, at least some of which were of moderate duration. Thus the lithic procurement activities associated with the individual occupations may not have been particularly intensive. Again, this may be related to the ubiquity of lithic sources in the region. There are severe constraints on the amount of material that mobile groups can carry with them (Parry and Kelly 1987), so it is doubtful that Archaic groups would have collected and transported any significant quantity of tool stone when it could be readily obtained from gravel outcrops almost anywhere on the Llano de Albuquerque. A more plausible hypothesis is that lithic raw materials were collected from the closest gravel outcrops on an as-needed basis. Given its marginal quality, the bulk of this tool stone was probably used to make expedient tools, although a few cores of high-quality material may have been transported for use in the manufacture of projectile points and other formal tools. A lithic technology organized in this fashion would produce a debitage assemblage very similar to that actually documented at LA 158642.

Because the lithic assemblages consisted almost entirely of local materials, little information was obtained about the prior movements of the groups who occupied the CNM Rio Rancho sites. The only clearly non-local lithic materials was obsidian. Four obsidian artifacts were recovered during the project – a projectile point and two flakes from the Archaic occupation at LA 158642, and a flake fragment from the Basketmaker component at LA 158640. The flakes were too small for XRF analysis but the projectile point was identified as Cerro Toledo obsidian. This obsidian is found in gravel deposits in the Rio Grande valley, which is consistent with the hypothesis that Archaic groups were moving onto the Llano from the river valley.

About 2% of the debitage in the Archaic assemblage was silicified wood and, apart from one angular debris fragment from LA 160886, none of the other components yielded this material. That distribution could be a function of sample size and the comparative rarity of silicified wood in the gravel deposits of the northeastern Llano de Albuquerque or, alternatively, it could be an indication that the silicified wood at LA 158642 is from a non-local source. Silicified wood is more common in the Ceja gravels of the western Llano, particularly in outcrops along the Rio Puerco escarpment, and it is generally the dominant or co-dominant lithic material at Archaic sites in that area (Elyea 1995; Schwendler and Railey 2009). It is therefore possible that LA 158642 was occupied in part by Archaic groups who moved into the area from the west.

GEOMORPHOLOGY

Geoarchaeological research was focused on evaluating the geomorphic processes affecting cultural deposits at the CNM Rio Rancho sites, but the results have some general implications for understanding the nature of the archaeological record on the Llano de Albuquerque. Most obviously, the sites were covered by a 2-20 cm thick layer of sandy sediments that had no measurable pedogenic alteration. This evidence, together with similar findings from previous investigations, indicates that the Llano de Albuquerque is blanketed by a thin layer of aeolian sand deposited within the last 100-200 years. As a result, most of the sites on the mesa are buried, which makes it more difficult to evaluate their significance and integrity on the basis of surface survey, and to plan and budget for data recovery.

The recent surface sands overlay Pleistocene age dune deposits in most of the excavation units, suggesting that the cultural deposits had been eroded prior to their recent reburial. Holocene age sediments with intact cultural deposits were preserved in certain contexts, however. Worman's analysis of the stratigraphy at LA 158640 indicated that sediments on the backslope of the dune ridge had been eroded by surface runoff and redeposited at the base of the slope. The artifacts remaining on the slope were a lag deposit, while those at the base of the slope were in a secondary context within a matrix of intermixed Pleistocene, Holocene, and recent sediments. The crest of the dune ridge was less subject to water erosion, and remnant Holocene deposits with intact cultural deposits were had uncovered in that area. Subsequent excavations at LA 158642 further demonstrated that intact cultural deposits were occasionally preserved beneath the sediment wedge at the base of the slope on the leeward side of the dune ridges. This slope erosion model appears generally applicable to the dune ridges on the Llano de Albuquerque, which makes it a useful tool for identifying site areas where excavation are most likely to be productive.

Finally, the alluvial deposits associated with the Archaic component at LA 158642 indicate that the camps were situated adjacent to a broad, shallow swale and not an incised channel. Further, pedological data from the study area suggest that an extensive sand sheet was deposited over the northern Llano de Albuquerque, probably during the mid-Holocene. Those aeolian sediments would have greatly increased capacity of the land surface to absorb and retain rainfall, thereby reducing surface runoff. Under those conditions, which may have persisted as late as 4000-3000 BP, Worman argues that drainages on the Llano may not have been continuous channels but instead consisted of discontinuous shallow swales like the one uncovered at LA 158642 (Figure 15.3). Any runoff that did occur after rainstorms therefore would have been concentrated in the swales and not carried to the Rio Grande. The enhanced moisture at these locations would have increased the productivity of many of the economically important plants and the ponding would have provided a seasonal water source for the Archaic groups exploiting those resources.

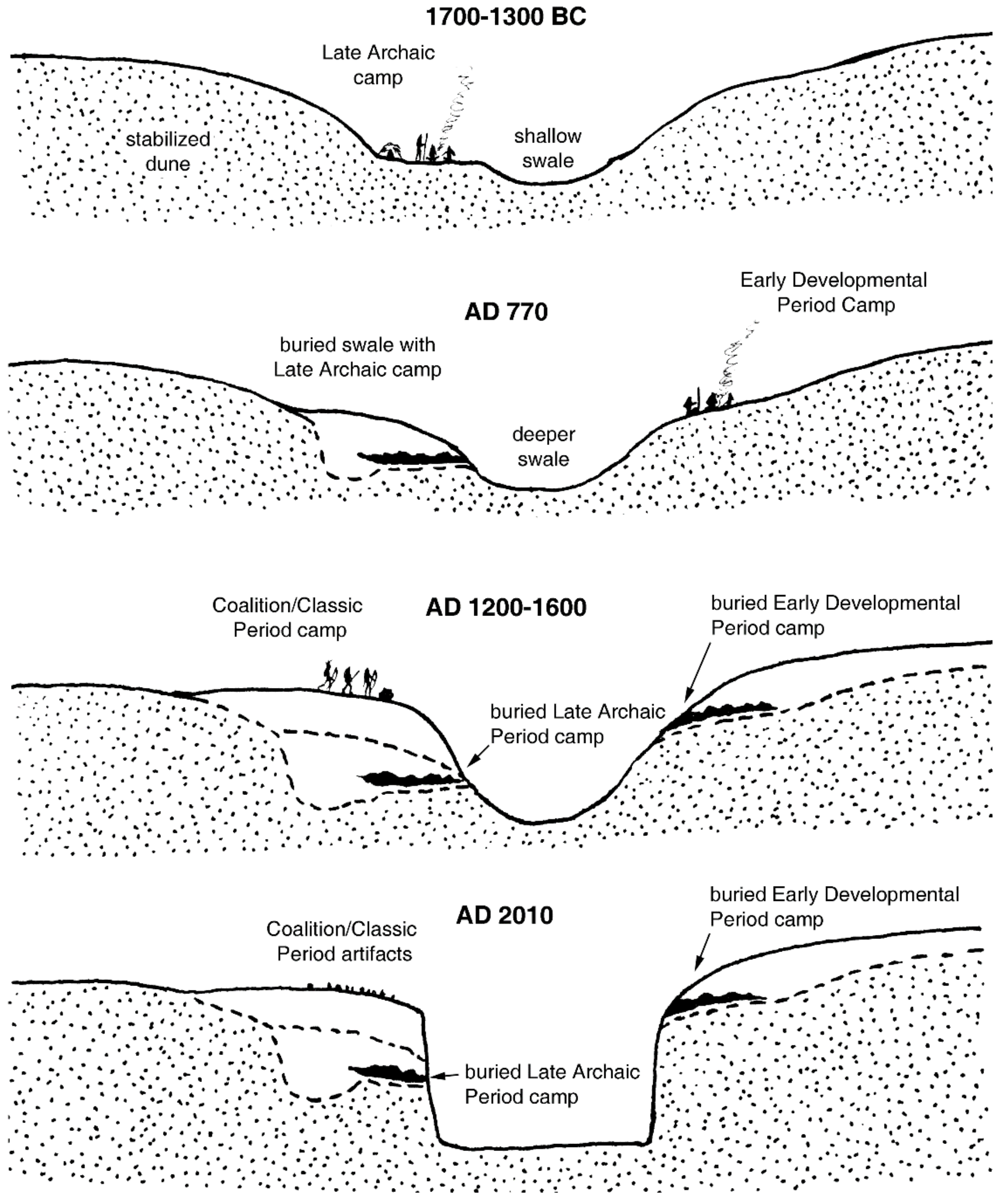


Figure 15.3. Schematic sequence of occupations and depositional episodes at LA 158642 near an unnamed drainage.

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Appendix A

RADIOCARBON DATES FROM EXCAVATED SITES

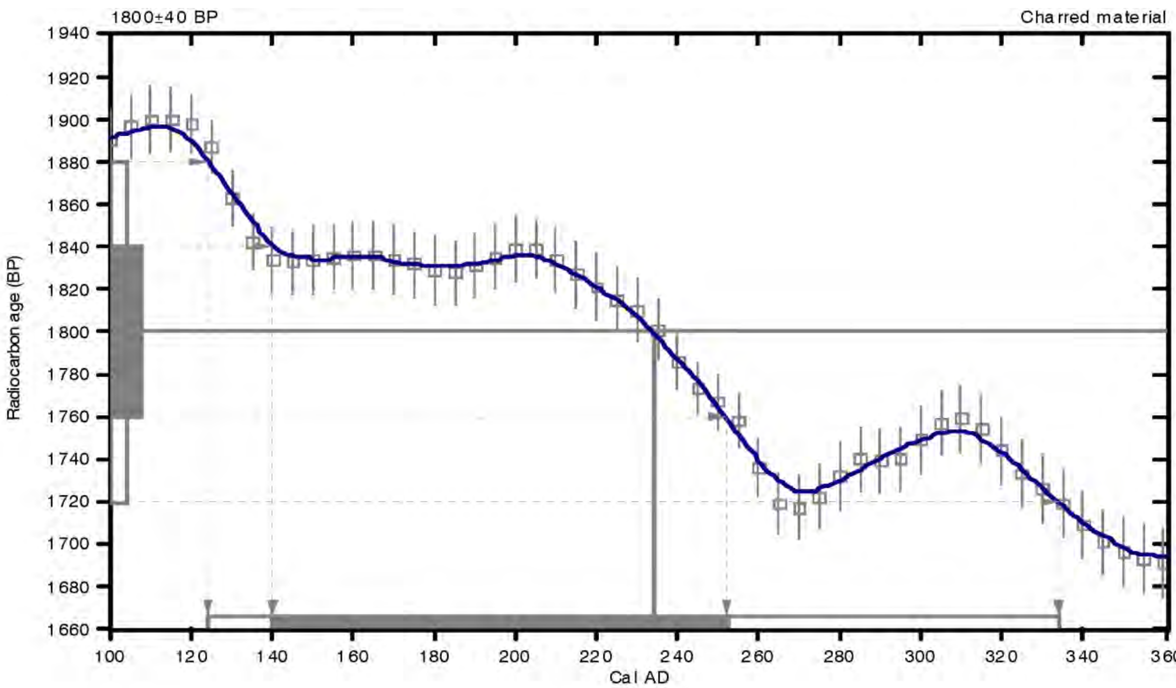
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-20.6:lab. mult=1)

Laboratory number:	**Beta-265700**
Conventional radiocarbon age:	**1800±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 120 to 330 (Cal BP 1830 to 1620)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 230 (Cal BP 1720)
1 Sigma calibrated result: (68% probability)	Cal AD 140 to 250 (Cal BP 1810 to 1700)



References:

Database used

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Calibration Database

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Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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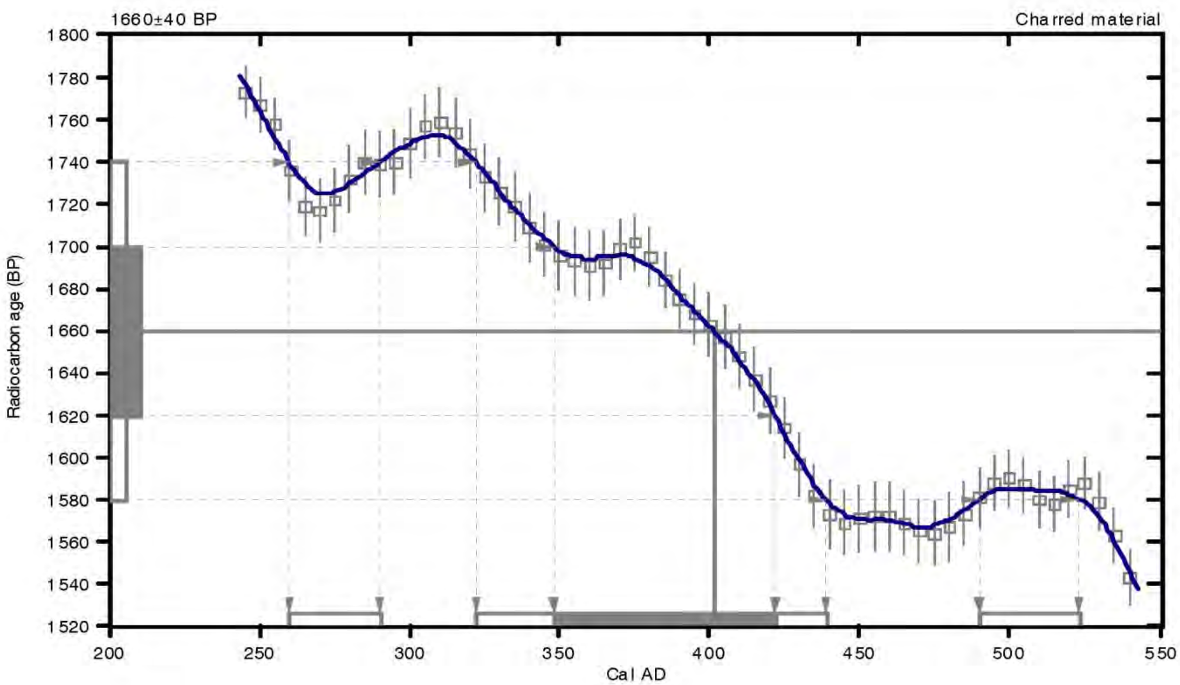
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-10.8:lab. mult=1)

Laboratory number:	**Beta-265701**
Conventional radiocarbon age:	**1660±40 BP**
2 Sigma calibrated results: **(95% probability)**	**Cal AD 260 to 290 (Cal BP 1690 to 1660) and Cal AD 320 to 440 (Cal BP 1630 to 1510) and Cal AD 490 to 520 (Cal BP 1460 to 1430)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 400 (Cal BP 1550)
1 Sigma calibrated result: (68% probability)	Cal AD 350 to 420 (Cal BP 1600 to 1530)



References:

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.1:lab. mult=1)

Laboratory number: **Beta-265702**

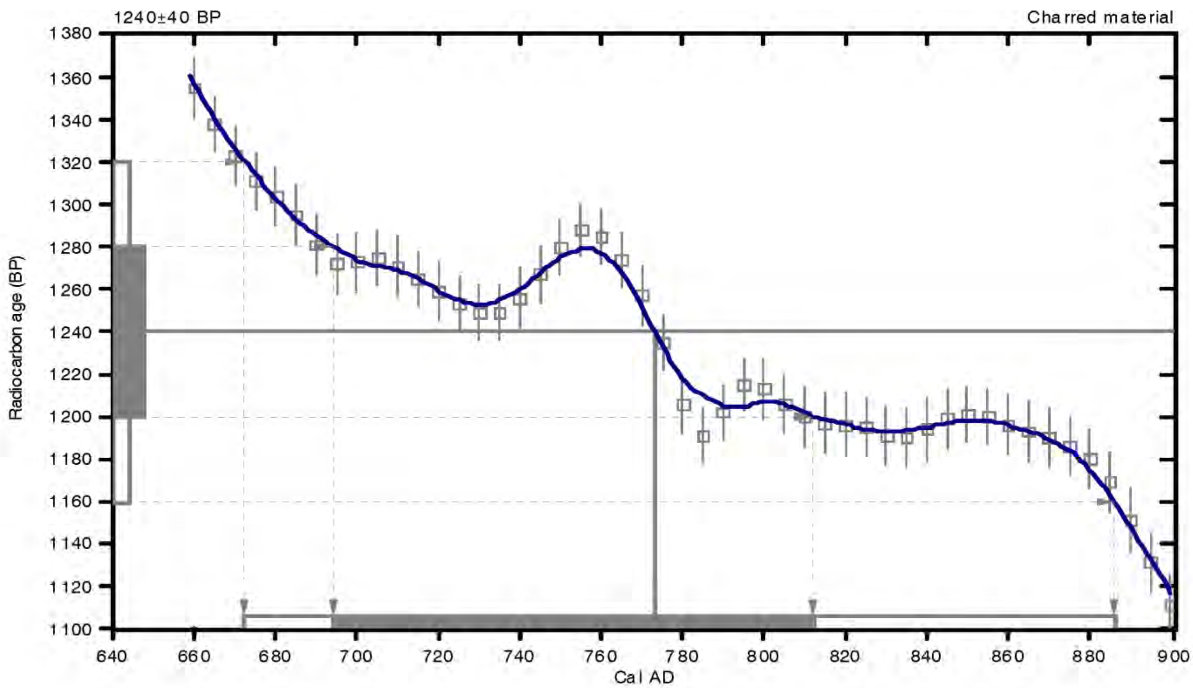
Conventional radiocarbon age: **1240±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 670 to 890 (Cal BP 1280 to 1060)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 770 (Cal BP 1180)

1 Sigma calibrated result: (68% probability) Cal AD 690 to 810 (Cal BP 1260 to 1140)



References:

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IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-19.2:lab. mult=1)

Laboratory number: **Beta-265703**

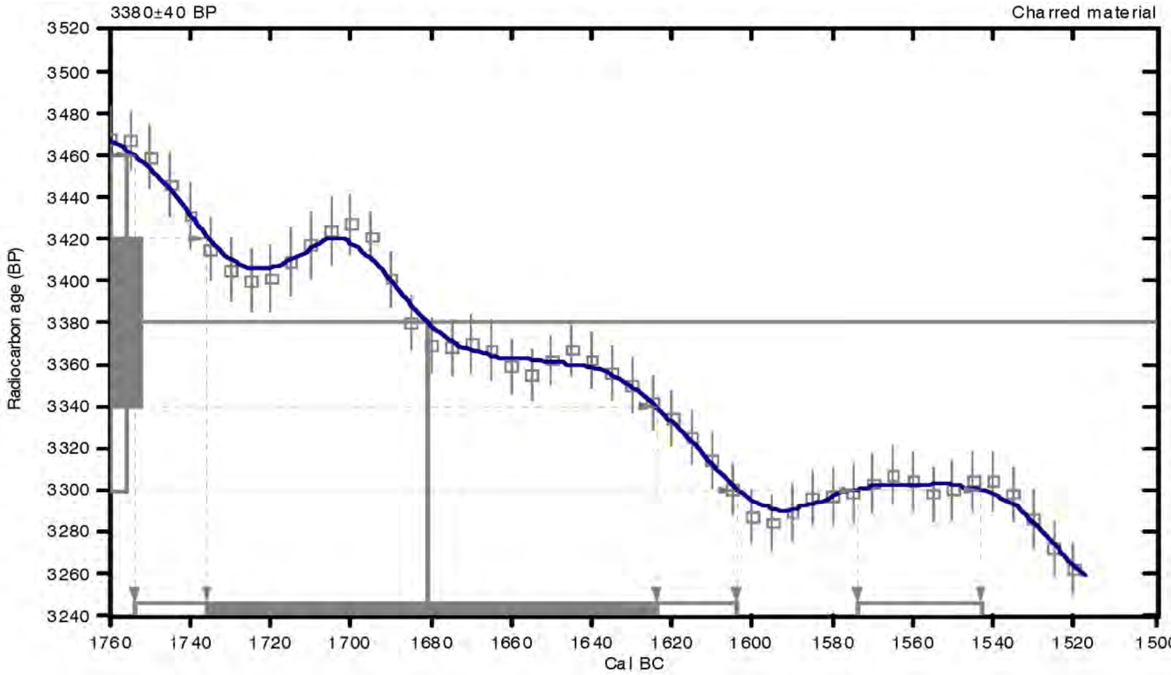
Conventional radiocarbon age: **3380±40 BP**

2 Sigma calibrated results: **Cal BC 1750 to 1600 (Cal BP 3700 to 3550) and**
(95% probability) **Cal BC 1570 to 1540 (Cal BP 3520 to 3490)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 1680 (Cal BP 3630)

1 Sigma calibrated result: Cal BC 1740 to 1620 (Cal BP 3690 to 3570)
(68% probability)



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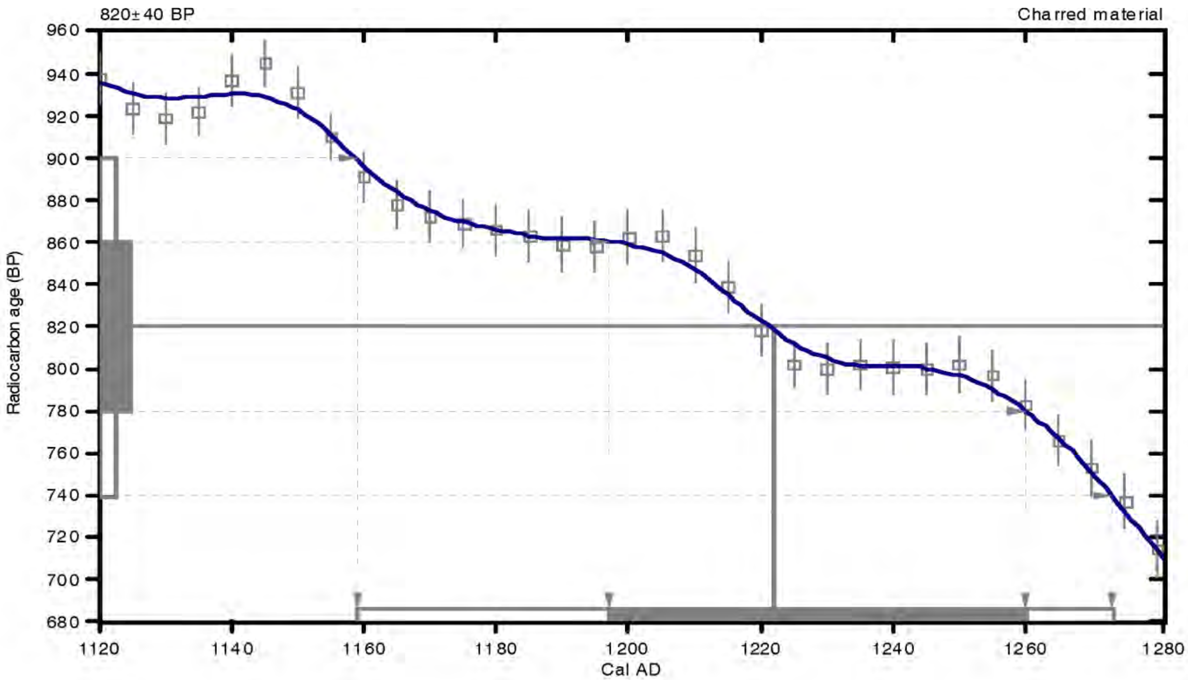
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-11.5:lab. mult=1)

Laboratory number:	**Beta-265704**
Conventional radiocarbon age:	**820±40 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 1160 to 1270 (Cal BP 790 to 680)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 1220 (Cal BP 730)
1 Sigma calibrated result: (68% probability)	Cal AD 1200 to 1260 (Cal BP 750 to 690)



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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-19.4:lab. mult=1)

Laboratory number: **Beta-265705**

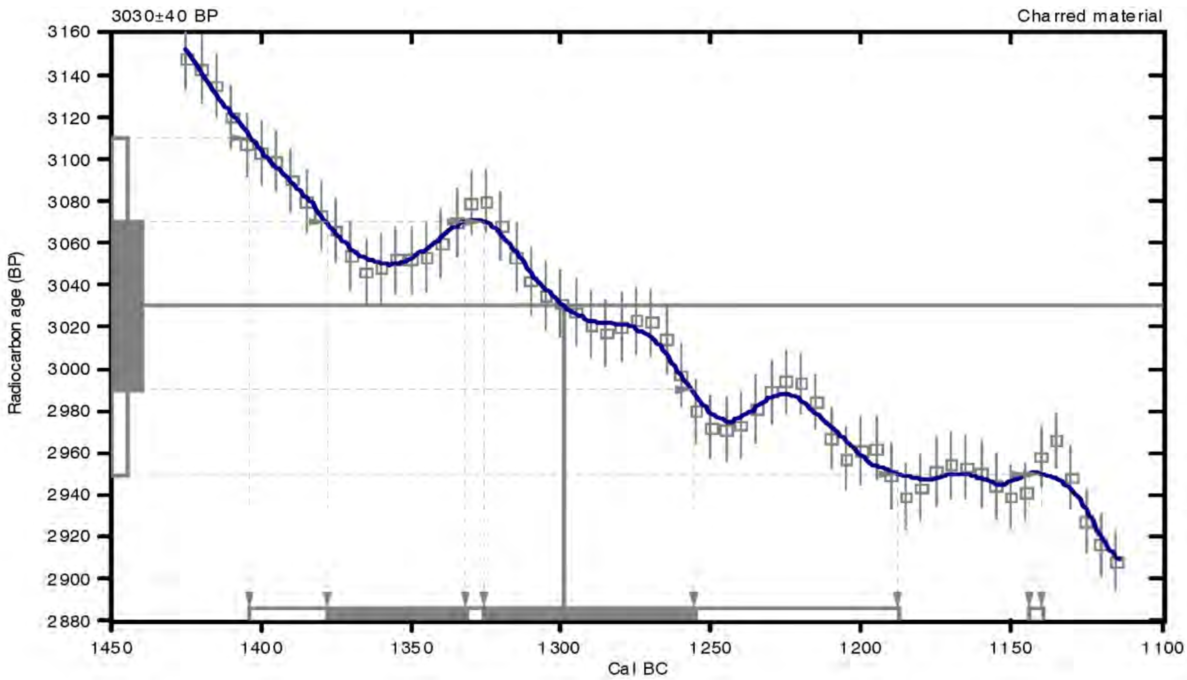
Conventional radiocarbon age: **3030±40 BP**

2 Sigma calibrated results: **Cal BC 1400 to 1190 (Cal BP 3350 to 3140) and**
(95% probability) **Cal BC 1140 to 1140 (Cal BP 3090 to 3090)**

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal BC 1300 (Cal BP 3250)

1 Sigma calibrated results: Cal BC 1380 to 1330 (Cal BP 3330 to 3280) and
(68% probability) Cal BC 1330 to 1260 (Cal BP 3280 to 3210)



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Appendix B

GEOARCHAEOLOGICAL INVESTIGATIONS

Geoarchaeological studies were conducted in tandem with archaeological excavations at sites LA 158640 and 158642 in the future location of the CNM Rio Rancho campus. While geoarchaeological techniques have been used to address a wide variety of questions, the current research was conducted primarily to illuminate site taphonomy, i.e. the post-depositional processes that impacted the patterns and associations visible in the archaeological record (c.f. "N-transforms", Schiffer 1972, 1987). Additional goals of the geoarchaeological research included illuminating the landscape context of the sites in relation to the larger geological and geomorphic contexts (see Chapter 3, this volume) and, where possible, inferring climatic conditions during the prehispanic occupations. The geoarchaeological research therefore focused largely on pedological (soil) and geomorphic (landform) investigations.

The in-field geoarchaeological investigations consisted of photographing and producing formal pedostratigraphic descriptions of the soils and sediments exposed in study units 1, 2, 3, and 6 at LA 158640. At LA 158642, formal pedostratigraphic descriptions were produced at study units 6 and 7, and photographs and measured profile drawings as well as pedostratigraphic descriptions were completed along the north bank of the arroyo at feature 1 and in a backhoe trench excavated to the west of study unit 2. The combined data generated insights into long-term landscape evolution, including catenary relationships, hillslope processes, and changes in the small ephemeral stream system that bisects LA 158642. The results of the geoarchaeological investigations largely were presented in chapters 7 and 8 of this volume, detailing the research at sites LA 158642 and LA 158640, respectively, and there are additional contributions to chapter 2. This appendix provides a discussion of the methods employed in the geoarchaeological investigations, the formal pedostratigraphic data for each recorded profile are presented in tabular form, and it includes a key to the terms used in those descriptions.

METHODS

After controlled archaeological excavations were completed, selected excavation units were cleaned and photographed. In addition, a backhoe trench was excavated immediately to the west of the large block of controlled excavations in study unit 2 at LA 158642; the trench was placed perpendicular to the arroyo, extending approximately 25 m uphill from the bank. The backhoe trench was photographed and a measured profile drawing of the east wall was produced. The north bank of the arroyo in the vicinity of Feature 1 at LA 158642 also was photographed and drawn. The exposed soils and sediments in the backhoe trench, arroyo bank, and in the excavation units selected for study were described using standard field techniques (Birkeland 1999: Appendix 1, 347–359; Buol et al. 1997; Schoenberger et al. 2002; Soil Survey Division Staff 1993, 1999). Terminology used in recording generally follows Birkeland (1999); basic definitions of common terms are provided below.

Soil horizons and depositional strata were identified visually and by comparing the color and structure of peds (natural soil aggregates) removed from the profile at different depths. The following characteristics of each stratum and horizon were evaluated in the field and recorded: depth, thickness, color, structure, consistence, texture, clay films, carbonate accumulation, boundary characteristics, and the presence, abundance, size and orientation of artifacts and other clasts. Boundary morphology and the size and orientation of clasts were evaluated visually while sediments were *in situ* in the profile. Calcium carbonate ($CaCO_3$) accumulation was measured by testing reactivity to a 10% solution of hydrochloric acid (HCl) applied to the vertical column and by visual inspection of sediments to identify carbonate nodules, filaments, coatings on clasts and sand grains and whitening of sediments.

A sample of sediment removed from each stratum was placed in a 2 mm soil sieve. Peds were examined macroscopically to characterize structure and a 10x hand lens was used to aid in the identification and description of clay films. After evaluating dry consistence, the remaining peds and sediment were crushed through the soil screen. The gravel content was estimated by comparing the amount of screened sediment to the clasts remaining in the screen. The size and degree of rounding of those clasts were recorded. Color was measured by comparing samples of dry and moistened screened sediments to a Munsell Soil Color Chart (1994). Finally, the soil texture class of each stratum was estimated by wetting a sample of screened sediments and observing characteristics such as stickiness, plasticity, consistence, grittiness, etc. While many of these observations (especially color and texture) potentially can be affected by inter-observer error, all formal soil descriptions were completed by Worman; the observations should be comparable between sample loci.

These in-field observations facilitated a characterization of the degree of pedogenic alteration of (soil development in) the sediments that comprise the different surfaces across the site as well as, where applicable, buried deposits. Because soils form slowly on stable surfaces, and because pedogenesis proceeds along a more-or-less predictable trajectory, these data inform on the ages and long-term stability of different surfaces. Within a region, where the soil forming factors (Jenny 1941) are comparable, the observed degree of pedogenic alteration can be compared to that recorded in locations with absolute age estimates to infer an approximate age for a stratum. The data also are relevant to the local history of erosion and deposition, and they provide some insight into the degree of post-depositional mixing. Additional direct observations of evidence for faunalturbation, including visible insect krotovina and the presence of active rodent burrows, also inform on recent sediment mixing. The relevant data were recorded independently for each excavation unit and for the backhoe trench and arroyo bank. Subsequently the data were aggregated to generate insights into processes affecting the archaeological record at the micro-regional scale (i.e., the area covered by the two sites).

KEY TO TERMINOLOGY

The information in this key is summarized primarily from Birkeland 1999: Appendix 1, 347–359. See also Buol *et al.* 1997; Holliday 2004; Schoenberger *et al.* 2002; Soil Survey Division Staff 1993, 1999.

HORIZON

Horizon designations consist of a master horizon, given as a capital letter, and subordinate distinguishing modifiers, given as lower-case letters. Soil horizons form in sediments at and near the surface through processes generally related to weathering and the movement of water through the solum; as such they are seldom isomorphic with depositional units.

Master horizons encountered here include A, B, C and K. The A horizon is the uppermost layer of the mineral soil, usually enriched in organic carbon, and in which biotic processes are most significant. It is also a zone of eluviation, i.e. weathering products are removed from this horizon and translocated downwards through the soil profile. The B horizon is the zone of illuviation in which weathering products translocated downward from higher in the soil profile accumulate. C denotes unaltered or minimally altered soil parent material, the sediments in which soils form. K horizons, also called petrocalcic horizons, are zones in which the accumulation of pedogenic calcium carbonate ($CaCO_3$) is sufficient to cause lithification of the sediments. These are stage III or higher in the classification of Gile *et al.* (1966), as modified by Machette (1985). Colloquially, they frequently are known as “caliche”.

Subordinate distinguishing modifiers used here include t, w, j, k, y, b and m. All of these but b and m are used to denote accumulation of pedogenic materials through illuviation and therefore they are by definition applied to the B or K horizons. b indicates burial, so Ab, for example, describes a former surface horizon that now is buried. m refers to a massive unit, one that is more than 90% cemented, usually as a result of illuviation. t denotes an accumulation of pedogenic clays, typically recognized by identifying clay films. w indicates weak illuviation in the B horizon, enough to cause a color change but insufficient for the specific pedogenic processes to be identified with certainty. Bw horizons frequently are referred to as cambic horizons. j is used to signal that the illuviation process, although recognizable, is weak; as clays accumulate through time, a B horizon would progress from Bw to Btj to Bt. k indicates the presence of pedogenic $CaCO_3$ and y refers to the presence of other soluble chemical salts such as gypsum ($CaSO_4 * 2H_2O$).

Numbers placed before the master horizon designation indicate a different source of deposition. Numbers after the designation indicate a change in the observed characteristics within a soil horizon that are not related to parent material.

Significant mixing of two horizons, where deposits originating in each remain identifiable, is indicated by listing both horizons, separated by a slash, e.g. “E/B”.

In cases where a horizon has characteristics of two master horizons, it is designated by both letters, e.g., “AB”. This is most common in cases of *soil welding,* where one horizon is being transformed into another due to a change in conditions, such as burial.

STRATUM

Designated strata such as those described in the backhoe trench at LA 158642 are depositional units, unlike soil horizons which form over time in near-surface strata (the generic term “stratum”, however, can be applied to a soil horizon or any other distinguishable layer of sediments). For the backhoe trench, the depositional strata are identified separately from soil horizons, and a horizon designation also is given indicating the primary pedological processes inferred for each unit. Strata are assigned Roman numeral designations, with numbers from I–VII following the inferred depositional chronology from oldest to youngest.

DEPTH

By convention, depth of soil horizons is measured from the top of the mineral soil. All measurements given here are in centimeters.

MUNSELL COLOR

Colors are estimated in the field by comparing dry and moist sediments to a Munsell Soil Color Chart (Munsell 1994).

STRUCTURE:

Structure describes the physical characteristics of peds (natural soil aggregates). It is characterized according to type, size, and grade.

Type describes ped shape and is divided into 5 classes: granular, angular blocky, subangular blocky, prismatic, columnar, and platy. The class designations are self-explanatory.

Size also is divided into five classes, from very fine to very coarse:

- Very fine..... granules or plates < 1 mm, blocks < 5 mm, prisms <10 mm.
- Fine..... granules or plates 1–2 mm, blocks 5–10 mm, prisms 10–20 mm.
- Medium..... granules or plates 2–5 mm, blocks 10–20 mm, prisms 20–50 mm.
- Coarse..... granules or plates 5–10 mm, blocks 20–50 mm, prisms 50–100 mm.
- Very coarse..... all peds larger than the coarse category.

Grade describes the distinctness of peds and the degree of structural development:

- Single grain..... no aggregation, dry sediments do not hold a face.
- Massive..... enough aggregation to hold a face, but no discernible ped structure.
- Weak..... peds are barely observable in place. Most of the material is unaggregated and few entire peds appear when the stratum is disturbed.
- Moderate..... peds are observable but not distinct in place. Many entire peds can be separated mechanically from the horizon.
- Strong..... peds are distinct in place and sediments removed from the horizon will be mostly entire peds.

GRAVEL PERCENTAGE

The gravel content of a deposit is estimated visually by passing sediments through a 2 mm sieve and comparing the amount of material larger and smaller than 2 mm. Categories used here include 0, 1, < 5%, 5–10%, and 10–100% by decile. In deposits that are spatially variable, the variability is characterized by providing a range (i.e., 20–40%). Additional descriptions of the gravels (such as degree of rounding, carbonate coatings etc.) are provided in the comments.

TEXTURE

Texture is estimated by observing dry consistence and then wetting a sample of screened material and observing wet consistence, stickiness, plasticity, the ability to form a stable ball and ribbon, the degree to which the moist sample soils hands, and the grittiness or smoothness of the sample. Based on the percentages of sand, silt and clay-sized particles, sediments are classified into the categories of sand, loamy sand, sandy loam, loam, clay loam, sandy clay loam, sandy clay, silt loam, silty clay loam, silty clay, silt, and clay.

CLAY FILMS

Clay film morphology is observed in the field by examining peds with a 10x hand lens. The films are classified according to amount, distinctness and location.

Amount is classified into four categories:

- None..... none observed.
- Very few..... covers < 5% of described surface.
- Few..... covers 5 – 25% of described surface.
- Common..... covers 25 – 50% of described surface.
- Many..... covers > 50% of described surface.

Distinctness is classified into three categories:

- Faint..... films are evident only at 10x magnification and create a weak contrast with unaltered material.
- Distinct..... films are visible to the naked eye and create distinct contrasts with unaltered material.
- Prominent..... films are conspicuous without magnification and create sharp contrasts, appear thick.

Location includes the following:

ped face, pores, bridges (between grains), and coatings (on grains).

CARBONATES

Carbonate content is estimated based on reaction to a 10% solution of hydrochloric acid (10%HCl) and visual inspection of filaments, coatings, nodules and whitening. The data are used to determine carbonate morphology, divided into stages as described by Gile *et al.* (1966) and Machette (1985).

HCl reaction is divided into five self-explanatory categories: non-effervescent, weakly effervescent, moderately effervescent, strongly effervescent and violently effervescent.

Filaments, coatings and nodules are divided into three categories: few/ faint, common, and very common. *Whitening* refers to the percent of the matrix, by area, that appears to be whitened by $CaCO_3$.

Carbonate Morphology is determined differently for gravelly and non-gravelly parent material as follows:

Stage (horizon)	**Non-gravelly parent material**	**Gravelly parent material**
I (Bk)	few filaments or faint coatings on sand grains; <10% $CaCO_3$	thin discontinuous clast coatings; some filaments; matrix can be calcareous next to stones, <10% $CaCO_3$
I+ (Bk)	filaments are common	many or all clast coatings are thin and continuous.
II (Bk)	few – common nodules, matrix between nodules is slightly whitened by $CaCO_3$. $CaCO_3$ occurs as veinlets and filaments. Some matrix can be non-calcareous. 10 – 15% $CaCO_3$.	continuous clast coatings. Local cementation of few to several clasts. Matrix is loose and calcareous enough to give somewhat whitened appearance.
II+ (Bk)	common nodules; matrix 50 – 90 % whitened. ca. 15% $CaCO_3$.	same as II except $CaCO_3$ in matrix is more pervasive
III (K)	continuous high-$CaCO_3$ fabric. Many nodules; $CaCO_3$ coats so many grains that >90% of horizon is white. $CaCO_3$–rich layers more common in upper part; ca. 20% $CaCO_3$.	continuous high-$CaCO_3$ fabric; horizon has 50 – 90% grains coated with $CaCO_3$ forming an essentially continuous medium. color mostly white. $CaCO_3$–rich layers more common in upper part; ca. 20 – 25% $CaCO_3$.
III+ (Km?)	continuous high-$CaCO_3$ fabric. most grains coated with $CaCO_3$; most pores plugged; >40% $CaCO_3$.	continuous high-$CaCO_3$ fabric. Most clasts have thick $CaCO_3$ coats. Matrix particles continuously coated with $CaCO_3$. Pores plugged by $CaCO_3$. +/- continuous cementation; >40% $CaCO_3$.
IV (Km)	Partly or entirely cemented (all parent materials). Upper part of K horizon is nearly pure cemented $CaCO_3$. (75 – 90%) with weak platy structure (weakly expressed laminar depositional layers). Remainder is plugged with $CaCO_3$ (50 – 75%).	

Stage (horizon)	Non-gravelly parent material	Gravelly parent material
V (Km)	Partly or entirely cemented (all parent materials). Laminar layers and platy structure strongly expressed at upper horizon. Incipient brecciation and pisolith (multiple thin layers of $CaCO_3$ around particles).	

LOWER BOUNDARY

The lower boundaries of strata are characterized according to distinctness and topography.

Distinctness is divided into four categories:

- Abrupt..... < 2 cm thick.
- Clear..... 2–5 cm thick.
- Gradual..... 5–15 cm thick.
- Diffuse..... > 15 cm thick.

Topography is divided into four categories:

- Smooth..... parallel to the soil surface.
- Wavy..... pockets of each stratum are wider than they are deep.
- Irregular..... pockets of each stratum are deeper than they are wide.
- Broken..... pockets of the horizon are entirely disconnected from other pockets.

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