CULTURAL RESOURCE

TECHNICAL SERIES
2000 - 1B Vol.1

Archaeological Data Recovery at Three Sites along NM 44, Sandoval and San Juan Counties, New Mexico

Cibola Research Consultants

New Mexico State Highway and Transportation Department

Archaeological Data Recovery at Three Sites along NM 44, Sandoval and San Juan Counties, New Mexico

NMSHTD Project No. SP-044-2 (226) 85
CN: 3525

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Cibola Research Report No. 231

Performed under
Jicarilla Apache ARPA Permit No. BIA-AAO-98-004
and Navajo Nation Permit No. C9822, ARPA Permit No. NAO-98-009

NMCRIS Project No. 58375
NMCRIS Activity No. 65016

NMSHTD Report No. 2000-1B, Vol. 1
August 2000

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Abstract

This report presents the results of an archaeological data recovery project for the NM 44-North highway improvement project in Sandoval and San Juan counties (NMSHTD Project No. SP-44-2 [226] 85, CN; 3525). A cultural resource survey previously completed for the project revealed 21 cultural resources within or adjacent to NM 44 (Marshall 1997). Subsequent review by the project engineers and the New Mexico State Highway and Transportation Department (NMSHTD) Environmental Section revealed that only three of these resources would be affected by the proposed construction. Data recovery at these locations was authorized and a research design and data recovery plan was completed by Cibola Research Consultants (Brown 1998).

The NM-44 North project was conducted with the use of federal funding. Data recovery at the three sites was conducted in compliance with the provisions of the National Historic Preservation Act of 1966, as amended through 1992, and applicable regulations. This report is consistent with applicable federal and state standards for cultural resource management.

The archaeological excavations were conducted in September and October of 1998. Permits to excavate LA 50460 (the Tancosa site) on Jicarilla Apache tribal lands were obtained from the Bureau of Indian Affairs (Permit No. BIA-AAO-98-004) and the Jicarilla Tribe. Permits to excavate LA 45961 (the Venado site) and LA 119580 (the Upper Kimbeto site) on Navajo tribal lands were obtained from the Bureau of Indian Affairs (NAO-98-009) and the Navajo Nation Historic Preservation Department (Permit No. C9822). The excavations were completed under the direction of Michael P. Marshall, Director of Archaeological Projects, Cibola Research Consultants.

All cultural remains identified within the NM 44-North project area have been excavated, and the research potential of each site within the highway right-of-way has been exhausted. The results of this data recovery project are presented in this report.

All three archaeological sites that were excavated are lithic artifact scatters of Archaic and early Formative period affinity with only limited to moderate research value. The data recovery project addressed research issues relating to cultural chronology and affiliation, site function, trade and exchange patterns, and subsistence and settlement systems. Information relevant to these research issues was obtained from the site excavations and is addressed primarily in Chapters 5 and 12. Various analytical methods were employed in the study. The ones that produced the most important results include the study of bone material from LA 50460 and the study of the botanical materials from the early component at LA 45961. Also of considerable

interest were the sixth millennium BC radiocarbon dates obtained from LA 50460.

Volume 1 of this report presents the results of the data recovery excavations and analysis of the materials recovered from LA 50460, LA 45961 and LA 119580. Volume 2, which has been placed on file in the New Mexico Cultural Resources Information System (NMCRIS) at the Laboratory of Anthropology in Santa Fe, includes updated site forms and site location maps. All other data, maps, and photographs have also been placed on file with NMCRIS. Artifacts recovered from the excavations have been curated by the Museum of New Mexico.

Chapter 1

Introduction

by Michael P. Marshall

This report presents the results of an archaeological data recovery project for the proposed NM 44-North highway improvement project (NMSHTD Project No. SP-44-2 [226] 85, CN: 3525). An archaeological survey of the NM 44-North corridor was completed by Cibola Research Consultants in October 1997 and 21 cultural resources were identified within and adjacent to the highway right-of-way (Marshall 1997). Subsequent review of the archaeological survey report by the New Mexico State Highway and Transportation Department (NMSHTD) Environmental Section and the New Mexico State Historic Preservation Division (NMSHPD) determined that three cultural properties of potential research value would be affected by the proposed highway construction. Avoidance of these cultural resources was not possible given the engineering plans for the proposed highway construction. Archaeological excavation and data recovery at the three cultural properties (LA 50460, LA 45961 and LA 119580) was therefore authorized. These sites are located in the Tancosa Wash, Counselor, and Kimbeto Wash areas (Figure 1).

A data recovery plan and research design for the proposed excavations at LA 50460, LA 45961, and LA 119580 was completed by Cibola Research Consultants in May 1998 and reviewed and approved by the NMSHTD. One of the archaeological sites, LA 50460, was located within the NM 44 highway right-of-way on Jicarilla Apache lands in Sandoval County, New Mexico. Excavations at this site were conducted under a Bureau of Indian Affairs (BIA) ARPA Permit No. BIA-AA0-98-004 dated September 9, 1998, and permission was granted to complete the excavations by the Jicarilla Apache tribe on August 18, 1999. The other two archaeological sites (LA 45961 and LA 119580) were located within the NM 44 highway right-of-way on lands under the jurisdiction of the Navajo Nation. Authorization to complete the data recovery projects at these locations was issued on July 10, 1998, by Navajo Nation Permit No. C9822 and ARPA Permit No. NA0-98-009.

Excavation and data recovery at the three NM 44-North sites were completed by Cibola Research Consultants in September and October of 1998. The excavations were conducted under the direction of Michael P. Marshall with the assistance of Elizabeth Marshall, Christina Marshall, and Louis Springer. Other workers on the project were local Navajo residents and included Johnny Chiquito, Johnny Begaye, Alfonso Gould, Alvin Gould, Jasper Gould, and Vincent Gould. Backhoe excavations at two of the sites (LA 45961 and LA 50460) were conducted by Alley Cat Excavating.

Because of time constraints imposed by the schedule for highway construction, excavations and data recovery at the sites were completed following the archaeological survey and without the benefit of preliminary archaeological testing. Therefore, the nature and extent of the

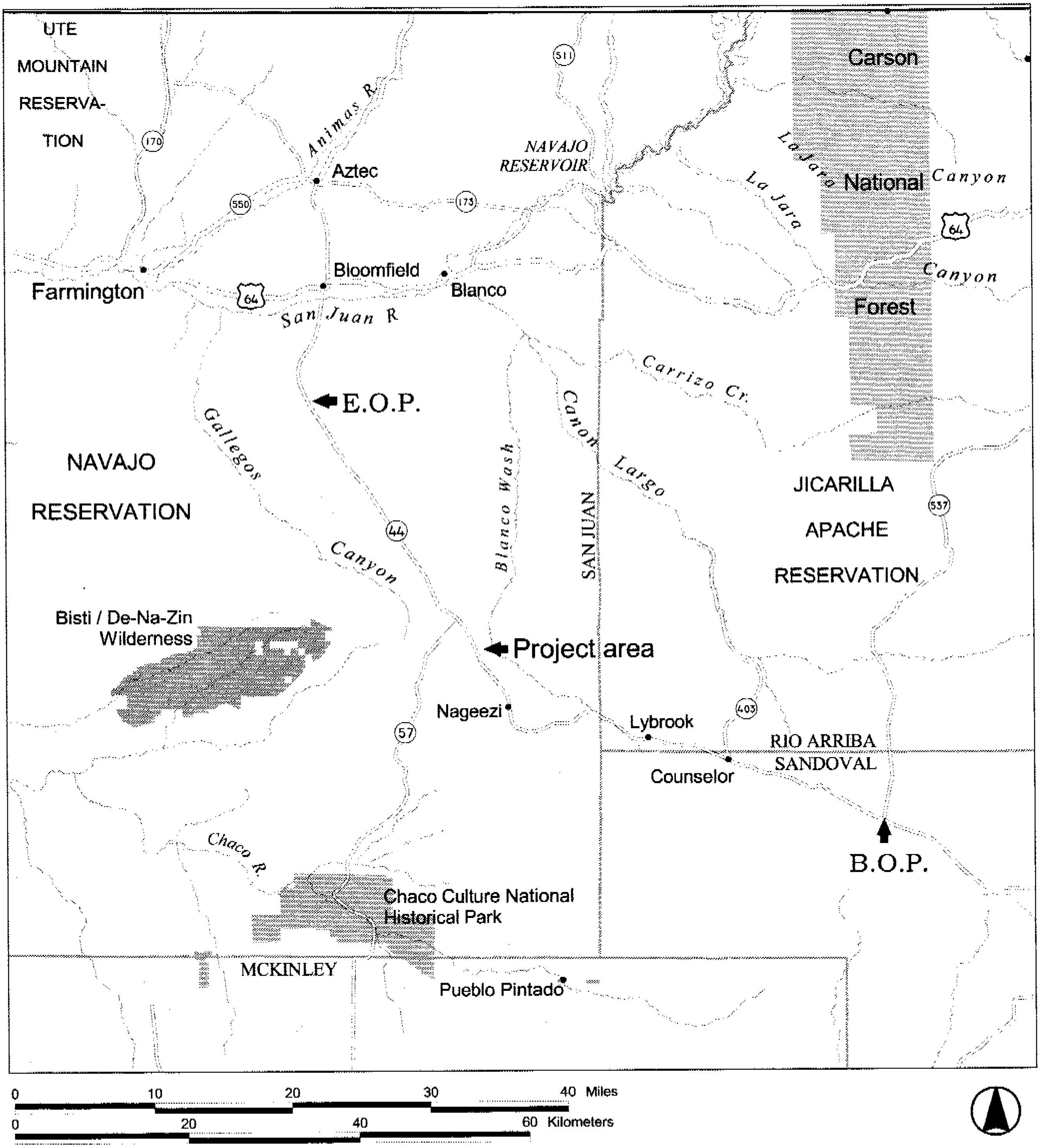

Figure 1. Location of the NM 44-North Project Area

excavations at the sites were allowed to change in order to accommodate the cultural remains that were discovered in subsurface contexts. Most of the data recovery (ca. 70 person-days) took place at LA 50460 where intact cultural sediments and structural features were found. Twenty person-days were devoted to the excavation of LA 45961, where minor cultural features and scattered artifacts were found. Excavations at LA 119580 encompassed 10 person-days and failed to reveal any intact cultural remains.

All of the archaeological sites excavated in the NM 44-North highway right-of-way are prehistoric Archaic period components defined by scatters of lithic artifacts and fire-heated stone. LA 50460 is an Archaic period site which yielded radiocarbon dates in the sixth millennium BC. LA 50460 has two components that were designated as the West and East proveniences. Both are located along the south side of the NM 44 highway right-of-way. A portion of the West Provenience was removed by previous NM 44 highway construction. The West Provenience was confined to an 8 by 34 m area along the south edge of the NM 44 roadcut. Excavations were completed in a 104 square meter area and involved the removal of an estimated 83.2 cubic meters of fill. A 50-cm-thick zone of cultural sediment was found 30–80 cm below the ground surface in the West Provenience. This cultural fill contained a concentration of chipped and ground stone artifacts, bone, and a low density scatter of fire-heated stone. No hearths were identified in the excavation. However, an area of dark charcoal-stained sediments measuring 2 by 3 m (Feature 3) was identified, which might have been a shelter or activity area. Radiocarbon dates from the West Provenience indicate an occupation of ca. 5720 to 5510 BC.

The East Provenience at LA 50460 was confined to an 8 by 12 m area and contained a 20-cm-thick zone of cultural fill, located 20 cm below the ground surface. Excavations were completed within a 72 square meter area and involved the removal of an estimated 14.4 cubic meters of fill. Located within the East Provenience were two concentrations of fire-heated stone that were designated Features 1 and 2. The estimated 2.25 cubic meters of fire-heated stone in the East Provenience is approximately 30 times the quantity found in the West Provenience. A diffuse scatter of chipped and ground stone artifacts and 26 bone fragments were also found in the East Provenience. A single radiocarbon date obtained from the East Provenience indicates an occupation ca. 5140 BC ± 190.

Excavations at LA 45961 revealed two occupational components. The earliest component consisted of an isolated undercut storage pit found at a depth of 1.0 m below the surface. This pit appears to have been an isolated feature. The only artifacts in the pit fill were three chipped stone flakes and a small ground sandstone slab fragment. Carbonized materials of *Zea mays* and wood were also found in the pit. Flotation samples yielded 961 carbonized corn cupules, 2 kernels, and 2 corncobs. The corn is a primitive flint or popcorn type with indurate floral bracts. Radiocarbon analysis of the corn yielded a date of 2570 BP ± 120 (ca. 740–500 BC). Radiocarbon analysis of carbonized wood from the pit fill yielded a date of 2030 BP ± 100 (ca. 180 BC to AD 20). Since the dates were obtained from the same confined fill within the pit, some type of radiocarbon analysis or sample error is apparent. Nonetheless, it is evident that the pit was used sometime during the late Archaic period.

The late component at LA 45961 is defined by a diffuse scatter of chipped and ground stone artifacts that extended over a 16 by 44 m area. However, most of the site had been disturbed by the construction of NM 44 and a nearby gas pipeline, and the site was originally much larger.

Excavations were confined to the north highway right-of-way within undisturbed areas with the highest artifact density. These excavations encompassed 96 square meters and 9.6 cubic meters of fill. A concentration of artifacts was found in the upper 15 cm of fill. However, no intact cultural sediments or structures were found in the late component. Unfortunately, no datable floral or faunal material was obtained from the late component. However, two small arrow point fragments found on the surface of the site suggest a Formative period affinity. A small section of this site may still be intact outside and south of the NM 44 highway right-of-way.

Archaeological survey investigations at LA 119580 revealed a small scatter of chipped stone artifacts and traces of fire-heated stone in a 10-m-diameter area. These artifacts occurred on the upper margins of a highway roadcut on the edge of a sand dune. Data recovery at LA 119580 involved the removal of the dune fill above the apparent occupation surface. Excavations encompassed a 64 square meter area and removed an estimated 25.1 cubic meters of fill. These investigations revealed no intact cultural remains, yielding only two subsurface artifacts. It is clear that the site was a limited activity area. A hearth stain that was excavated in the west site area was found to contain modern bottle glass. No diagnostic artifacts or datable samples were obtained. The chipped stone artifacts are probably of prehistoric affinity, but the specific cultural-temporal affiliation of the site cannot be determined.

All intact cultural remains that extended into the NM 44 right-of-way at LA 50460, LA 45961, and LA 119580 were excavated. Therefore, the effect of the NM 44-North project on the three archaeological sites in the project areas has been mitigated and no further treatment is recommended.

The artifacts and other cultural materials recovered from the excavations have been analyzed and submitted to the Museum of New Mexico for curation. An extensive photographic record of the excavations and site features has been placed on file with the New Mexico Cultural Resources Information System (NMCRIS) in Santa Fe with the site forms. Lithic artifact analysis forms and code sheets for the sites have also been placed in the site files.

Chapter 2

Environmental Context

by Marie E. Brown and Michael P. Marshall

The three archaeological sites investigated in the NM 44-North data recovery project are located in the eastern portion of the San Juan Basin in northwestern New Mexico. All of the sites are located on upper tributaries of the San Juan drainage system west of the continental divide. Two of the sites (LA 50460 and LA 45961) are situated in upper tributaries of the Largo Canyon drainage system. The other site (LA 119580) is situated in the upper Kimbeto drainage which flows southwest into the Chaco River.

The San Juan Basin forms the eastern half of the Navajo section of the Colorado Plateau physiographic province. Stratigraphically, the basin is actually a series of "nested basins with a younger central basin surrounded by uplands of varying structure and age" (Vivian 1990:16). The strata of the San Juan Basin are composed primarily of sandstone, shale, and clay deposits of late Cretaceous and early Tertiary affinity. During the late Cretaceous period, the study area was located near the western shoreline of a tropical sea. The edge of the sea fluctuated over time, leaving a variety of depositional strata of both marine and terrestrial natures. At the end of the Cretaceous period, the sea retreated and extensive volumes of sediments were deposited in the San Juan Basin (Vivian 1990).

Some researchers limit the San Juan Basin to the central basin floor. However, most archaeologists follow Kelley's (1950) definition and include adjacent portions of surrounding landforms. The San Juan Basin is characterized by three major types of structural features—the Central Basin, the Hogback monocline, and uplifts and platforms that border the monocline. The Central Basin is roughly circular, extending 160 km north-south and 145 km east-west. Elevations within this basin range from 1,500 to 2,500 m above sea level. The NM 44-North archaeological sites are situated on the eastern edge of the basin within the 2,050 to 2,085 m elevation range.

The majority of the basin is drained by the San Juan River. The landscape, which consists of broad plains and valleys with small mesas and buttes and occasional canyons, was produced by erosion. The Hogback monocline "represents a steep flexure between an outer anticlinal bend and an inner synclinal bend" (Vivian 1990:16). Alternating uplifts—the Carrizo, Ute, La Plata, Nacimiento, San Pedro, and Zuni Mountains and the Defiance Plateau—and platforms—the Four Corners, Chama, Puerco, Acoma, and Zuni—comprise the outermost rim of the San Juan Basin and were formed during the Cretaceous period.

Vivian (1990:25–31) divides the San Juan Basin into two major zones, the interior lowlands and the encircling uplands, each of which is divided into several smaller units based on drainage patterns and geology. The lowland units are further separated into subareas. The NM 44-North project area is situated within the Gobernador Slope of the lowland subarea. The

Gobernador Slope is roughly triangular. It is bounded by the San Juan River on the north, the Hogback monocline on west, part of the Nacimiento Uplift on the east, and the Chaco watershed on the south and west (Vivian 1990:16-28). Drainage in the area of the Tancosa site (LA 50460) flows northwest in Tancosa Wash into the Largo Canyon system. Drainage in the area of the Venado site (LA 45961) flows east into the Largo Canyon system. Drainage in the area of the Upper Kimbeto site (LA 119580) flows southwest along Kimbeto Wash into the Escavada-Chaco system. The situation of the NM 44-North sites allowed access to resources of the basin floor, Nacimiento Uplift, and Largo Canyon environments.

Soils in the Gobernador Slope subarea are basically of marine origin and are composed of fine- to medium-grained sediments. Although finer-grained soils can store water longer, "they tend to collect minerals more quickly, thereby creating a potential for salinization" (Vivian 1990:19). Eolian soils that form on the margins of wide sandy washes have good potential for agricultural use. Clay soils in badland and alluvial canyon floor environments are indurated and have only marginal agricultural potential. Most of the historic agricultural fields in the area are situated on sandy alluvial fans at the mouths of secondary drainages. Open areas of sandy soil may also have been dry-farmed during periods of increased moisture.

Surface water in the vicinity of the excavated sites is ephemeral but can often be found in arroyo floors and bedrock catchment basins after local rainfall. Tancosa Wash near LA 50460 usually contains a small flow of water and a few pools. Water can also be obtained by excavating small wells into the sandy floor of Kimbeto Wash near LA 119580.

Climate

The climate of the project area can be classified as semiarid. Generally, it is mild and dry. Winds are moderate, with dry westerly winds maintaining a low relative humidity. Air masses from the Pacific and Gulf of Mexico lose most of their moisture before reaching the San Juan Basin. The climate of the area "is conditioned by cyclic shifts of air mass circulation that move varying quantities of heat and moisture and create a biseasonal precipitation pattern" (Vivian 1990:20). During the winter, high pressure systems moving south and southeast draw cool, moist polar Pacific air from the northwest, producing winter storms. During the summer, most of the moisture comes from warm, moist tropical air originating in the Gulf of Mexico. However, greater precipitation is produced by occasional moist tropical Pacific air, drawn to the area by low pressure systems. Intense and localized convection storms commonly occur during the summer.

These weather patterns result in a biannual precipitation regime for the San Juan Basin. Although the total annual precipitation is divided almost equally between summer and winter, the summer is usually wetter. A sharp summer peak occurs from July to early September and a more rounded winter peak occurs from December to March. Because it occurs in short, localized, heavy rains, much of the summer moisture is lost to runoff. On the other hand, because winter precipitation in the form of snow generally melts slowly, the moisture is absorbed by the soils. Late fall is usually dry, but spring is the driest season. The total annual precipitation is low because of the rain-shadow effect that greatly reduces the amount of moisture reaching the basin. While the Central Basin averages about 20 cm (8 inches) per year, the surrounding

mountains receive 40 to 50 cm (24 to 28 inches). Precipitation in the NM 44-North site areas is approximately 10 inches per year. The amount of precipitation can vary from year to year, and cyclical patterns in overall rainfall in the past have created more arid or mesic conditions than presently exist.

The study area is characterized by high diurnal and annual temperature variations. Summers are hot and winters are cold to very cold. Yearly temperatures in the Central Basin area range from minus 24° to 106° Fahrenheit. The average frost-free season is 150 days. There is a strong, inverse correlation between the length of the frost-free period and elevation. The frost-free seasons are also affected by topographic location and cold air drainage (Gillespie 1985). Consequently, valley and canyon floors have shorter growing seasons. Late spring or early fall frosts occasionally result in corn and squash crop loss (Brugge 1980:461).

Flora

The vegetation of the San Juan Basin is affected by a number of interrelated factors—latitude, elevation, rate of evaporation, temperature, annual precipitation, and seasonal distribution of rainfall. In general, the Central Basin is characterized by grasslands. Juniper and mixed pinyon-juniper woodlands occur in the intermediate elevations. The mountains surrounding the basin support coniferous forests. Most of the woodlands adjacent to the study area are pinyon-juniper with occasional oak thickets. Scattered ponderosa pine can also be found within 5 km of the excavated sites.

"Local variables such as the presence of dunes or badlands have a strong effect on the exact mix of species available" (Sebastian 1992:10). Flora noted in the vicinity of the excavated NM 44-North sites includes various grasses, sagebrush, rabbitbrush, snakeweed, narrow-leaf yucca, Ephedra, four-wing saltbush, greasewood, pinyon, juniper, tumbleweed, prickly pear cactus, scrub oak, stickseed, primrose, Indian paintbrush, four o'clock, and cliffrose.

The Tancosa site (LA 50460) is located on the northern edge of Apache Flats, a large plain that supports a Great Basin Desert Scrub vegetative community. Vegetation in this community is dominated by big sagebrush *(Artemisia tridentata),* saltbush *(Atriplex canescens),* greasewood *(Sarcobatus vermiculatus),* alkali sacaton grass *(Sporobolus cryptandrus),* winterfat *(Ceratoides lanata),* and rabbitbrush *(Chrysothammus nauseosus).*

The Venado site (LA 45961) and the Upper Kimbeto site (LA 119580) are located within a coniferous woodland-savanna vegetative community. Vegetation in this community is dominated by one-seeded juniper *(Juniperus monosperma),* pinyon pine *(Pinus edulis)* big sagebrush *(Artemisia tridentata),* and rabbitbrush *(Chrysothamnus nauseosus).*

Fauna

More than 30 reptilian, 100 avian, and 30 mammalian species have been recorded for the San Juan Basin (Bierei 1977). Larger fauna are generally associated with major vegetational zones. Mule deer are common in most woodland zones. Pronghorn antelope are few in numbers because their prime habitat is not extensive, but they were observed in 1999 on the sagebrush plains near LA 50460. Smaller species tend to cross-cut the vegetation zones. As a result, small mammals (especially leporids), rodents, reptiles, and birds constitute the major fauna in the basin. Animal species represented in the fauna assemblage from LA 50460, in order of abundance, include mule deer, jackrabbit, prairie

dog, pocket gopher, desert cottontail, dog or coyote, pocket mouse, and kangaroo rat. Most of the smaller mammals are probably intrusive and postdate the site occupation. No faunal remains were recovered from LA 45961 or LA 119580.

Chapter 3

Site Descriptions

by Michael P. Marshall

LA 50460 (The Tancosa Site)

Previous Research: This site was first identified in an archaeological survey for a buried telephone cable along the outside south edge of the NM 44 highway right-of-way (Velarde 1985). A 1992 survey of the NM 44 right-of-way in the area failed to identify the site (Nelson 1992). However, the site was located during the 1997 survey of the NM 44-North highway right-of-way and was found to extend into the highway right-of-way (Marshall 1997:87). It was determined that the site would be affected by the proposed NM 44 highway improvements, and authorization to complete mitigative work at the site was issued by the New Mexico State Highway and Transportation Department.

Location: This site is located on the south side of NM 44 in Sandoval County, New Mexico (Figure 1). The specific location of the site is identified in Volume 2 of this report, which has been placed in the NMCRIS files at the Archeological Records Center in Santa Fe. The site is situated on the Jicarilla Apache Reservation at an elevation of 2,050 m (6,725 ft) above sea level.

Environment: This site is situated near the northwestern edge of a large open plain known as Apache Flats. It is in the upper Largo Canyon drainage system. The site is on a low rise approximately 175 m north of Tancosa Arroyo. Apache Flats is an extensive and elevated sagebrush-covered plain that encompasses approximately 100 square miles. Apache Flats is one of the largest upland plains in northwestern New Mexico. These plains are situated on upper tributaries of the Largo Canyon system within the Tancosa, Chacon, Valles, Menfee, Peña, and Five Lakes canyon drainages. Apache Flats is bounded on the south and east by the Continental Divide, on the west by Sisnathyel Mesa, and on the north by Largo Canyon.

Ephemeral lakes and ponds no doubt existed on Apache Flats during the prehistoric period, and the area may have attracted large herds of grazing animals. The site is near the northwestern edge of the plains, providing access to both Apache Flats and Upper Cañon Largo, which may have also been a passage for grazing animals. Visibility from the site location is extensive, but higher landforms occur about 300 m to the east. Water is usually available within Tancosa Wash, 175 m to the west.

The site is directly east of the plains adjacent to Tancosa Wash. It is on the summit of a low rise that is covered by a low, stabilized sand dune which has formed on the northeastern edge of the rise. Vegetation includes sagebrush, snakeweed, rabbitbrush, prickly pear cactus, and various grasses. A few scattered juniper trees occur on hill slopes that are 200 m or more to the east. Willows and occasional cottonwood trees fringe Tancosa Wash, 175 m to the west.

Excavation Methods: Archaeological excavations at LA 50460 were completed in October of 1998. The entire site area within the NM 44 highway right-of-way was investigated. Based on the distribution of surface artifacts, the site measured 18 m north-south by 82 m east-west along the south side of NM 44. The northern edge of the site had been destroyed by earlier construction along NM 44, and a gas pipeline had bisected the site along the southern edge of the highway right-of-way (Figures 2 and 3). Traces of chipped stone material were also found south of the highway right-of-way, but the main site area appears to have been within the highway right-of-way.

The surface distribution of all cultural materials in the site area was first marked with pin flags. A 2 by 2 m grid system was established over the site area with 41 grid units along the east-west axis and 9 grid units (A–I) between the south right-of-way fence and the north roadcut. Grading of a drainage area along the highway had removed an 8-m-wide area between the NM 44 pavement and the edge of the roadcut. All surface artifacts were mapped within the grid system and collected.

Excavations were initiated along the edge of the highway embankment in the West Provenience, where cultural materials were exposed in the roadcut. Initial excavations into the roadcut revealed a concentration of cultural material extending to a maximum depth of 70 to 80 cm below the ground surface, above a substrate of clean yellow sand. Most of the artifacts found in the excavations were located within the 30 to 70 cm zone. This 40-cm-thick zone of fine eolian sand was also lightly charcoal-stained. The few artifacts found above and below this zone may have been displaced by rodent activity. Materials within the cultural horizon may also have been impacted by rodent activity.

Based on these observations, three sample levels were designated for continued excavation: Level 1, the relatively sterile overburden, 0–30 cm below the ground surface; Level 2a, the upper section of the cultural deposit, 31–50 cm below the ground surface; and Level 2b, the lower section of the cultural deposit, 51–70 cm below the ground surface. A few artifacts were also found in the upper section of clean yellow sand directly under the cultural horizon, 70–80 cm below the ground surface. However, these materials were included within the Level 2b sample as they were probably displaced by rodent activity. Test pits and trenches excavated to a depth of 1.5 to 2.0 m below the ground surface failed to reveal any evidence of cultural material below the 80 cm level.

A total of 104 square meters was excavated with hand tools in the West Provenience (Figure 4), encompassing an estimated 83.2 cubic meters of fill. Artifacts within the West Provenience sediments occurred in rather low densities, necessitating the excavation of a large quantity of fill to obtain samples of adequate size. All of the cultural sediments were sifted through ¼-inch screen. However, the upper overburden, within a 10 to 20 cm zone below the surface, was found to contain few artifacts, and much of this fill was discarded without sifting. A 50-cm-thick zone of cultural sediments occurred 30 to 80 cm below the surface. At least 52 cubic meters of cultural fill was sifted.

Following the excavation of the West Provenience with hand tools, a tractor was used to grade a wide strip across the long axis of the site between the gas pipeline and the excavation area. This area was stripped to a depth of 20 to 30 cm to determine if additional cultural sediments or features were present in the site area. This graded area was 72 m east-west by 6 m north-south. This activity resulted in the identification

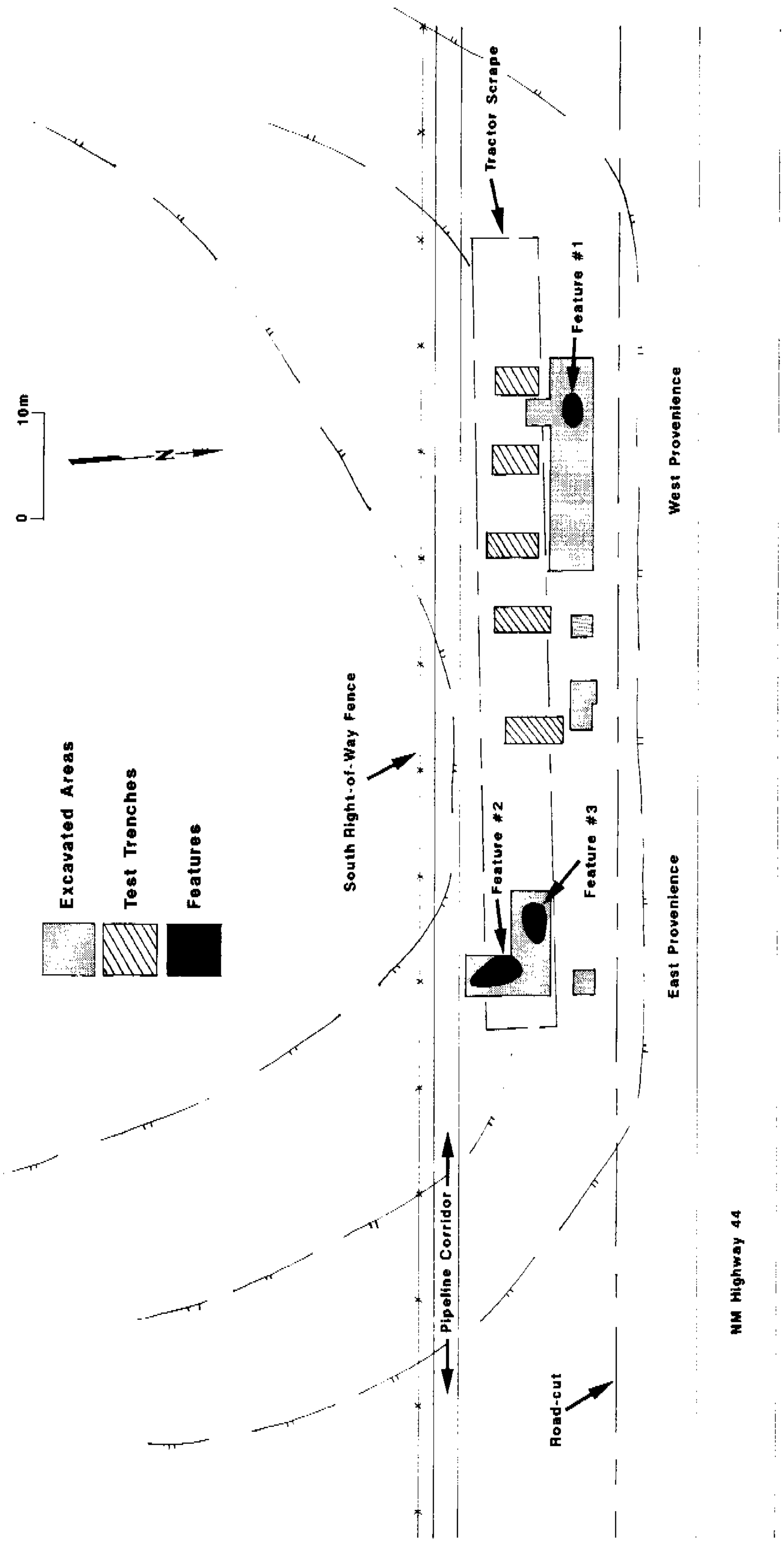

Figure 2. Map of LA 50460 showing locations of excavation units, test pits, and backhoe test trenches in the East and West Proveniences

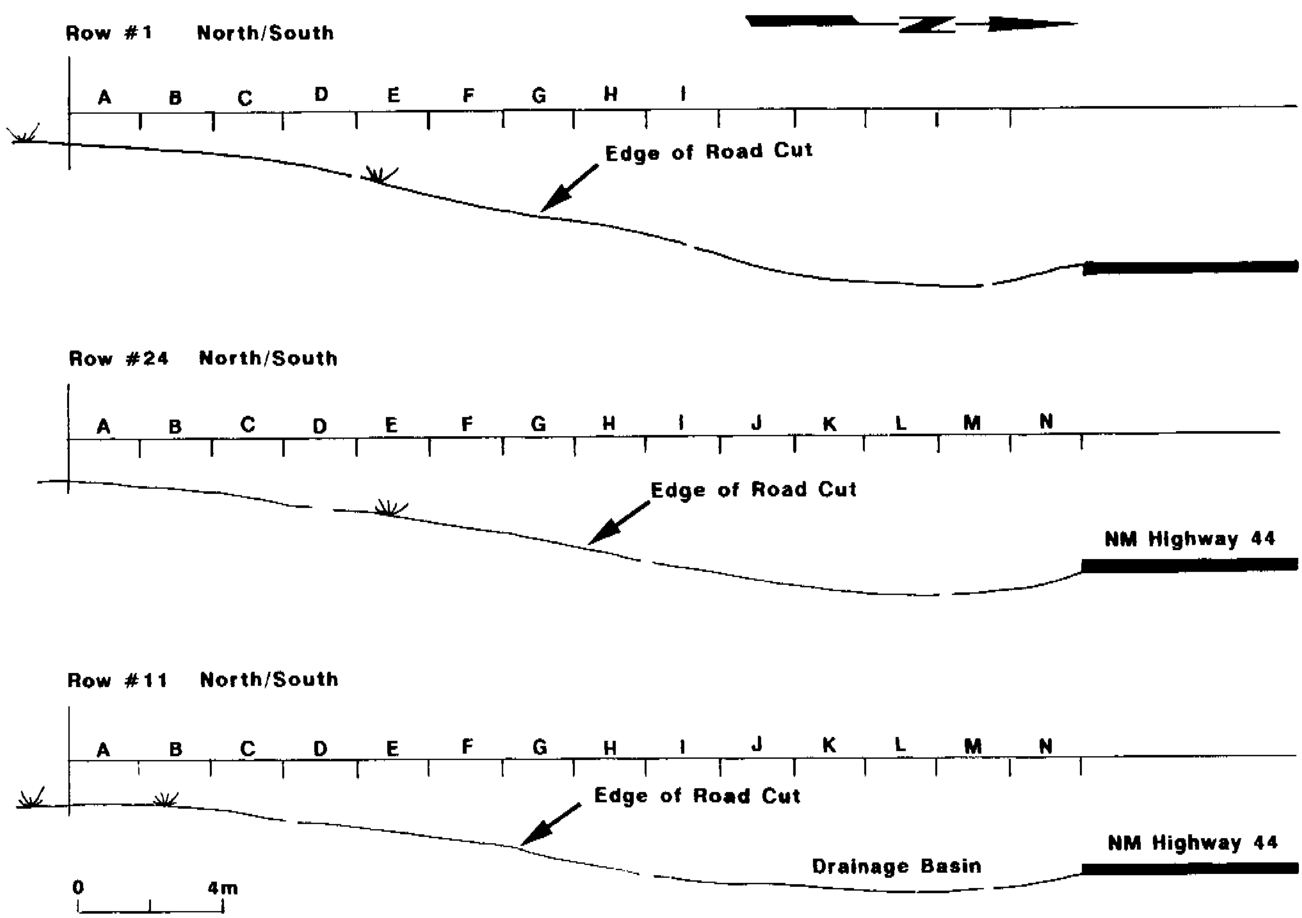

Figure 3. North-south surface contours of LA 50460

of additional cultural remains in the East Provenience site area, which was subsequently excavated with hand tools.

Six backhoe trenches were also excavated across the site within the bladed area to a depth of 1.5 m. Each backhoe trench was 2.75 m wide by 5 to 6 m long. Traces of cultural material were found in the upper 70 cm adjacent to the West Provenience, but no intact cultural features were identified. The test trenches also revealed that the substratum consisted of sterile compact sand. No cultural remains that justified further excavation with hand tools were found in the test trenches.

Following the tractor work, excavation with hand tools was continued in the East Provenience. A 20-cm-thick layer of dark charcoal-stained soil with associated artifacts and fire-heated rock was identified at 20 cm below the ground surface. The remaining overburden in the East Provenience was removed with hand tools and excavations were initiated within the 2 by 2 m grid units. A total of 18 grid units or 72 square meters were excavated with hand tools in the East Provenience. Two rather large concentrations of fire-heated stone were identified, and cultural sediments were found 20 to 40 cm below the ground surface and extending over a 12 by 8 m

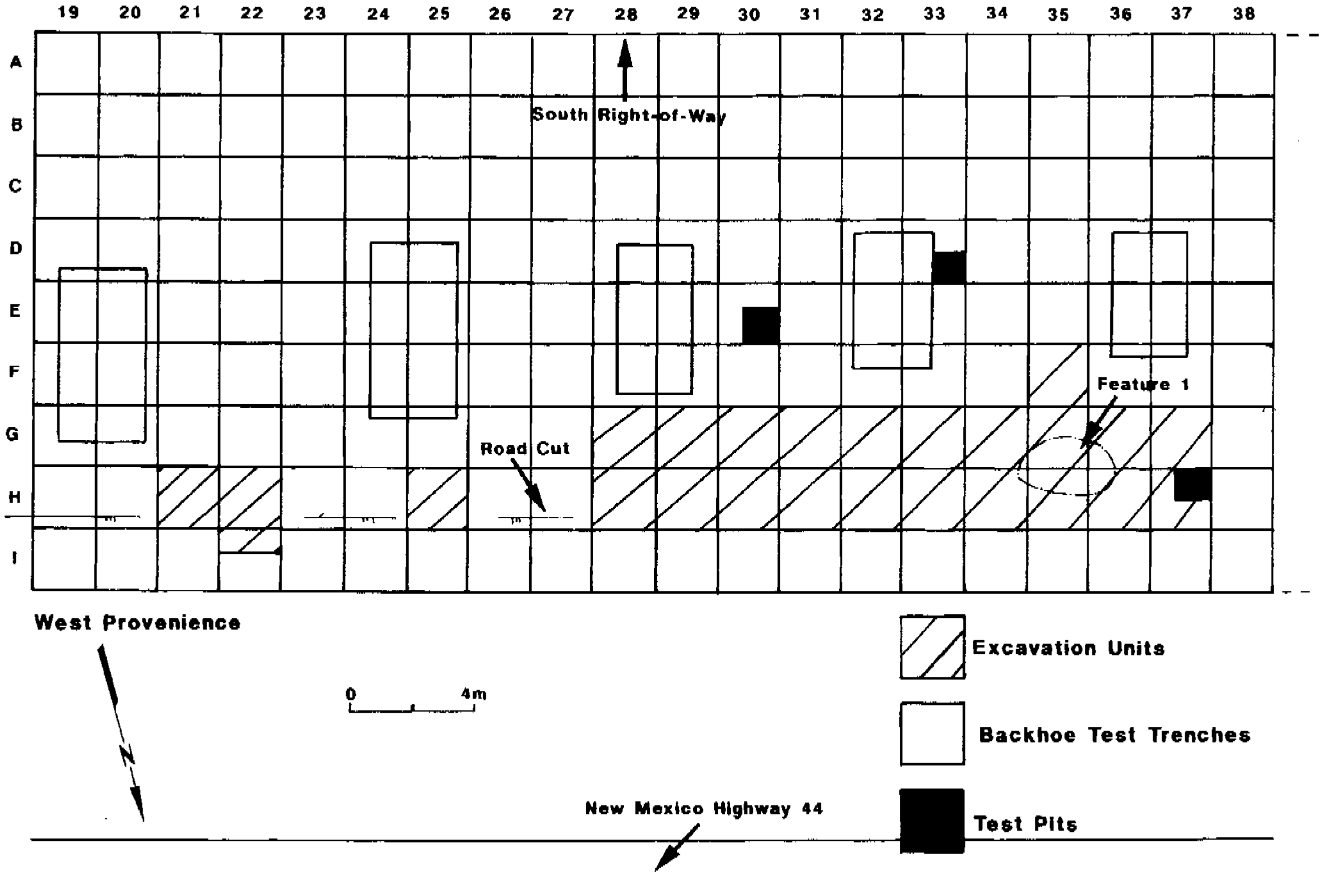

Figure 4. Map of West Provenience, LA 50460

area. The entire area was excavated and all cultural sediments were sifted through ¼-inch screens. Approximately 14.4 cubic meters of cultural fill were removed from the East Provenience excavation units.

Artifact density within the East Provenience was low. However, there was an abundance of fire-heated stone. Most of the fire-heated stone was concentrated in two areas that have been designated as Features 2 and 3.

Cultural-Temporal Affinities: LA 50460 is an Archaic period encampment. Three radiocarbon dates were obtained from the site. The oldest date of 7670 ± 130 BP was obtained from the Level 2b horizon in the West Provenience. A similar but slightly later date was obtained from the upper fill in Level 2a (7460 ± 180 BP). The latest date in the group came from the East Provenience (7090 ± 190 BP). These dates are among the earliest for Archaic period sites in the northern San Juan Basin and identify the occupation as contemporaneous with the Jay phase of the Oshara Tradition. However, the projectile points from the site consist of a mixed assemblage of short-stemmed/concave-base points unlike the early Archaic Oshara materials. The specific cultural phase remains undetermined.

Excavation Results: Archaeological survey of LA 50460 revealed a diffuse scatter of lithic artifacts and occasional fire-heated stones extending over a 42 m east-west by 18 m north-

Figure 5. LA 50460 West Provenience during excavation

south area (Figure 2). The northern section of the site had been destroyed by earlier construction along NM 44 and artifacts were exposed along the south road bank of the highway. Excavations revealed that cultural materials were concentrated in two areas identified as the West and East Proveniences.

West Provenience

Cultural materials in the West Provenience were exposed in the south embankment of the NM 44 roadcut and extended over approximately 34 by 8 m (272 square meters) (Figures 4 and 5). An undetermined area of the West Provenience had been removed by grading along the south side of NM 44. Excavations in the West Provenience revealed a 50-cm-thick zone of charcoal-stained sand that extended from 20 to 30 cm below the surface to a depth of 70 to 80 cm. These cultural sediments contained a concentration of lithic artifacts and fire-heated stone. No occupation surface was identified within the cultural deposit. However, many of the artifacts were found in the 50–70 cm zone. Flotation of the cultural sediments in the West Provenience indicates considerable mixing by rodents and insects. The cultural deposits were probably somewhat diffused by this activity and were originally confined to a somewhat narrower zone.

Excavations in the LA 50460 West Provenience resulted in the recovery of 448 specimens of

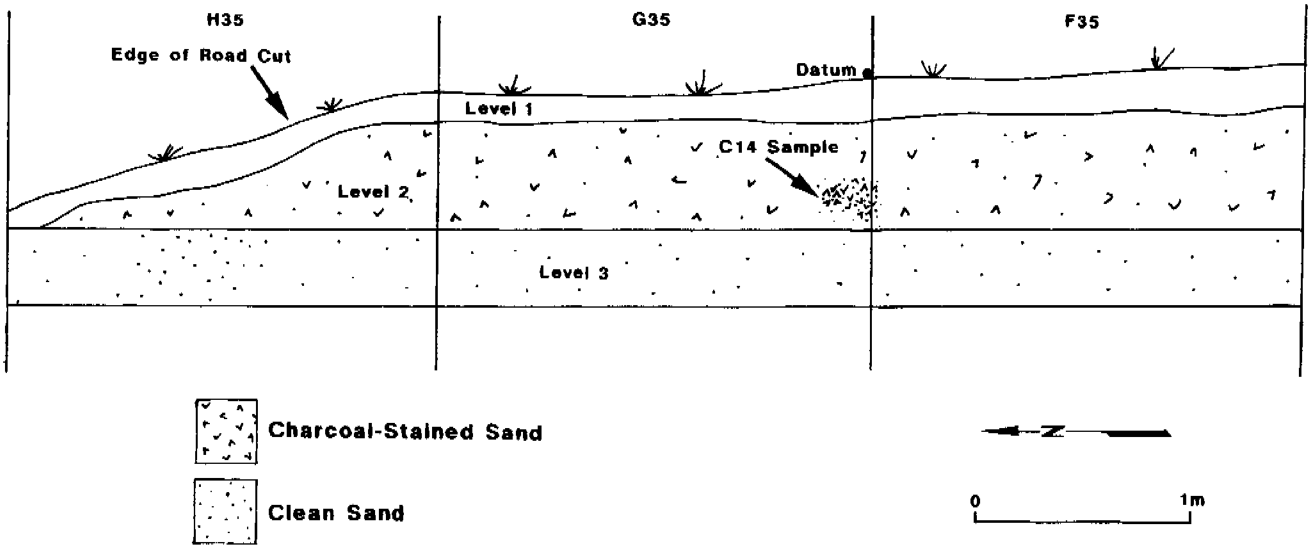

Figure 6. North-south stratigraphic profile of LA 50460 West Provenience

chipped stone, 21 ground stone artifacts, 486 bone fragments, and 197 fragments of fire-heated stone. The majority of the cultural materials found at the site were confined to a 16 by 4 m area. No hearths or definite structural features were found.

Feature 1: The only feature identified in the West Provenience was a concentration of slightly darker charcoal-stained sediments within grid units G35-G36 and H35-H36 (Figure 6). These darker sediments (Feature 1) were concentrated in an ovoid area measuring 2.0 m by 1.25 m with a basin cross-section, 20 to 75 cm below the surface. However, this charcoal-stained concentration can also be traced over a larger (2.0 by 3.0 m) area. No evidence of walls or floor could be identified. There was no evidence of oxidation. The fill within the feature consisted of charcoal-stained sand and contrasted with the surrounding soil which was only lightly charcoal stained. The fill had no evidence of laminations and was uniform in texture. There were a few small rounded adobe elements within the fill, but none appeared to be oxidized. A number of diagnostic artifacts were found in the Feature 1 area (Figure 7), but no defined concentration of artifacts occurred within the feature. Flotation samples from the fill were similar to those obtained elsewhere in the West Provenience.

Feature 1 was defined only on the basis of a slightly darker concentration of charcoal-stained soil. However, this basin-shaped concentration may have been an activity area or possibly a shelter.

Stratigraphic Section (Figure 8): A diffuse band of cultural sediments, 50 cm thick (Level 2), was identified in the West Provenience area, extending from ca. 30 cm to 80 cm below the ground surface. This zone of cultural fill consisted of loose to compact charcoal-stained sand. The layer was uniform in texture, and no laminations or other discernable layers were present. Level 2 contained occasional bits of carbonized wood and a concentration of artifacts. No defined occupation surfaces were visible. For analytical purposes, the Level 2 cultural deposit was arbitrarily subdivided into upper (Level 2a,

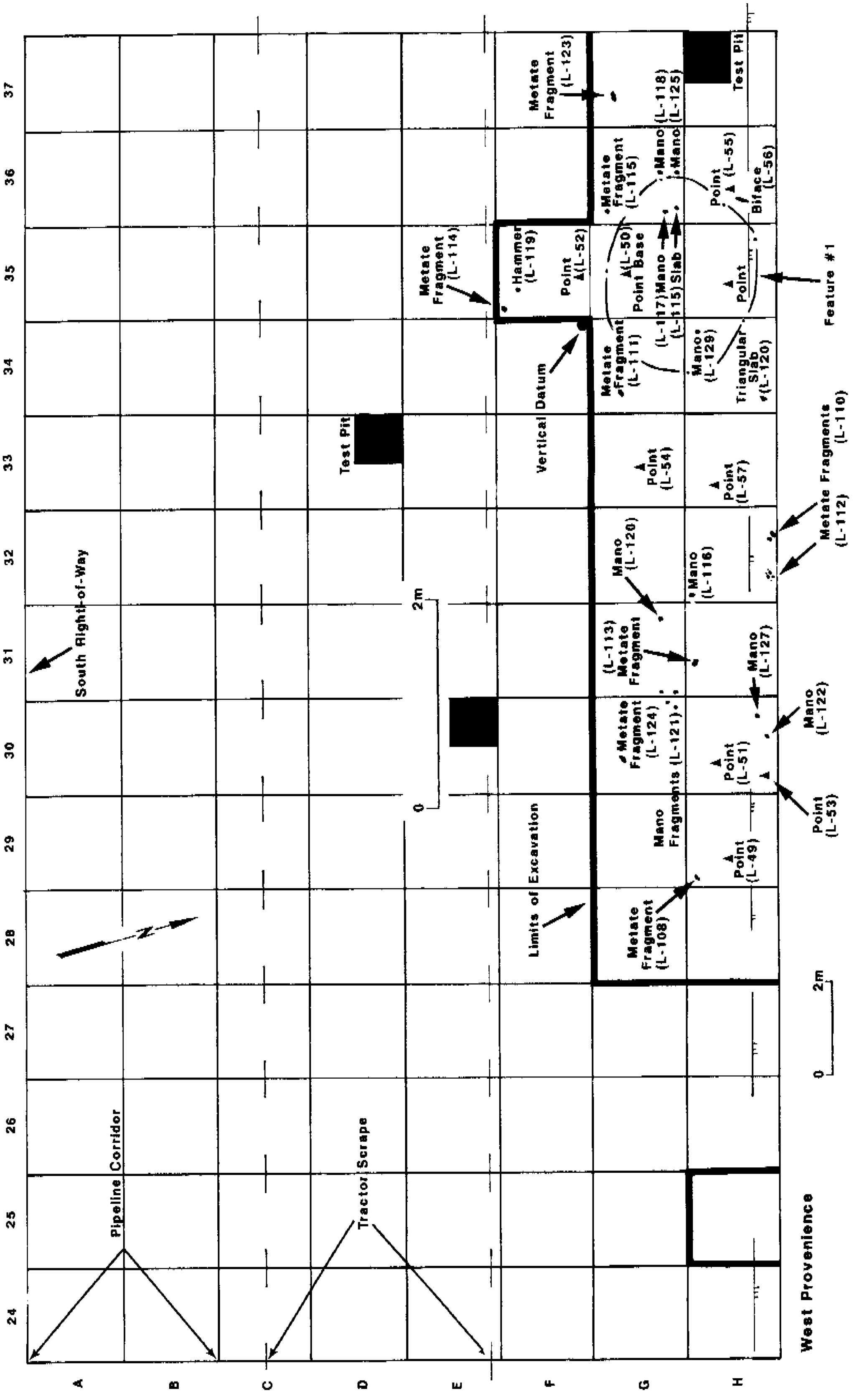

Figure 7. Location of ground and chipped stone at LA 50460 West Provenience

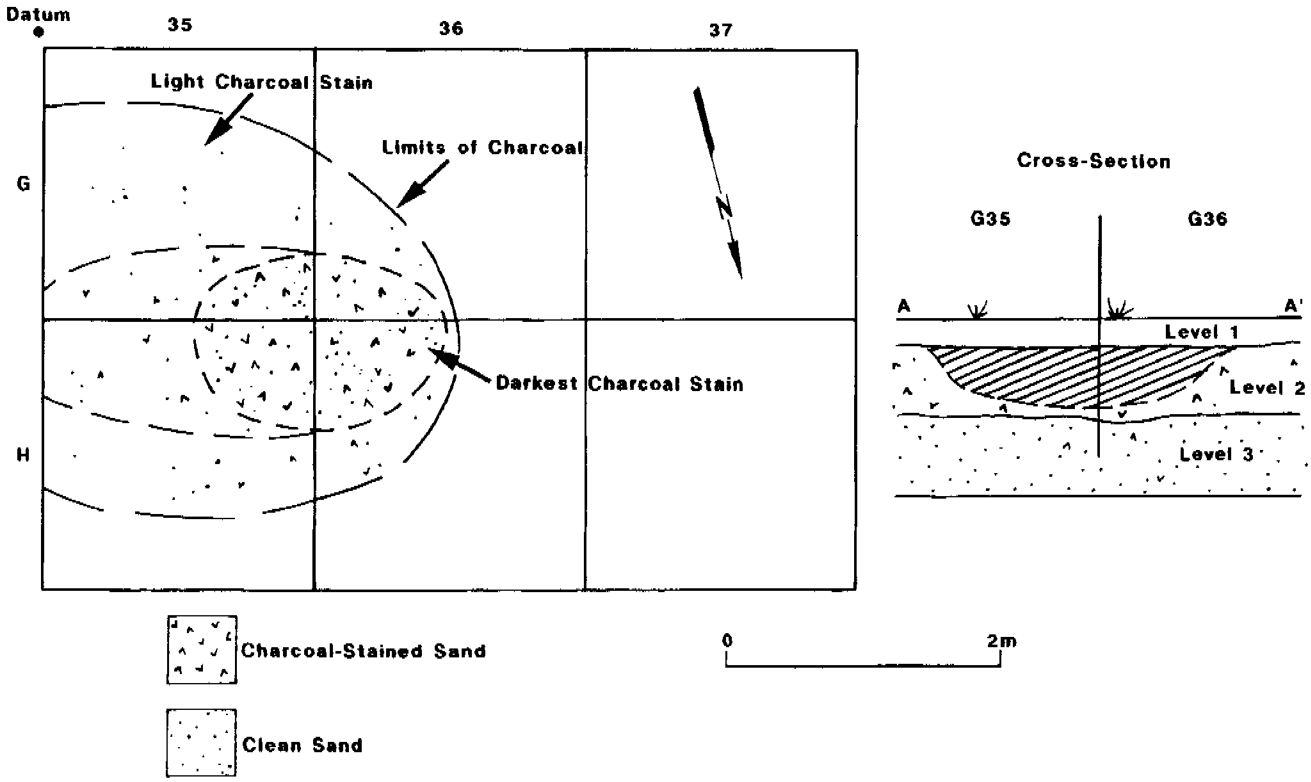

Figure 8. Plan and cross-section of Feature 1, LA 50460 West Provenience

30–50 cm) and lower (Level 2b, 51–80 cm) horizons.

The cultural deposits in the West Provenience were buried below a 30 cm layer of fine tan eolian sand. This layer (Level 1, 0–30 cm below the surface) contained occasional artifacts, but no evidence of charcoal. Underlying the cultural layer (Levels 2a and 2b) was a substrate (Level 3) of sterile yellow sand. This sand was clean and coarse and extended to a maximum tested depth of 2.0 m. This substrate indicates the West Provenience was placed on a low dune at the edge of the Tancosa drainage floor.

Artifact Assemblage: The cultural materials recovered from the West Provenience included 448 specimens of chipped stone, 21 ground stone artifacts, 4 hammerstones, 486 bone fragments, and 197 pieces (0.279 cubic meters) of fire-heated stone. The densities of these materials per cubic meter of excavated fill are provided in Chapter 12.

Chipped stone artifacts from the West Provenience (Figure 7) include 5 cores, 429 specimens of debitage, 4 bifaces, 8 projectile points, 1 endscraper, and 1 retouched fragment. The incidence of retouched and utilized material is infrequent, but biface flakes are relatively common. The density of chipped stone material in the West Provenience (8.13 per cubic meter) is relatively low, but slightly higher than in the East Provenience. It is interesting to note that bone (9.3 per cubic meter) is slightly more frequent than chipped stone, which is very unusual for open-air Archaic period sites in the San Juan Basin.

The most common chipped stone material types from the West Provenience are orthoquartzite (39.5%), silicified wood (32.8%), and obsidian (19.6%). Visual identification of the obsidian indicates that 73% is clear-translucent, probably from the Jemez source, and 27% is dusty, and probably from the Polvaderas. Five obsidian specimens from the West Provenience were subjects of EDXRF (Energy-Dispersive X-Ray Fluorescence) analysis and specimens from both the Valle Grande (Jemez) and the El Rechuelos (Polvadera) sources were identified. Other less common material types include chert (4.2%) and chalcedony (3.8%). There is nearly twice the incidence of obsidian in the West Provenience as in the East Provenience.

Ground stone materials from the West Provenience (Figure 7) are relatively common and include 9 one-hand manos, 5 metates or metate fragments, and 5 ground stones probably used as metates. Ground stone artifacts represent approximately 0.5% of the lithic artifact sample from the West Provenience. The manos are one-hand cobbles that exhibit considerable use and the metates are informal slabs showing only expedient use. Also in the collection are 1 cobble anvil stone with batter marks, 4 hammerstones, and 1 ground triangular sandstone slab of undetermined function.

Three mineral specimens were recovered during the West Provenience excavations. Two are unmodified hematite nodules and one is a nodule of limonite ochre. The limonite nodule was found in Level 2a of grid unit H30 and is 0.5 cm in diameter. The hematite nodules include one specimen from Level 2a of grid unit G36 that is 7.2 cm in diameter and another from Level 2b in grid unit G30 that is 2.6 cm in diameter.

Faunal Assemblage: A total of 486 bones was recovered from the West Provenience. The estimated density of bone materials within the West Provenience fill is 9.34 specimens per cubic meter. Most (396 specimens) are mule deer or deer-size bones. Other species identified in the collection include cottontail rabbits (15), jackrabbits (31), prairie dogs (18), pocket gopher (16), pocket mouse (1), kangaroo rats (2), coyote or dog (2), and other mouse-sized mammals (5). A total of 28 mule deer or deer-size bones are charred or calcined, while none of the other animal bones are burned.

Many of the small animals, especially the mice and rats, are probably intrusive. However, a few of the prairie dog and rabbit bones are eroded, suggesting possible association with the Archaic period occupation. It is clear that the primary hunting emphasis at the West Provenience was on the procurement of mule deer. The butchering of mule deer was conducted on site, as many non-meat-bearing bones (i.e., metapodials, lunates, calcaneum, astragalus, and phalanges) were discarded in the area. No bone tool implements are present in the collection. Many of the long bones were fractured, probably for the extraction of marrow.

Botanical Assemblage: Ten flotation samples from the West Provenience, encompassing 65,800 cc of cultural fill, were analyzed. The samples were obtained from the upper and lower sections of the cultural fill and from the Feature 1 area. Samples were taken in areas with the darkest charcoal-stained soil. Other than a few fragments of carbonized greasewood, juniper, and sage, no cultural botanical materials were found. The presence of one-hand manos and small slab metates in the West Provenience indicates that plant products were processed at the site. The absence of seeds is likely the result of poor preservation, despite the effort to analyze large quantities of cultural fill.

Four pollen samples from LA 50460 were analyzed: one surface control sample, one sample

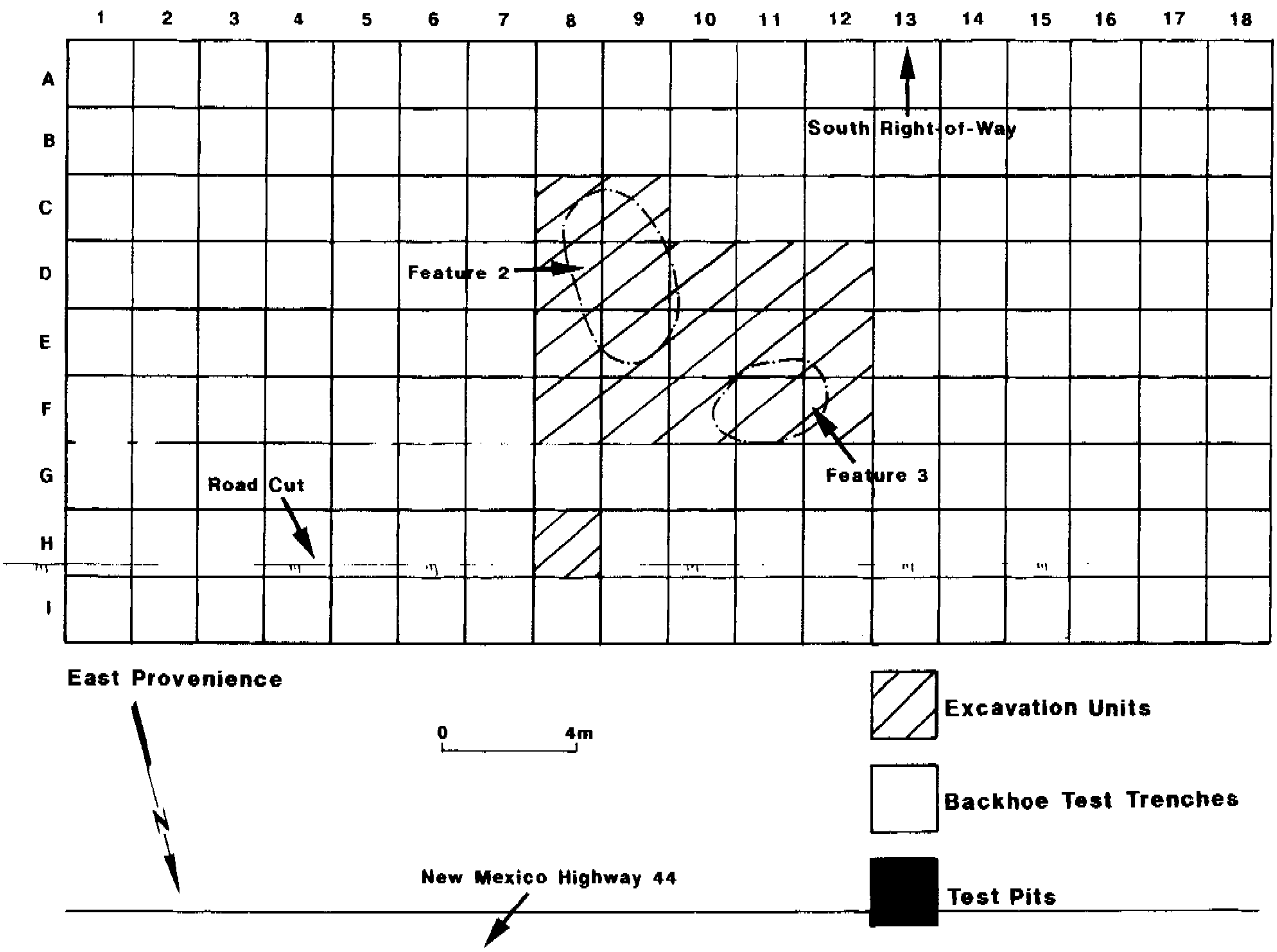

Figure 9. Map of East Provenience, LA 50460

from the West Provenience cultural fill, and two samples from the East Provenience cultural fill. None of the samples showed any evidence of cultigens or other clearly culturally associated pollen. The slightly higher incidence of arboreal pollen in the surface control sample than in the culturally associated samples suggests that the local environment, during the site occupation, was more of an open scrubland than it is today. However, the cultural sediments at LA 50460 have been subjected to considerable bioturbation that probably resulted in a mixing of ancient and modern pollen.

East Provenience

The East Provenience at LA 50460 consisted of a concentration of fire-heated stone and artifacts within a 12 m northwest-southeast by 8 m northeast-southwest area (Figures 9, 10, and 11). This concentration of cultural material was identified within grid units C–F 8–12, approximately 30 m east of the main area of the West Provenience. The East Provenience shows some similarity to the West Provenience but is clearly a functionally discrete location. Radiocarbon dates suggest that the East Provenience

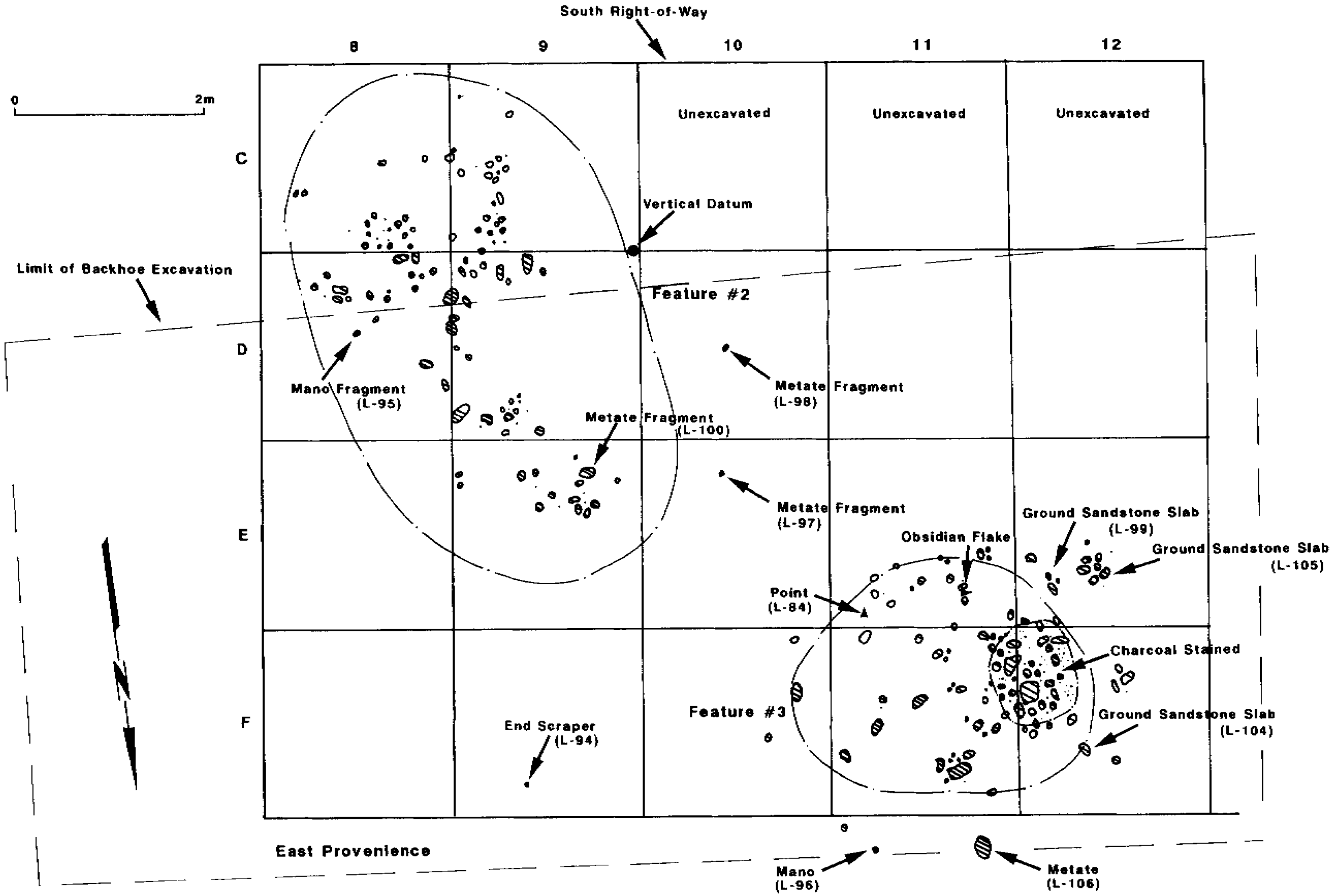

Figure 10. Map of LA 50460 East Provenience showing locations of Features 2 and 3 and distribution of ground and chipped stone tools

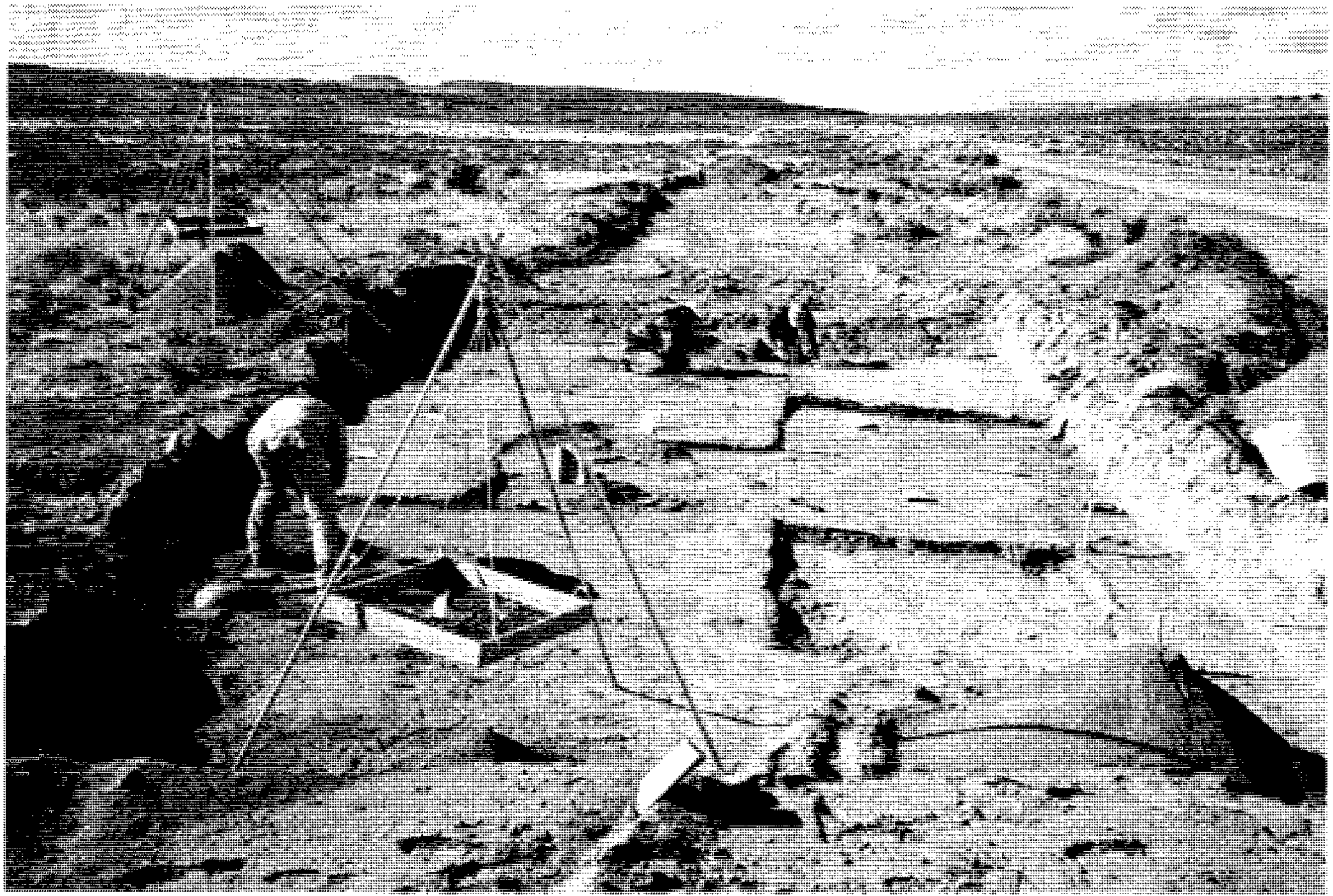

Figure 11. East Provenience during excavation

may have been utilized approximately 370 to 580 years later than the West Provenience. The East Provenience has a much higher incidence of fire-heated stone than the West Provenience and lower frequencies of bone and obsidian. Most of the chipped stone found in the East Provenience is local orthoquartzite and silicified wood. Otherwise, the chipped stone and ground stone assemblages appear similar to the West Provenience collection.

The East Provenience consisted of two concentrations of fire-heated stone (Features 2 and 3) within the 20–40 cm zone below the ground surface. There is an estimated 2.25 cubic meters of fire-heated stone within the provenience, most of which are pieces of soft angular sandstone from 2 to 15 cm across. There is no evidence of hearth pits or basins, and the stones appear to have been heated on open fires. A diffuse and low-density scatter of chipped and ground stone and occasional bone fragments was present in the area.

Feature 2: This feature consisted of a cluster of fire-heated stone that was concentrated in a 3.0 by 2.6 m area. The feature was confined to a layer that was 20 to 40 cm below the ground surface (Figure 10). Most are soft and angular sandstone fragments measuring 2 to 15 cm across. The estimated volume of stone within the feature is 1.33 cubic meters. The sandy fill in the

feature area was lightly charcoal-stained. The densest concentration of fire-heated stone and the darkest charcoal-stained soil occurred in the west part of Feature 2, in an 80 cm by 1.0 m area. Despite the abundance of fire-heated stone and charcoal-stained soil, there were no oxidized surfaces or well-defined hearth pits or basins.

The concentration of artifacts around the margins of Feature 2 included a single Armijo type projectile point, three ground sandstone slab metate fragments, a complete slab-basin metate (L-106), a one-hand mano, and numerous fragments of debitage. Flotation samples from this feature yielded only one burned Cheno-Am seed and a few carbonized bits of juniper, greasewood, and wolfberry.

Feature 3: This feature also consisted of a cluster of fire-heated stones. They were concentrated in a 2 by 4 m area (Figure 10) and were located from 20 to 40 cm below the ground surface. The heated stones are similar to those found in Feature 2 and mostly consist of soft angular sandstone fragments 2–15 cm in size. The estimated volume of heated stone material within Feature 3 is 0.82 cubic meters. The fill in the Feature 3 area consisted of lightly charcoal-stained sand. Two sandstone metate fragments and a number of chipped stone artifacts were found in Feature 3. There was no evidence of oxidized surfaces or well-defined hearth pits or basins. A flotation sample taken from the fill of the feature in Grid D9 failed to recover any macrobotanical material.

Stratigraphic Section: The cultural layer in the East Provenience was a thin 15- to 20-cm-thick zone that began 20 cm below the ground surface. The cultural layer was defined by a concentration of fire-heated rock and a diffuse scatter of artifacts. The soil in the cultural layer was lightly charcoal-stained. Soil above and below the cultural level was sterile sand.

Artifact Assemblage: The cultural material recovered from the East Provenience included 127 specimens of chipped stone, 12 ground stone artifacts, 28 bone fragments, and 446 pieces (2.25 cubic meters) of fire-heated stone. Fire-heated stone was abundant in the East Provenience and occurred at 31 times the frequency as was found in the West Provenience. The densities of these materials per cubic meter of excavated fill are provided in Chapter 8.

Chipped stone artifacts from the East Provenience included 125 specimens of debitage, 1 projectile point, and 1 endscraper. The incidence of retouched and utilized material is low, and only one endscraper (L-94) was recovered from grid unit F9. The density of chipped stone material in the East Provenience (7.98 specimens per cubic meter) was also relatively low.

The most common chipped stone material types from the East Provenience are orthoquartzite (50.4%) and silicified wood (34.5%). Obsidian represents 12.6% of the sample. Visual identification of the obsidian indicated that it is all clear-translucent and is probably from the Jemez source. However, X-ray fluorescence analysis of four samples from the East Provenience identified 3 specimens from the Valle Grande source (Jemez) and 1 specimen from the El Rechuelos source (Polvadera). Minor quantities of chalcedonic material (2.5%) are also present in the East Provenience sample.

Ground stone materials from the East Provenience are relatively common and consist of three manos and nine slab metates or slab metate fragments. The one-hand cobble manos are well-used, whereas the metates are small slabs of soft sandstone showing only expedient use. Ground stone artifacts in the East Provenience sample represent approximately 9% of the lithic assemblage or nearly twice the incidence found in the West Provenience.

A single mineral specimen was recovered from the East Provenience excavations in grid unit C9. It is an unmodified hematite nodule that is 0.6 cm in diameter.

Faunal Assemblage: Twenty-eight bones were recovered from the East Provenience. The estimated density of bone materials in the East Provenience is 1.9 specimens per square meter, much less than the density (9.3 specimens) in the West Provenience. The East Provenience sample consists of 2 prairie dog and 26 deer-size specimens. One of the prairie dog bones is eroded, suggesting possible association with the Archaic period occupation. Five of the deer-size bones are burned or calcined.

Botanical Assemblage: The five flotation samples from the East Provenience contained 41,700 cc of cultural fill. A few fragments of carbonized juniper wood and three burned fragments of wolfberry wood were identified in the samples. The only burned seed found in the entire sample was a single Cheno-Am specimen recovered from grid unit E10.

The presence of numerous manos and slab metates in the East Provenience collection indicates that seeds were processed at the site. Therefore, the relative absence of plant products is probably a result of poor preservation rather than a reflection of non-use.

Two pollen samples were obtained from cultural fill in the East Provenience. One was taken from sediments adjacent to the slab-basin metate in grid unit G11 and the other was taken from the matrix around the fire-heated stones in grid unit F11. Neither of the samples revealed evidence of cultigens or any other species of obvious cultural association.

LA 45961 (The Venado Site)

Previous Research: This site was originally identified during a cultural resource survey of NM 44 by the New Mexico State Highway and Transportation Department. Archaeological survey revealed a diffuse scatter of chipped stone that was bisected by NM 44 and extended for approximately 100 by 100 m (Koczan 1983). The site was subsequently tested by the Museum of New Mexico in 1984 (Lancaster 1985:19–22). The archaeological testing was confined to a single test trench on the south side of NM 44, east of the gas pipeline shed, and in the area of two possible hearths north of NM 44. No intact cultural remains were identified in the testing project, and the association of the two hearth stains with the site could not be substantiated. No further research was recommended. The Museum of New Mexico later reevaluated the site during a survey for a buried telephone cable along the south edge of the NM 44 highway right-of-way (Oakes 1985), but no further testing was conducted.

LA 45961 was reevaluated during the 1997 NM 44-North cultural resource survey (Marshall 1997). This inspection revealed a diffuse scatter of chipped stone artifacts on the south side of NM 44 in a 16 by 40 m area. However, only a section of the site, encompassing approximately 6 by 40 m between the highway roadcut and gas pipeline, appeared to be undisturbed. None of the previous archaeological test excavations had been completed within this section of the site. Therefore, the New Mexico State Historic Preservation Division, in consultation with the New Mexico State Highway and Transportation Department, decided that additional excavations at the site were warranted. These excavations were completed by Cibola Research Consultants in September 1998 and are described herein.

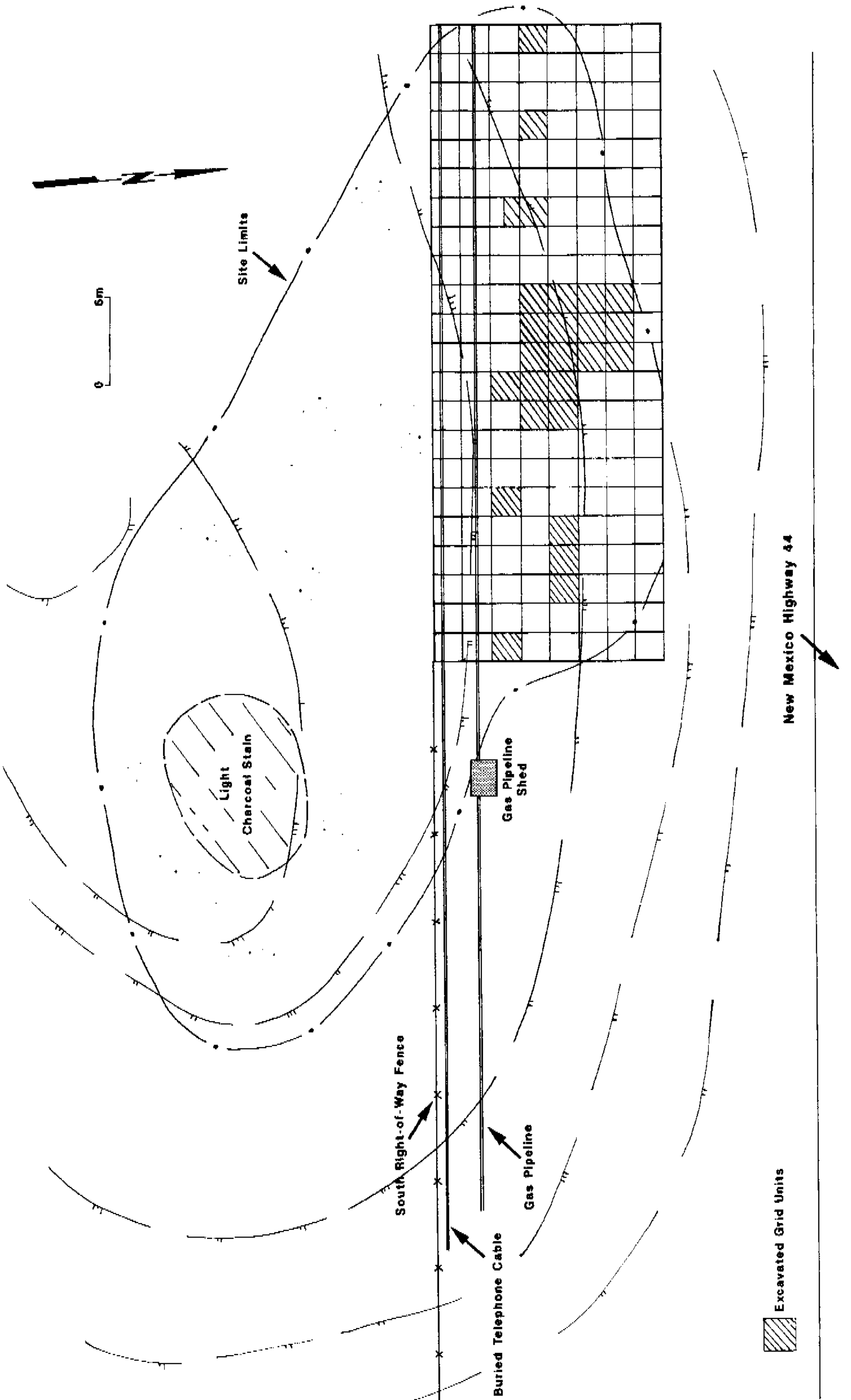

Figure 12. Map of LA 45961

Location: This site is located on the south side of NM 44 in Sandoval County, New Mexico (Figure 1). It is on land under the jurisdiction of the Navajo Tribe. The specific location of the site is described in Volume II of this report, which has been placed in the NMCRIS files at the Archaeological Records Center in Santa Fe.

Environment: LA 45961 is situated on the lower, north-facing slope of an east-west trending ridge at an elevation of 2,079 m (6,820 ft) This ridge overlooks a western tributary of Venado Canyon, which is an upper tributary of the Largo Canyon drainage system. The canyons and forested slopes of Sisnathyel Mesa are located south and west of the site. The site area slopes gently to the north. The soil is a sandy loam. Vegetation includes scattered pinyon and juniper trees, sagebrush, rabbitbrush, snakeweed, greasewood, wolfberry, stickweed, and Indian ricegrass.

LA 45961 is one of three Archaic period sites which are bisected by NM 44 in the upper Venado Canyon area (Marshall 1997), and other Archaic period sites no doubt occur in the area. All of the known sites are on low ridges overlooking the open canyon floor to the north.

Visibility from the sites extends over the adjacent canyon valley but is restricted by low ridges to the south. Each of the sites is on the edge of the pinyon-juniper forest on well-drained slopes. Water is frequently available in bedrock waterholes and in the major arroyos. Fuel wood is common and local pinyon trees occasionally yield substantial nut harvests.

Excavation Methods: LA 45961 was excavated in September 1998 (Figures 12 and 13). All surface artifacts were marked with pin flags. The surface artifact distribution was diffuse and extended over a 40 m east-west by 16 m north-south area within the NM 44 right-of-way south of the highway. A few artifacts were also found north of the NM 44 right-of-way, indicating that the site originally extended into the present highway corridor. Much of site area was probably removed by highway construction when the NM 44 corridor was originally graded during the 1920s and as a result of later improvements.

A 2 by 2 m grid system was established over the south right-of-way slope in the area of the diffuse artifact scatter. This system encompassed grid units 1–22 on the east-west axis and grid units A–H on the north-south axis (Figure 14). The artifacts were scattered over a north-facing slope and roadcut. Only an area 8 m in width, located from 16 to 22 m south of the highway pavement, remained undisturbed. The lower slope of the site on the road embankment (0–16 m south of the pavement) had been entirely removed by the highway roadcut and drainage ditch. The upper slope, 22 to 26.5 m from the south edge of the highway, had been previously disturbed by gas pipeline construction. Therefore, most of the excavations were confined to the undisturbed section of the site within an 8 by 44 m area.

The distribution of surface artifacts within the south highway right-of-way was plotted on the site map (Figure 14). Excavations were initiated in areas where most of the artifacts were found. Surface artifact density was very low, as only 66 specimens of chipped stone were identified within a 352 square meter area. Data recovery included the surface stripping of twenty-four 2 by 2 m grid units (96 square meters) and the excavation of four test pits to a depth of 50 cm to 1.0 m.

The surface stripping and test pit excavations were completed with hand tools, and all sediments were sifted through ¼-inch screens. These excavations revealed only low densities of lithic artifacts, which were confined to the upper 15 cm. The majority of the grid units (64 square

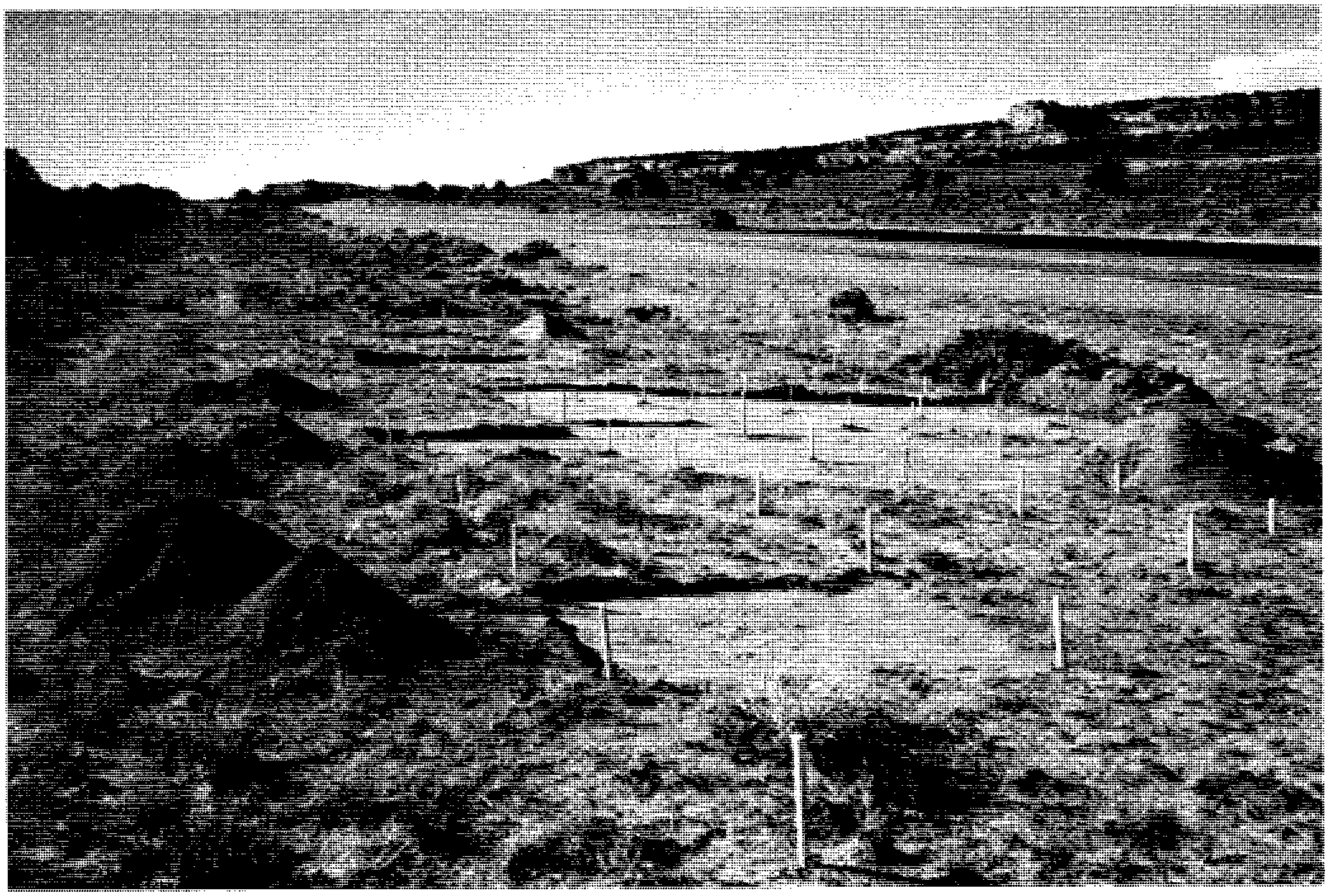

Figure 13. LA 45961 during excavation

meters) were excavated in the central site area where most of the surface chipped stone artifacts were found.

Many of the grid unit excavations failed to yield any artifacts, and no cultural features such as hearths or pits were found during the hand tool excavations. No artifacts were found below the 15 cm level, which consisted of compact sterile sand.

Following the hand tool excavations, five large backhoe test trenches were excavated across the site to a depth of 1.0 to 1.25 m (Figures 15 and 16). These backhoe trenches were 2.25 m wide and from 5 to 8 m in length. Most of the backhoe trench excavations failed to identify any cultural remains and encountered a sterile substrate of compact sand and gray sandy clay from 15 cm to 1.25 m below the ground surface. However, a single pit with undercut sides was found 1.0 m below the ground surface in backhoe Test Trench 1 in the west site area. Expansion of the backhoe trench around the pit and excavation of the adjacent area at the level of the pit rim by hand failed to reveal any other associated features or cultural remains. This pit clearly represents an early component of the site that is not associated with the lithic artifact scatter found on the surface and in the upper 0–15 cm of sediments.

Other than in Test Trench 1, no evidence of cultural remains was found below the 15 cm level. The soil exposed in most of the trench

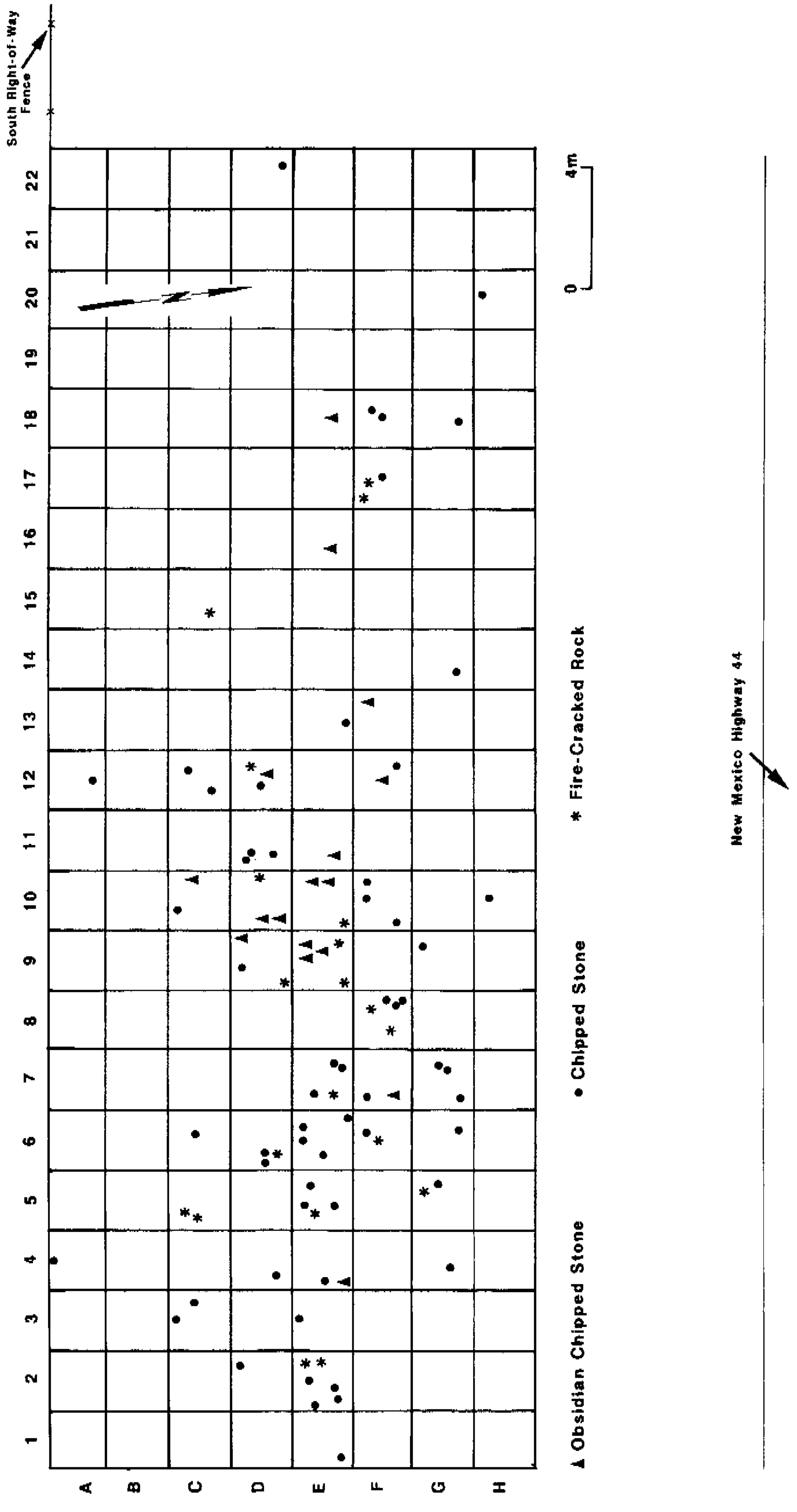

Figure 14. Distribution of surface artifacts, LA 45961

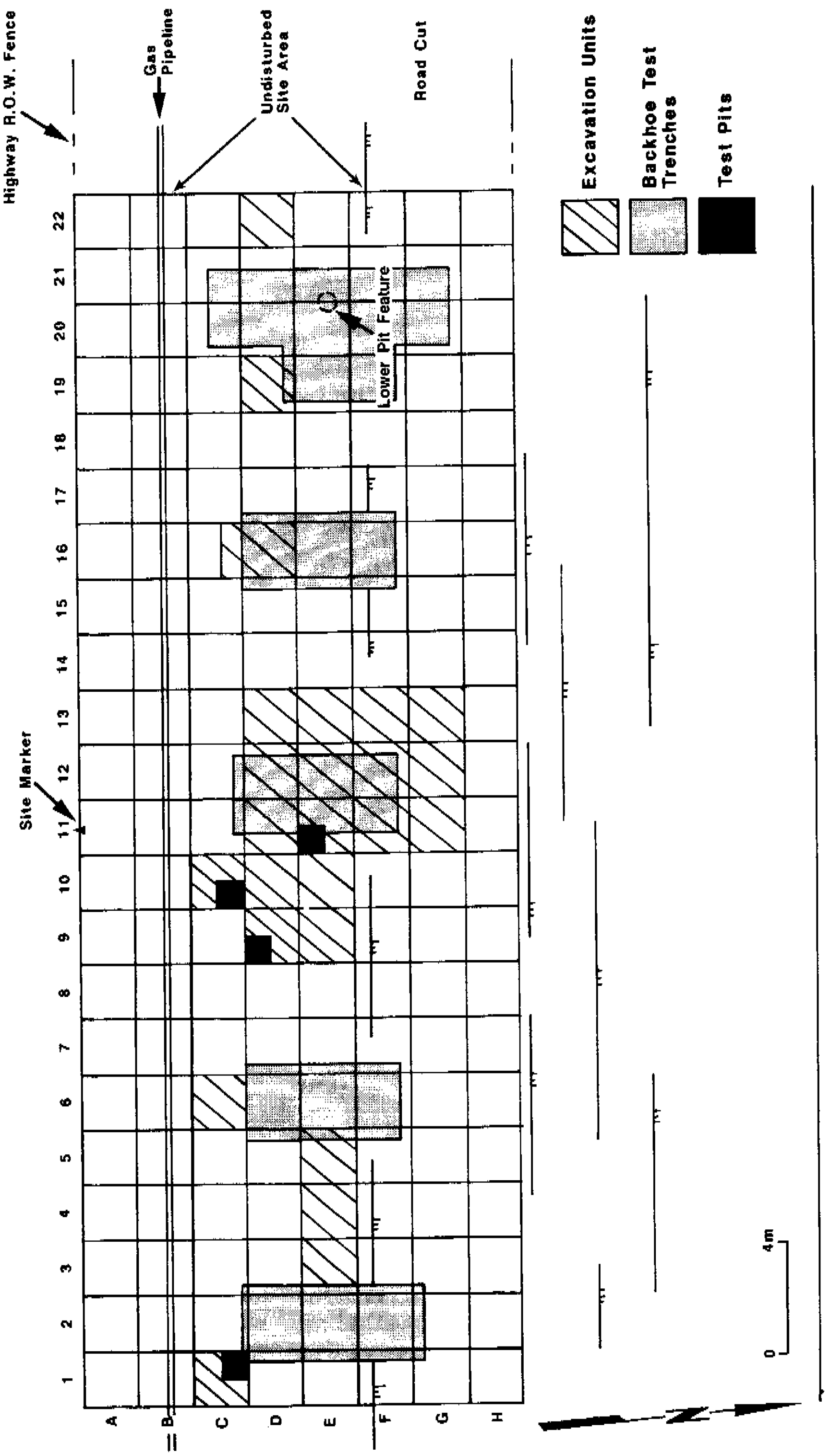

Figure 15. Map of LA 45961 showing locations of excavation units, test pits, and backhoe test trenches

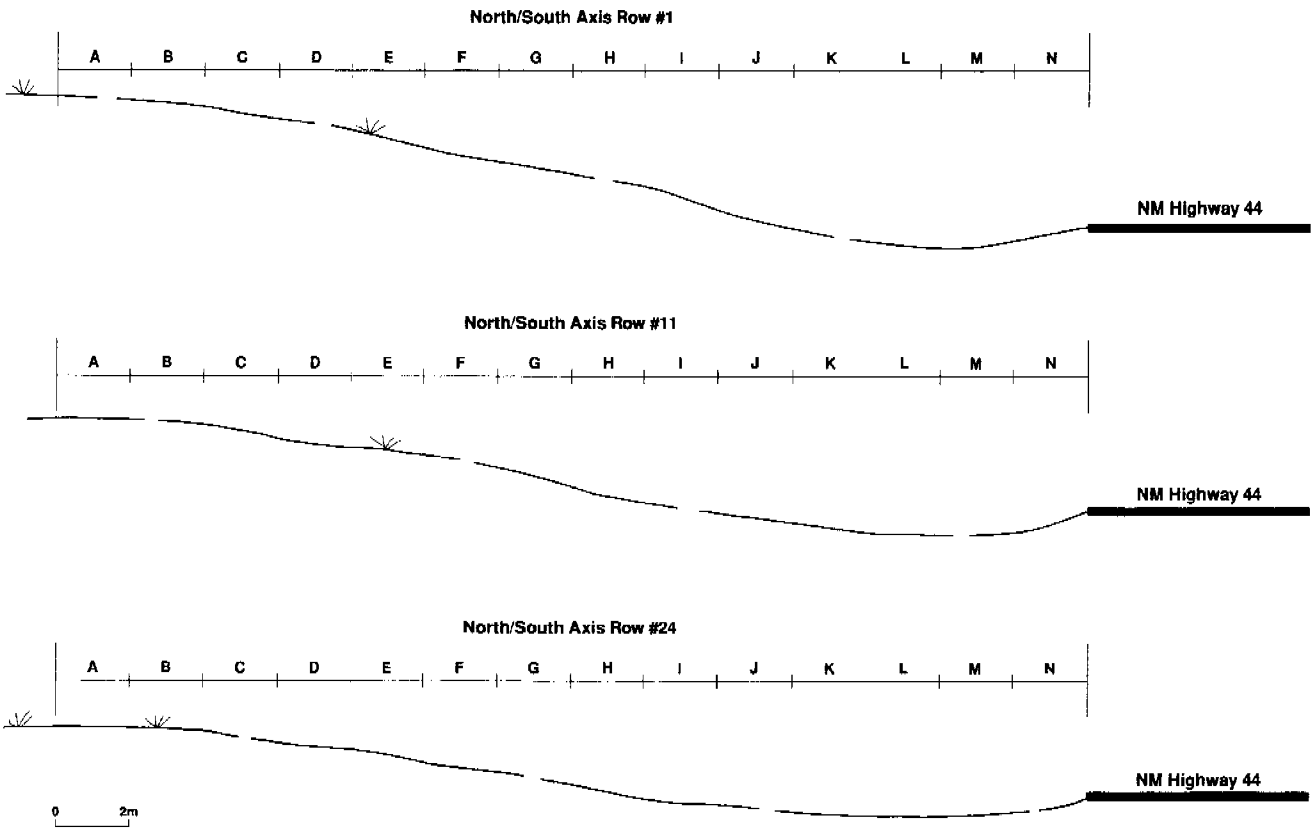

Figure 16. North-south surface contours of LA 45961 excavation area

profiles consisted of compact tan sand without evidence of lamination or stratigraphic definition. However, in Test Trench 4, a zone of compact light gray sandy clay was encountered from 40 cm to 1.0 m below the surface. Elements of clay within this zone had a somewhat globular or daubed nature and exhibited traces of white carbonate stains. No charcoal or evidence of cultural materials was found in the sandy clay section.

Cultural-Temporal Affinities: Excavations at LA 45961 revealed two occupation levels that are labeled the upper and lower components. The lower component is the older occupation and was defined by an isolated pit with undercut sides. This pit was found in Test Trench 1 at a depth of 1.0 m below the ground surface. Carbonized wood in the pit dated to 2030 BP ± 100 (ca. 180 BC to AD 20). Another radiocarbon sample obtained from carbonized corn found in the pit fill was dated to 2570 BP ± 120 (ca. 740 to 500 BC). Three small flakes were the only artifacts found within or adjacent to the pit. However, the radiocarbon dates from the pit indicate that it was used during the late Archaic period.

The upper or late component at the site was defined by a diffuse scatter of chipped stone found in the upper fill 0–15 cm below the surface. No date samples were obtained during the late component excavations. However, two base fragments from small arrow points were found on the surface and are probably of early

Formative period affinity. Obsidian hydration measurements of four specimens from the late component (3.1 to 3.4μ) are comparable to late Archaic–early Formative period assemblages. However, one specimen from grid unit F11 yielded a 1.2μ measurement similar to historical samples, such as those found in the Navajo pueblitos (Marshall 1995).

Late Component: The only evidence of the late component occupation was a diffuse scatter of chipped stone, traces of ground stone, and a few fragments of heated stone. Most of the artifacts identified in the recent investigations were confined to a 16 by 40 m area in the south NM 44 highway right-of-way. However, the site originally extended into the NM 44 highway area and along the north edge of the highway and may have once extended over an area 50 m east-west by 100 m north-south. Excavations within the 16 by 44 m area in the southern portion of the right-of-way failed to uncover any intact cultural features or sediments. No date samples were obtained, and the specific cultural-temporal affinity of the late component cannot be determined. However, two small arrow point fragments identified in the 1997 archaeological survey are corner-notched points of probable early Formative period affinity.

Early Component: Following the excavations of the late component site area, five large backhoe trenches were excavated across the site to depths of 1.0 to 1.25 m. These trenches were 2.25 m wide by 5.0 to 8.0 m in length. Most failed to reveal any evidence of cultural remains below the first 15 cm. However, in Test Trench 1, in the western site area, a bell-shaped pit was found at a depth of 1.0 m below the present ground surface. This pit obviously represents a much earlier component than the artifact scatter identified near the surface. Test Trench 1 was expanded in the area of the pit, but no other features or artifacts were identified in the 29.25 square meter area that was excavated surrounding the pit opening. There was also no evidence of the early component in the other backhoe tests at the 1.0 to 1.25 m level. This pit was the only evidence of the early component at the site and was apparently an isolated feature.

The pit feature was revealed on the margin of grid units 20E and 21E (Figure 17). The feature had an ovoid opening, measuring 65 by 75 cm, and extended for a depth of 95 cm below the pit rim. The maximum diameter of the pit, which was 20 cm above the base, was 1.10 m.

The rim of the pit and sections of the walls exhibited evidence of oxidation, and occasional fragments of burned sandy-clay material, exfoliated from the walls, were found in the pit fill. The pit was either used as an oven or it had been burned to dry the pit walls prior to use as a storage container. However, the pit rim or walls were not sufficiently fired to allow for archaeomagnetic sampling.

The pit was filled with sandy-clay soil containing charcoal fragments and rounded pellets of burned clay from the pit walls. A single stone was found in the pit fill at a depth of 45 cm below the rim. This rock was an angular fragment of sandstone, 16 by 10 by 6 cm. The only artifacts found in the pit fill were three small flakes of chipped stone and a small ground stone slab fragment. Excavation and screening of sediments on the surface in a 10 square meter area around the pit rim failed to locate any additional artifacts or other cultural remains.

Macrobotanical analysis of extensive flotation samples from the upper and lower sections of the pit fill revealed considerable evidence of carbonized *Zea mays* cupules, 2 corncobs, and 2 corn kernels. Also present were 11 carbonized seeds of *Chenopodium* or *Amaranthus*. Occasional carbonized wood fragments in the fill

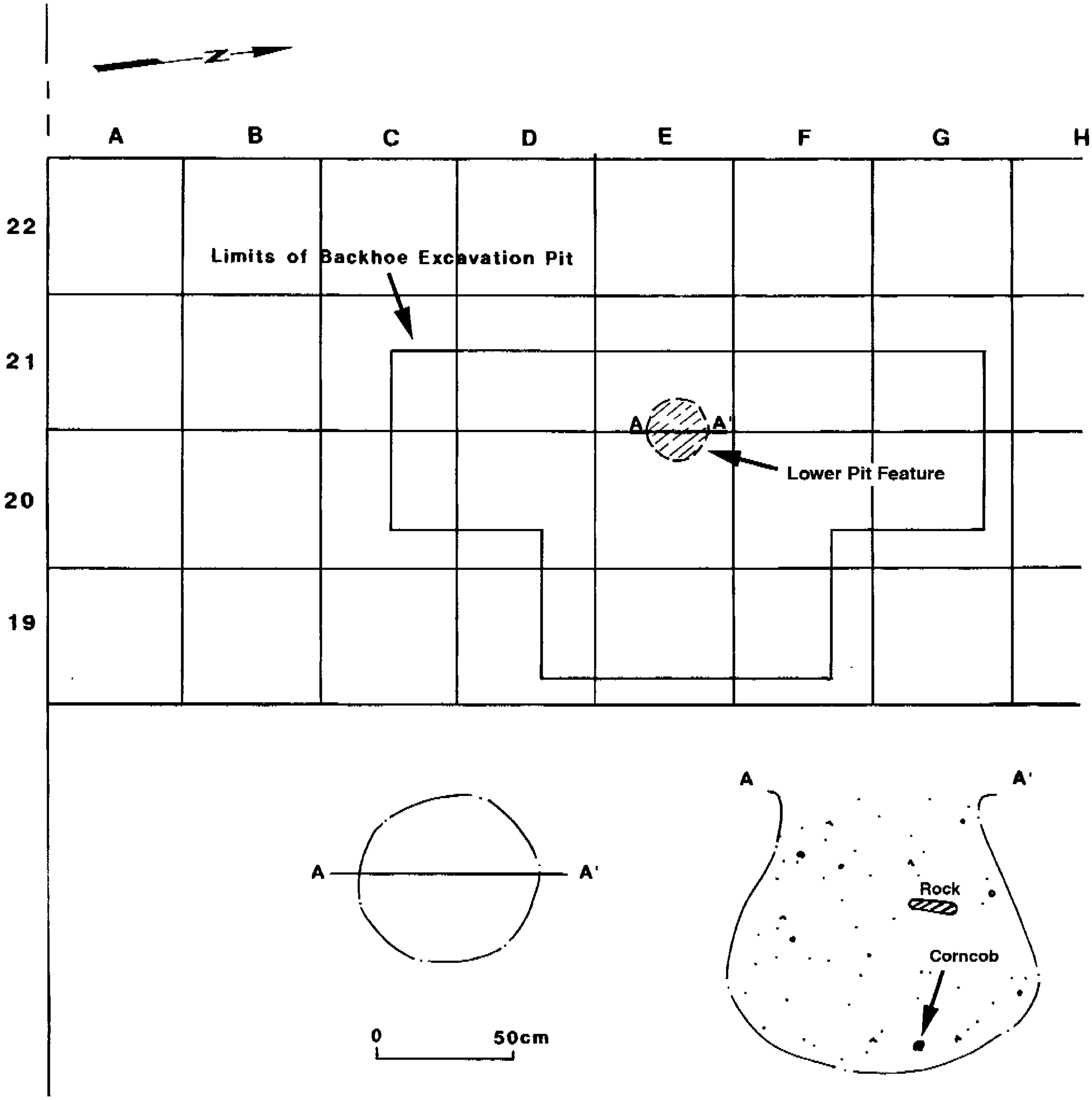

Figure 17. Location, plan, and cross-section of the pit feature, LA 45961

included sagebrush, pinyon, and juniper. Maize pollen was found in both pollen samples obtained from the pit fill.

Unfortunately, no diagnostic artifacts were associated with the feature. The pit may have been an isolated storage pit or roasting oven

associated with a nearby garden plot. The radiocarbon dates from corn within the pit indicate that the structure was used during the late Archaic period (ca. 740 to 500 BC). The corncobs found in the pit have 10 rows, exhibit indurate floral bracts, and are examples of a primitive flint/popcorn maize strain. Despite the absence of associated cultural remains, the presence of corn dated to this early period is significant and substantiates other evidence that maize agriculture was practiced in the San Juan Basin during the late Archaic period.

Artifact Assemblage: Cultural materials recovered during the LA 45961 excavations include 270 chipped stone artifacts, 2 ground stone artifacts, and 58 fragments of fire-heated stone. No bones were recovered. The density of chipped stone artifacts is estimated to be 17.3 specimens per cubic meter of cultural fill. This density is relatively low, but it is approximately twice the number identified at nearby LA 50460. Only minor quantities of fire-heated stone were found (0.093 cubic meters), and neither concentrations of heated stone nor hearths were identified.

The chipped stone materials recovered from the site during the excavations consist of 263 pieces of debitage, 2 cores, 1 graver, 2 fragmentary projectile points, 1 retouched flake, 1 endscraper, and 1 hammerstone. The debitage consists of 11 fragments of angular debris, 103 core flakes, 64 biface flakes, 2 core trimming flakes, 43 unidentified flake fragments, 38 pieces of microdebitage, 1 hammerstone flake, and 1 small circular sandstone slab. Also present in the collection was a hematite nodule, 10.7 cm in diameter, which was found in grid unit E12, 10 cm below the ground surface. Two other small arrow points were found on the surface during the 1997 survey.

The single graver was found in the excavation of grid unit C6. The endscraper, a retouched flake, and a projectile point fragment were found on the surface in a small scatter north of the NM 44 right-of-way. One of the other projectile points (L-18) was found in grid unit D13, 10 cm below the surface. Two cores were found at the site. One (L-29) is a silicified wood core, which was found on the surface north of the NM 44 highway right-of-way. The other is a chert core (L-10) that was found during the excavation of grid unit E4.

The most common chipped stone materials in the LA 45961 collection are obsidian (36.1%) and chalcedony (25.7%). All five obsidian artifacts submitted for EDXRF source analysis were found to come from the Valle Grande obsidian source. However, visual examination of the remaining pieces suggests that Polvadera materials are also present. Other material types include silicified wood (16.3%), chert (11.1%), orthoquartzite (8.6%), quartzite (1.1%), quartz (0.7%), and Chuska chert (0.7%).

Only two specimens of ground stone were recovered from the LA 45961 excavations, both of which are one-hand cobble manos. Ground stone artifacts represent approximately 0.7% of the lithic artifact assemblage from LA 45961. One of the manos is nearly circular, bifacially ground, and 10 cm in diameter. It exhibits pecked marks over one ground surface, which suggests possible additional use as an anvil stone. The other mano is a fragment with a single ground face.

Faunal Material: No bone was recovered from the LA 45961 excavations.

Botanical Material: The only macrobotanical materials recovered from the site were retrieved from the lower pit fill. A large flotation sample of 43,150 cc from the pit fill was analyzed, and a few macro specimens were collected during the pit excavation. The samples obtained from the pit included carbonized wood fragments of juniper,

pinyon, and sagebrush. Also present were 11 burned seeds of *Chenopodium* or *Amaranthus*, 2 *Zea mays* cobs, 961 corn cupules, and 2 corn kernels. The botanical materials are described in detail in the ethnobotanical analysis for the project completed by Paul Knight (Chapter 9).

Three pollen samples from LA 45961 were analyzed by Jannifer W. Gish (Chapter 10). One was a control sample from the surface and two others were obtained from the fill of the pit feature associated with the early component. Maize pollen recovered from the pit fill samples is consistent with the presence of macrobotanical specimens of maize from the pit. The pollen samples from the pit also contain Cheno-Am pollen, which is consistent with the carbonized Cheno-Am seeds found within the pit. The somewhat lower incidence of arboreal pollen in the pit fill samples, in comparison with the surface control sample, suggests that the local environment at the time of the early component occupation was a more open scrubland and less forested than it is today.

LA 119580 (The Upper Kimbeto Site)

Previous Research: This site was first recorded during the 1997 cultural resource survey for the NM 44-North highway improvement project (Marshall 1997). The site was defined as a small scatter of chipped stone artifacts. It was subsequently determined that the site would be affected by the proposed NM 44 improvement project and mitigative treatment of the location was authorized.

Location: The site is located on the upper slope of a steep road embankment along the north side of NM 44 in San Juan County, New Mexico (Figure 1). The dune slope is at an elevation of 2,085 m (6,840 ft) above sea level. The specific location of the site is described in Volume 2 of this report, which has been placed in the NMCRIS files at the Archaeological Records Center in Santa Fe.

Environment: The Upper Kimbeto site is situated in a dune area near the crest of a low north-south trending ridge. It is about 700 m east of Kimbeto Wash. The site is in the upper headwaters of Kimbeto Wash near the divide between the Kimbeto and Blanco drainage systems. Low sandstone outcrops surrounded by sand dunes occur north of the site. The site is situated within the dunes. It is in an open juniper-pinyon woodland. Vegetation also includes sagebrush, rabbitbrush, and Indian ricegrass. The closest available water can be found in shallow wells along the floor of Kimbeto Wash.

Excavation Methods: LA 119580 was excavated in September and October of 1998. The distribution of all surface artifacts along the upper slopes of the NM 44 roadcut was marked with pin flags. The surface artifact distribution was sparse and was confined to a small area. Also identified in the site area were a few fragments of modern bottle glass and a hearth stain 5 m west of the artifact scatter. No artifacts were found outside the highway right-of-way.

The southern section of the site had been removed by the construction of NM 44, and only a 7-m-wide area, near the top of the roadcut and along the immediate north edge of the highway right-of-way, remained intact and undisturbed. A few artifacts were scattered down the slope of the roadcut.

A 2 by 2 m grid system was established over the north right-of-way slope in the area of the artifact scatter (Figure 18). It consisted of 10 grid units along the east-west axis (–3 to + 7) and 4 grid units along the upper edge of the roadcut (A to D). The distribution of surface artifacts within the site area was plotted on the site map and

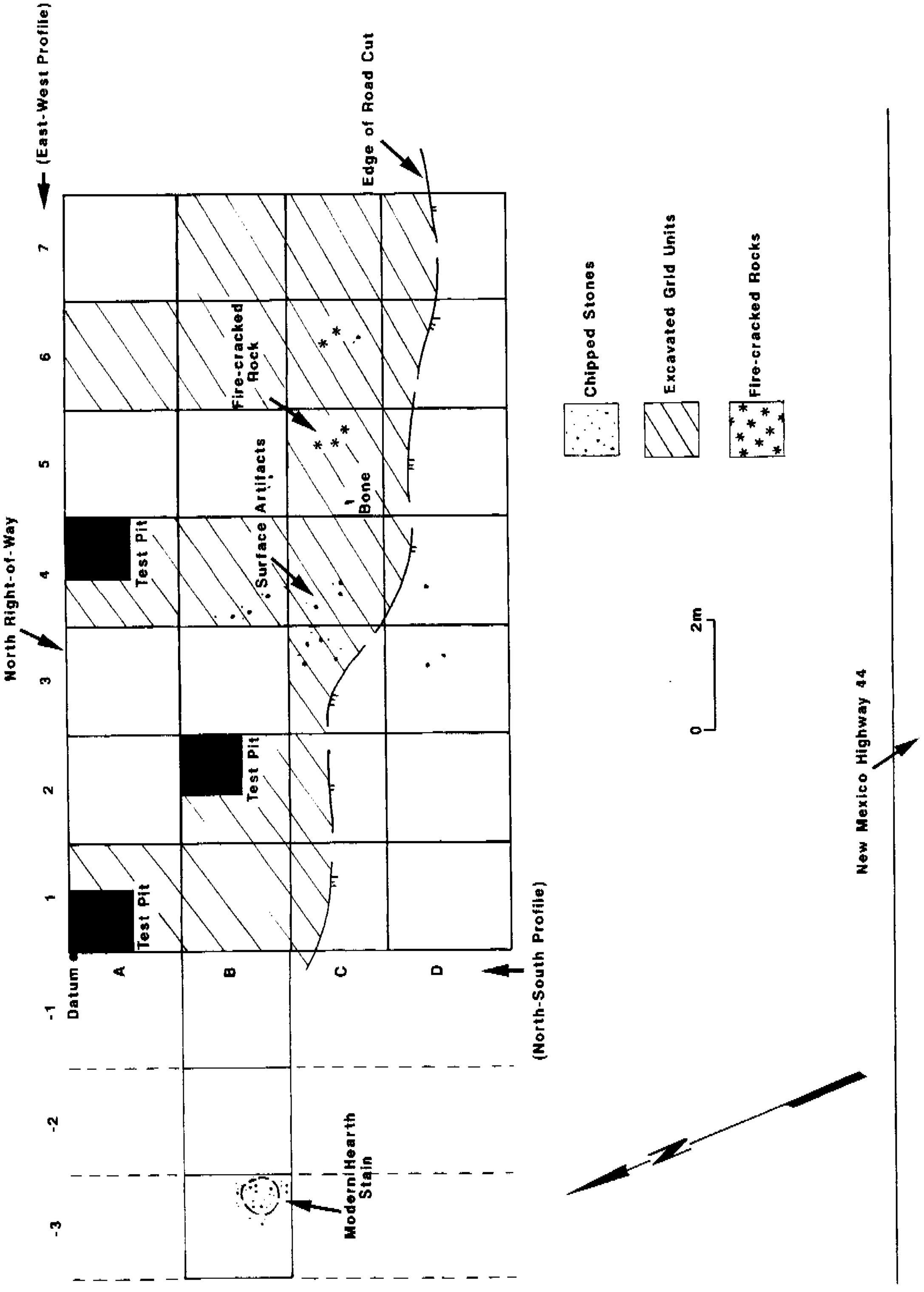

Figure 18. Map of LA 119580

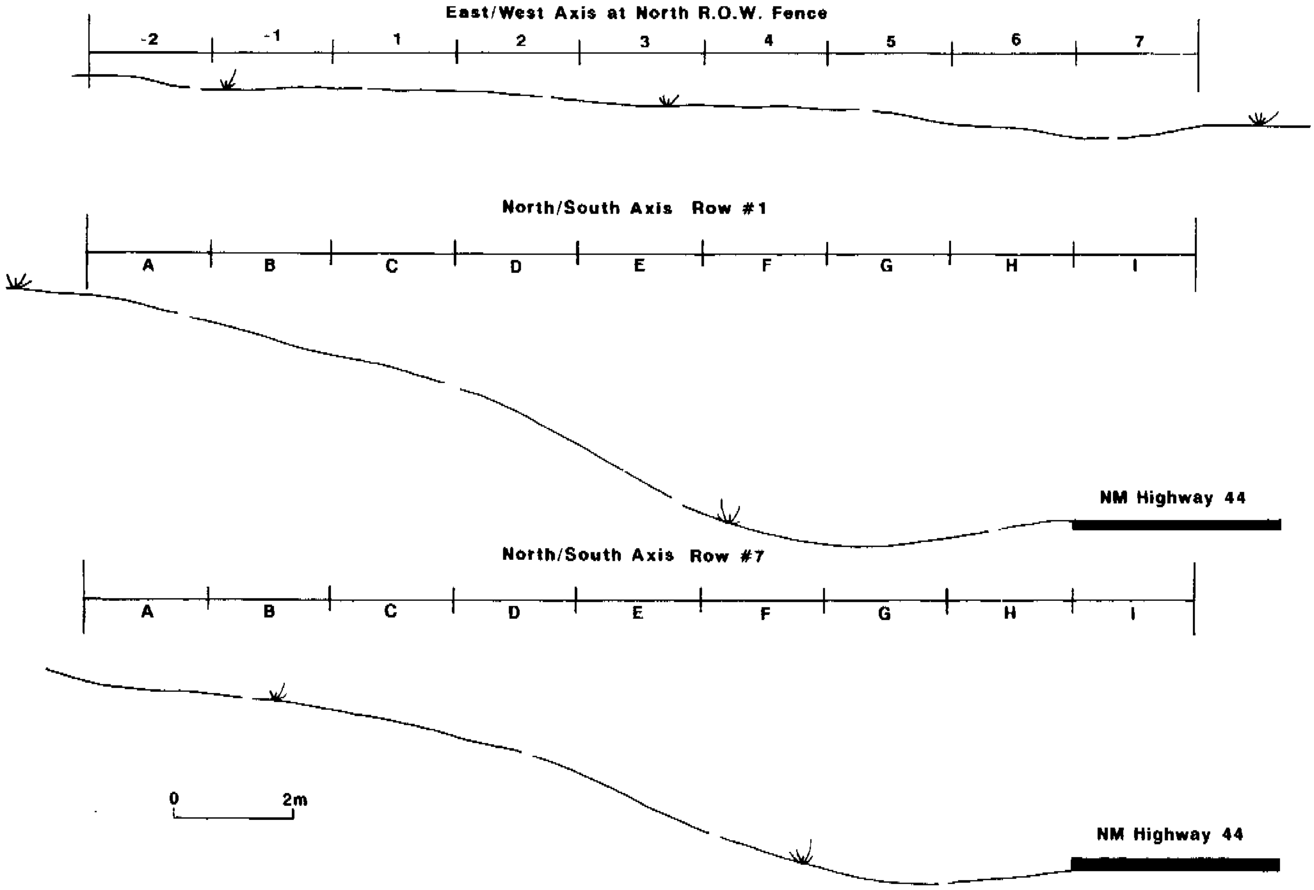

Figure 19. Surface contours of LA 119580

collected according to grid unit locations. The slope of the highway cut in the site area is shown in Figure 19.

All of the excavations at the site were completed with hand tools (Figure 20). A total of 64 square meters was excavated to varying depths of 5 cm to 1.5 m, and an estimated 25.1 cubic meters of fill was removed. Excavations were initiated in grid row C at the level of the apparent occupation surface and were extended north into the upper bank of the site. Excavations in grid rows A and B required the removal of 50 to 80 cm of dune sand that superimposed the apparent occupation surface. Sifting of sediments through a ¼-inch screen was confined mainly to the level of the apparent occupation surface (Level 3). However, some of the fill from the upper sand dune (Levels 1 and 2) and the compact yellow sand below the occupation surface (Level 4) were also sifted to determine if artifacts were present. Test pits were excavated to the bedrock substrate at a depth of 1.0 to 1.5 m below the ground surface.

Cultural-Temporal Affinity: LA 119580 consisted of a small scatter of chipped stone artifacts of probable prehistoric affinity. No date samples or diagnostic artifacts were found at the site, and the specific cultural-temporal affinity of the site is undetermined. Also present at the site was a recent hearth. Fragments of brown beer bottle glass were found in and adjacent to the

Figure 20. LA 119580 during excavation

hearth, indicating that it is a modern feature, probably of post-1950 affinity.

Site Description: This site consisted of a sparse scatter of 15 chipped stone artifacts and 5 fragments of fire-heated stone within an 8 m east-west by 6 m north-south area. The artifacts were exposed along the upper north edge of the NM 44 roadcut, and the south site area had been removed by previous road construction. Artifacts were exposed along the embankment from 3 to 8 m below the north right-of-way fence; the north edge of the site was covered with a sand dune. The dunes along the north edge of the site were thought to have covered intact cultural remains. However, excavations into the dune slope revealed only traces of artifacts in subsurface contexts and no intact cultural sediments or features. The site was probably a limited activity area, or perhaps the small artifact scatter identified in the LA 119580 area was on the margins of a larger site removed by the construction of NM 44. In any event, no evidence of intact prehistoric cultural remains was found at the site and no diagnostic artifacts were recovered.

A hearth stain located near the surface in grid unit -3B was exposed along the upper edge of the roadcut, 5 to 40 cm below the dune slope. It consisted of oxidized sand and charcoal bits over an area 65 cm in diameter and 5 to 10 cm thick. The hearth fill contained sub-carbonized juniper wood bits and fragments of modern brown bottle

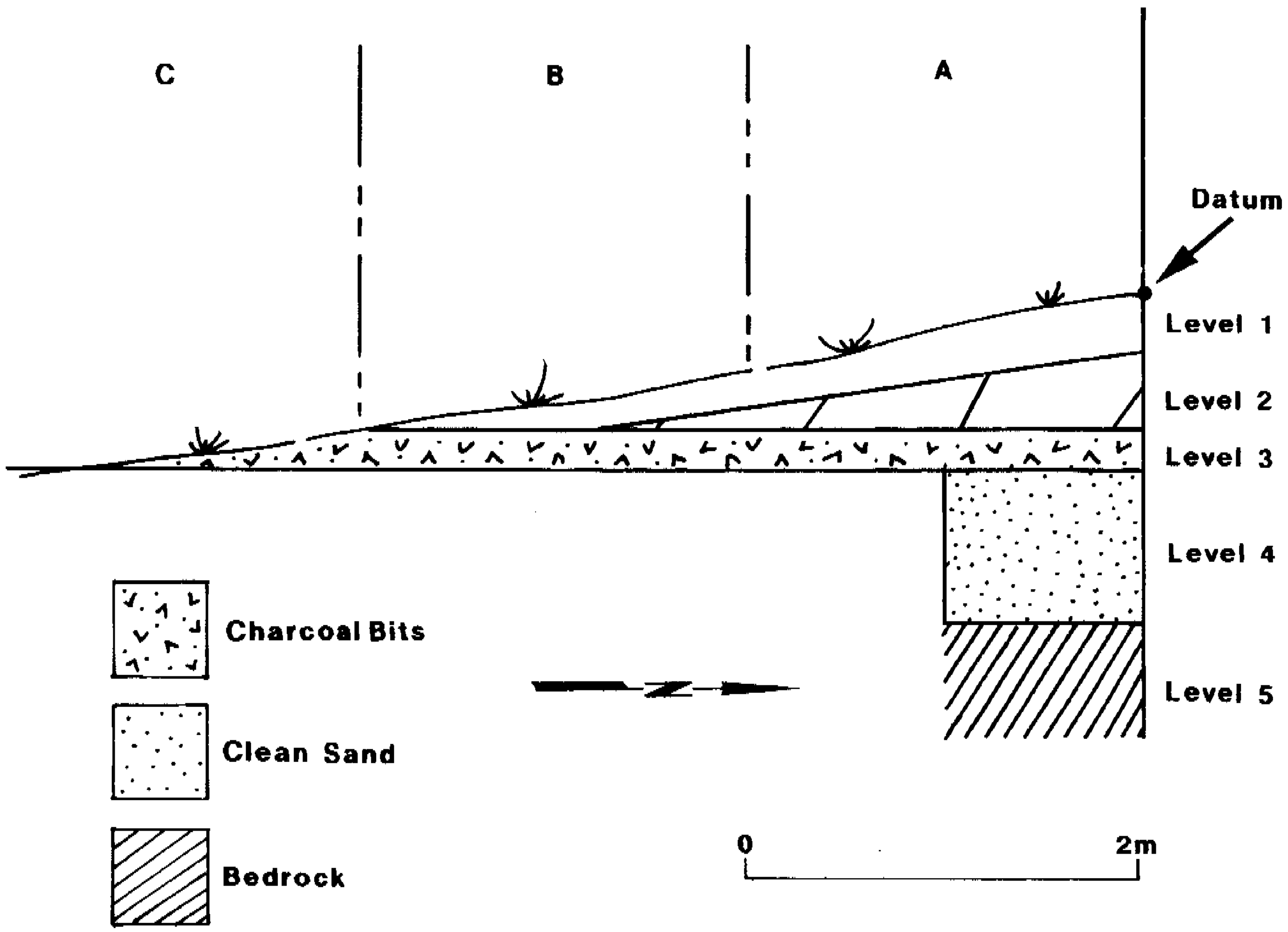

Figure 21. North-south stratigraphic profile of LA 119580

glass. It is clear that this hearth is of recent affinity.

Stratigraphic Profile: Excavations at LA 119580 were confined to a 64 square meter area along the upper northern edge of the NM 44 road embankment. The embankment is a rather steep slope that is cut deeply into the soft sandstone substrate (Figure 21). The upper north edge of the embankment remains intact and is covered by an active sand dune. The excavations were completed in a 6-m-wide section along the north edge of the road embankment and varied from 20 cm to 1.5 m in depth. An east-west cross-section of the excavated area along the north right-of-way fence (Figure 22) illustrates the stratigraphic units encountered in the excavations. All of these units are natural deposits, and no intact cultural sediments were identified. The few artifacts found at the site appear to be associated with the Level 3 sediments believed to have been the ground surface during the prehistoric occupation.

Five stratigraphic levels were identified in the excavation profiles. Levels 1–4 are all eolian deposits of slightly different type. These deposits overlie a substrate (Level 5) of very soft bedrock of consolidated sand or sandstone.

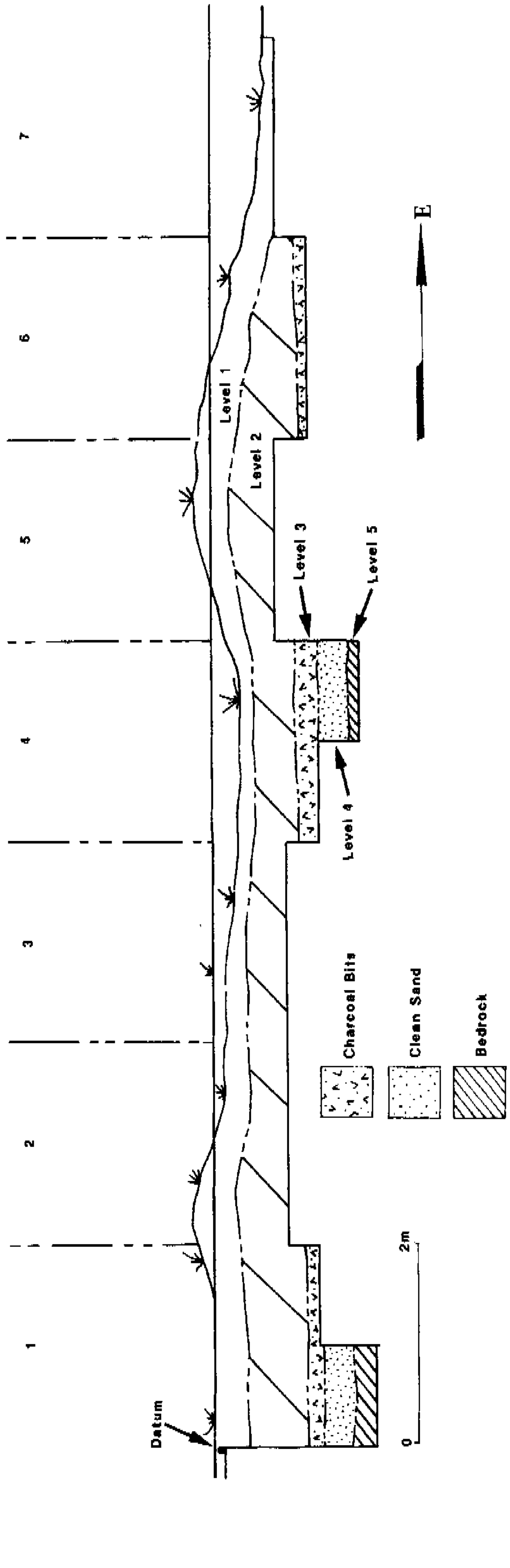

Figure 22. East-west stratigraphic profile of LA 119580

Level 1 is the upper deposit of eolian sand. This light tan dune sand is very loose and fine. It is of recent origin and in some areas has drifted over the base of the NM 44 right-of-way fence to a depth of 25 to 45 cm. This upper level varies from 20 to 45 cm thick.

Level 2 is a slightly compact layer of clean eolian sand that is approximately 40 cm thick. It contains occasional charcoal fragments, many of which are sub-oxidized juniper wood. This charcoal is obviously of modern affinity and may be associated with a nearby hearth.

Level 3 is a 20-cm-thick zone of compact sand that contains some silt. It is slightly darker than levels 1 and 2. The artifacts found at LA 119580 appear to be associated with this level, which was probably the ground surface during the prehistoric site use. However, excavations in Level 3 failed to reveal any intact cultural features or sediments and only traces of chipped stone artifacts.

Level 4 is a 30-cm-thick zone of clean yellow sand. The sand is somewhat coarser than the fine sand of the upper two levels, but less consolidated than the Level 1 and 2 deposits. This sand may be partly derived from the soft sandstone bedrock that is located below the level and is exposed north of the site.

Level 5 is the bedrock substrate that consists of very soft sandstone.

Artifact Assemblage: Only 15 chipped stone artifacts were recovered from LA 119580. All are unmodified debitage: 13 core flakes and 2 fragments of angular debris. Most of the material is white chalcedony (11 specimens), with 2 specimens of orthoquartzite and 2 of silicified wood. No diagnostic tools were present, and none of the flakes appears to have been utilized. No ground stone material was found at the site. The artifact assemblage from the site indicates that the location was a short-term and limited activity area and involved only the primary reduction of chipped stone materials.

Flora and Fauna Material: No biological materials were recovered from LA 119580. No cultural sediments or macrobotanical materials associated with the prehistoric site occupation were found during the excavations. Carbonized and sub-carbonized wood fragments were found in the Level 2 sediments and in association with the hearth, but all of these materials are of modern affinity. Pollen samples from the site were not analyzed, since no prehistoric context for the samples could be defined.

Chapter 4

Research Design

by Michael P. Marshall and Kenneth L. Brown

A research design and data recovery plan for the NM 44-North excavations at LA 45961, LA 50460, and LA 119580 was compiled by Cibola Research Consultants prior to the excavations (Brown 1998). This plan was reviewed and approved by the New Mexico State Historic Preservation Division and was submitted as part of antiquities permit applications to the Navajo Nation Historic Preservation Department and the Bureau of Indian Affairs. This plan outlined the procedures proposed for the mitigation project and identified a number of research issues to be addressed by the investigations. Five research problem domains were identified in the data recovery plan: (1) chronology; (2) cultural affiliation; (3) lithic technology, style, and function; (4) trade and exchange; and (5) subsistence and settlement systems. These problem areas are discussed in the following notes and are addressed in the chronology and discussion chapters of this report.

Chronology

Chronological placement of the sites within the regional cultural-historical continuum is a fundamental problem that must be addressed. Surface artifacts suggested probable Archaic period affinity for the three sites addressed in this study. However, specific dates of the sites were unknown. There is a critical need for absolute dates from Archaic sites in order to evaluate existing projectile point typologies (Hogan et al. 1991:6.9) and outline the general course of Archaic period cultural development in the San Juan Basin.

The temporal placement of the cultural remains is of primary importance to the reconstruction of Archaic period cultural development. Without absolute dates, the information value of associated artifacts and features is greatly reduced. Relevant chronological issues include whether there is a continuum of lithic artifact types that is expressed in specific temporally diagnostic characteristics. No tree-ring date samples or fired earth suitable for archaeomagnetic dating were found during the excavations. However, carbonized wood and other materials found at LA 45961 and LA 50460 yielded five radiocarbon dates. Some additional chronological information was obtained from 15 obsidian artifacts that were submitted for hydration analysis. No absolute date samples were obtained from LA 119580. Radiocarbon dating, obsidian hydration, and stratigraphic context have contributed to the temporal assignment of occupations at LA 45961 and LA 50460. This information is presented and discussed in the chronology chapter of this report.

Cultural Affiliation

The definition of cultural affiliation with respect to previously identified cultural phases, and a

critical examination of material culture and site structure with regard to possible cultural or ethnic affinity, is a perennial research issue that is briefly addressed in this study. The project area, in the eastern periphery of the San Juan Basin, has been subject to external influences from the Rio Grande Valley, the Northern Colorado Plateau, the Southern Plateau–Basin and Range, and the Great Basin regions. The most common Archaic phase sequence identified in the San Juan Basin is the Oshara Tradition, which was first defined by Cynthia Irwin-Williams (1973) in the Arroyo Cuervo area on the southeast margin of the basin. The Oshara phase sequence (Jay-Bajada, San Jose, Armijo, En Medio, Trujillo) has been described on numerous occasions and will not be reiterated here.

Other Archaic period traditions that have been identified within and marginal to the San Juan Basin include San Pedro phase sites of the Cochise Tradition (Elyea 1999) and Green River–San Rafael phase sites (Elko Corner-notched, Sudden Side-notched, and San Rafael Side-notched projectile point types) which appear to be affiliated with the Northern Plateau–Great Basin Tradition (Holmer 1986). There has been some confusion as to the identity of the large side-notched dart points in the San Juan Basin area, as they are often identified as Cochise (Moore 1991 and others). However, the current consensus seems to favor a Northern Plateau affinity (Acklen et al. 1997:306; Beckett 1997:20) since these projectile points show more similarity to the Northern Plateau and Great Basin materials than to the Cochise side-notched forms. Acklen and others (1997:306) argue that large side-notched points occur with such frequency in the San Juan Basin and Jemez Mountain areas that they should be included in the Oshara Tradition. However, these points are not usually considered to be Oshara and have been dated in New Mexico from ca. 3500 BC to AD 200 (Acklen 1993:306). In a sample of 215 Archaic period components in the Gallegos Mesa area, 13 sites or 6% of the sample contained large side-notched points (Vogler et al. 1993:122).

The possible cultural affinity of the NM 44-North sites is evaluated in Chapter 12 and in comments on LA 50460 in Chapter 13. Evidence from projectile point types and the incidence of nonlocal lithic material types is evaluated.

Technology, Style, and Site Function

Technology, which in its broadest sense is the knowledge available for collecting and modifying objects, cross-cuts all data categories, including lithic and archaeofaunal data. Style, which has been defined by Hegmon (1990:8) as a consistent series of choices, can be used to discern different temporal horizons and cultural groups. Sackett (1973:323) defines style as being based on morphological or formal technological attributes independent of function. In regards to both style and function, Jelinek (1976:22) refers to the "Frison effect," which is the transformation of a tool form as a result of breakage and rejuvenation, thereby masking original stylistic attributes. These concepts are important in elucidating characteristics that are specific to a particular Archaic group, whether chronological or cultural or a result of functional variation.

Hogan et al. (1991:6.26–6.27) proposed five categories of Archaic sites which may be expected in the San Juan Basin: residential bases, camps, stations, caches, and resource acquisition locations. Residential base camps are expected to contain debris from a variety of activities suggesting multi-function encampments. Camps should also have evidence of habitation, but with more restricted and less dense material debris. Stations include such locations as game observation points, where material debris is limited. Caches are temporary storage facilities

for equipment or subsistence resources. Locations are places where resources were harvested or acquired. The only material evidence at these loci is likely to be debris from tool maintenance or use. An evaluation of the various NM 44-North site attributes and assemblage characteristics is presented in the discussion section of this report in an effort to determine the site types and functions.

Trade/Exchange and Mobility/Range

Trade and exchange is the redistribution of goods and services across space (Braun and Plog 1982:511). Maintenance of economic and political associations, and transmission of information, are important aspects of trade. Trade and social interaction are structured by the mobility or range of a social group within a geographic range. In the context of the Archaic Southwest, this is usually the movement of a small band of people to a series of seasonally available resources (serial foraging). At Archaic period sites trade and group mobility may be indicated by the distribution and frequencies of various nonlocal lithic materials and by other exotic artifact types.

The distribution of exotic lithic raw materials should reflect either trade relations and social contact with adjacent cultural groups or the movement/range of populations. Nonlocal raw materials may have been collected during a different phase of the seasonal round, or expeditions may have been conducted to collect raw materials. Trade of exotic raw materials or products appears to have been well-developed by the early Archaic period. For example, probable trade in Jemez obsidian material is evidenced by the wide distribution of occasional Jemez Mountain obsidian artifacts in Archaic period sites (Baugh 1997:252–255) northwest in Utah and southeast into Texas.

Exchanges of goods and information within the context of a mobile hunting and gathering economy were, no doubt, important in terms of social relations with trading partners and may have strengthened kinship ties, political alliances, and interdependency during times of stress or hardship. Some evidence regarding these issues is provided in a discussion of nonlocal lithic materials recovered from LA 45961 and LA 50460.

Subsistence and Settlement Systems

Subsistence issues can be addressed through the acquisition and analysis of archaeobotanical and archaeofaunal data. Subsistence studies address the involvement of people and technology with plants, animals, and the environment. This concerns settlement and social systems, particularly the adaptability of the social groups to changing environments and resource availability. This should be expressed in terms of seasonal mobility patterns, social group size, and site function. One important area of research regarding subsistence is the use of pinyon nuts by Archaic groups. Pinyon probably was not as abundant before 2300 BC as it is today (Hogan et al. 1991:6.19). Also, *Pinus edulis,* the pinyon found in the San Juan Basin, has a cone-crop frequency of 1 to 5 years, which makes it a less reliable food resource than the *Pinus monophylla* found in the Great Basin, which has cone-crop frequency of 1 to 2 years. One research objective is to determine to what extent Archaic groups in the project area used pinyon resources. Toll and Cully (1983) have suggested that food resources in the northern part of the San Juan Basin are most plentiful during the late fall and winter and in the pinyon-juniper zone. Current models of Archaic settlement systems oftentimes assume that Archaic winter habitations are in the uplands where pinyon nuts were harvested and stored for winter use (Hogan et al. 1991:6.19).

Hogan et al. (1991:6.20) proposed two alternative adaptations for winter subsistence when the pinyon crop failed. First, Archaic groups hunted more animals to sustain them through the winter months. Second, a variety of plant resources were harvested during the summer and fall months for winter use. Plant resources would have been cached near where they were harvested for retrieval during the winter months. To minimize the effort of transporting cached food to winter habitations, winter encampments were established in areas amenable to retrieving food caches in both lowland and higher elevations. This would explain why Archaic sites in the Fruitland Coal and Gas Development (FCGD) areas are at the lower boundary of the pinyon-juniper plant community. The lowland plant community likely provided abundant quantities but a restricted variety of resources such as ricegrass, dropseed, and goosefoot/pigweed. Small game, including rabbits, would also have been taken by Archaic populations (Hogan et al. 1991:6.22). Knowledge of Archaic subsistence practices is critical to understanding the transition to agriculture, which appears in the San Juan Basin about 2000 BC but does not become a dominant aspect of the overall subsistence base until about 500 BC (Bargman et al. 1999; Simmons 1986). The analysis of botanical and faunal remains from the NM 44-North sites is presented in chapters 9, 10, and 11 and is summarized in the discussion section of this report (Chapter 12).

Chapter 5

Chronological Considerations

by Michael P. Marshall

One of the principal objectives of the NM 44-North data recovery project and research design was to obtain information regarding the chronological placement of the archaeological sites. No wood suitable for dendrochronological dating or fired earth suitable for archaeomagentic dating was found. However, information relevant to the chronological placement of the cultural remains was obtained from 5 radiocarbon samples, 15 obsidian hydration samples, and by the relative placement of cultural remains within stratigraphic contexts.

Radiocarbon Dating

An attempt was made to obtain carbonized material for radiocarbon dating from all possible contexts. However, only five areas yielded sufficient charcoal for conventional radiocarbon dating: one from the East Provenience of LA 50460, two from the West Provenience of LA 50460, and two from the early component of LA 45961. No charcoal was found in association with the late component at LA 45961, and the only carbonized material found at LA 119580 was associated with a recent hearth.

The radiocarbon dates obtained from the NM 44-North sites are listed in Table 1 and the analysis data sheets provided by Geochron Laboratories are presented in Appendix A. All of the dated radiocarbon materials from LA 50460 are carbonized juniper, pinyon, or greasewood. The radiocarbon dates from LA 50460 are quite early, suggesting an occupation during the early Archaic period. The date from the Level 2b sediments in the West Provenience is the oldest: 7670 BP ± 130 (ca. 5720 BC). The date from Level 2a in the West Provenience is somewhat later: 7460 BP ± 180 (ca. 5510 BC). The East Provenience, which is 30 m east of the West Provenience and located in a somewhat higher stratigraphic position, yielded a radiocarbon date of 7090 BP ± 190 (ca. 5140 BC). This date indicates that the East Provenience is a somewhat later component that was occupied a few hundred years later than the West Provenience.

The radiocarbon dating of LA 50460 to the early Archaic period in the sixth millennium BC is of considerable interest. Most of the early Archaic period sites in the San Juan Basin area have been identified as Jay or Bajada phase with rather distinctive shouldered and long-stemmed projectile points (Huckell 1996:332; Vogler et al. 1993; Wiens 1994). However, the projectile points from LA 50460 are unlike the Jay or Bajada types and consist of a mixed assemblage of short-stemmed and corner-notched types (see Chapter 6). These differences in associated projectile point forms are of concern, but they do not necessarily call into question the validity of the radiocarbon dating. Indeed, the fact that all three dates obtained from LA 50460 are similar helps to substantiate their validity. Furthermore, all of the radiocarbon samples had perfect LS ^{14}C

Table 1. Radiocarbon Dates from NM 44-North Excavations

Sample Number	Provenience	Sample Material	Date Range	Mean and Span
GX-25533-LS Cibola 3	LA 45961, lower pit fill (40-90 cm below pit rim)	Maize kernels and corn cobs	2570 ± 120 BP	Mean: 620 BC Span: 740-500 BC
GX-25531-LS Cibola 1	LA 45961, lower pit fill (40-60 cm below pit rim)	Carbonized wood, sage, pinyon and juniper	2030 ± 100 BP	Mean: 80 BC Span: 180 BC to 20 AD
GX-25532-LS Cibola 2	LA 50460-West Prov. Level 2b, 50-70 cm Grids G35 and F35	Carbonized wood, pinyon, juniper and greasewood	7670 ± 130 BP	Mean: 5720 BC Span: 5850 to 5590 BC
GX-25535-LS Cibola 5	LA 50460 West Prov. Level 2a, 40-50 cm Grid G36	Carbonized wood, mostly juniper with some pinyon and greasewood	7460 ± 180 BP	Mean: 5510 BC Span: 5690 to 5330 BC
GX-25534-LS Cibola 4	LA 50460 East Prov. 20-30 cm, Grids E9, E10, D8, D9, F11 and F12	Carbonized wood, pinyon and juniper	7090 ± 190 BP	Mean: 5140 BC Span: 5330-4950 BC

spectra and there is no doubt as to the accuracy of the results. The samples were treated by the standard method, and there was enough material to measure them without dilution (personal communication, Dr. Alexander Cherkinsky, Geochron Laboratories).

Although the general sequence of projectile point types defined for the Oshara phase in the San Juan Basin may be accurate, there are serious problems with the specific temporal affinities of the types. Many of the types used to identify Oshara phases overlap and have different temporal-regional affinities, or are a result of functional rather than strictly temporal variation. Turnbow (1997) provides an excellent study of projectile point types in his analysis of material from the Jemez Mountain area. This study provides a systematic typological definition but notes considerable problems when point types, normally believed to be Oshara phase indicators, are listed along with their associated radiocarbon dates (Turnbow 1997:216, 221). Turnbow finds no clear one-to-one correlation between projectile point types and previously defined temporal periods. He also notes (1997:223) that the absence of projectile point types, other than Jay and Bajada in the early Archaic period of the San Juan Basin, is suspect since a wide variety of projectile point types has been identified in the adjacent Northern Colorado Plateau during the early Archaic period (Anderson 1989; Holmer 1986).

The problem with using Archaic projectile point types as chronological indicators in the San Juan Basin will require continued evaluation and the collection of absolute dates in association with projectile points. However, the LA 50460 radiocarbon data suggest that a mixed projectile point assemblage containing stemmed-serrated and corner-notched types may occur much earlier in the San Juan Basin than originally believed and may be contemporaneous, but not mixed, with Bajada and perhaps Jay assemblages. Only through the continued dating of projectile points in the area can the early dates of the LA 50460 assemblage can be verified or refuted. However, for the present archaeologists working in the area should be alerted to the possible earlier occurrence of stemmed-serrated and corner-notched types in early Archaic period context.

Two radiocarbon samples were obtained from carbonized materials within a pit feature associated with the early component at LA 45961. This pit was found in a test trench 1.0 m below the ground surface and is clearly not associated with the artifact scatter found in the 0–15 cm surface layer. This upper artifact scatter is recognized as a much later, but undated, occupation. The two radiocarbon samples obtained from the early component pit fill consist of one sample of carbonized wood and one of carbonized maize.

The wood from the pit consisted of sage, pinyon, and juniper and yielded a date of 2030 ± 100 BP (ca. 80 BC), whereas the maize sample yielded a date of 2570 ± 120 BP (ca. 620 BC). The significant difference between the two samples is curious since both of the samples were found within the pit in the same well-defined and confined provenience. Whatever the cause of this variation, it is clear that the pit dates to the late Archaic period. Unfortunately, no associated diagnostic artifacts were found with the pit. However, the date obtained for the maize contributes to the growing evidence for early maize cultivation in the San Juan Basin.

Obsidian Hydration

Fifteen obsidian samples were submitted to the Obsidian Laboratory at Sonoma State University for hydration analysis following sourcing at the University of California (Appendix B). The samples were 10 specimens from LA 50460 and 5 specimens from LA 45961. No obsidian artifacts were recovered from the Upper Kimbeto site, LA 119580. The results of the obsidian hydration band analysis is presented in a letter report by Thomas M. Origer, Director of the Obsidian Laboratory (Appendix C). Six measurements were completed for each specimen and the mean was determined (Table 2). All five obsidian projectile points from LA 50460 were analyzed and yielded measurements of 4.0 to 4.4μ.

Use of obsidian hydration analysis as an absolute dating technique is problematic (Acklen 1993), as hydration rates appear to vary depending on moisture and temperature values and perhaps source material. However, the use of obsidian hydration as a relative chronological technique within a site appears to be justified (Acklen et al. 1995). Some researchers have assigned absolute dates to band measurements, but such designations cannot be considered accurate as radiocarbon dates and obsidian hydration dates are often quite different. Nonetheless, hydration analysis remains useful, especially for diagnostic artifacts and for artifacts that have been dated by absolute methods.

Within the NM 44-North samples, it is interesting to note that the relative temporal position of each of the site components is reflected in the hydration analysis (Appendix C). Samples from the older West Provenience component of LA 50460 (radiocarbon dated to 7460 BP ± 180 and 7670 BP ± 130) yielded hydration measurements of ca. 4.2 to 4.4μ. The slightly later component in the East Provenience of LA 50460 (radiocarbon dated to 7090 BP ± 190) yielded hydration measurements of 3.7 to 4.0μ. LA 45961, which appears to be late Archaic, yielded measurements of 3.1 to 3.4μ with a single specimen measuring 1.2μ.

Although obsidian hydration rates have potential value for identifying the relative age of cultural remains, comparison of hydration measurements with projectile point types has yielded mixed results. Previous studies have demonstrated a variable correspondence between projectile point typology and obsidian hydration rates (Bertram et al. 1989; Trierweiler et al. 1988). San Jose points from the Navajo Indian Irrigation Project yielded

Table 2. Obsidian Hydration Samples from the NM 44-North Excavations

Site and Sample No.	Artifact Type	Provenience	Mean Measurement (μ)	Source
LA 45961				
11	Debitage	Grid C10-Surface	3.4	Valle Grande (Jemez)
12	Debitage	Grid D9-Level 1, 0-15 cm	3.1	Valle Grande
13	Debitage	Grid C10-Level 1, 0-15 cm	3.1	Valle Grande
14	Debitage	Grid F11-Level 1, 0-15 cm	1.2	Valle Grande
15	Debitage	Grid E11-Level 1, 0-15 cm	3.1	Valle Grande
LA 50460 East				
1	Debitage	Grid D11, 20-30 cm	3.7	El Rechuelos (Polvadera)
2	Debitage	Grid D10, 20-30 cm	3.9	El Rechuelos
3	Debitage	Grid E11, 20-30 cm	3.8	El Rechuelos
4 (L-84)	Point	Grid E11	4.0	Valle Grande
LA 50460 West				
5 (L-49)	Point	Grid G29, Level 2a, 45 cm	4.4	El Rechuelos
6 (L-53)	Point	Grid G30, Level 2b, 53 cm	4.3	Valle Grande
7 (L-51)	Point	Grid H30, Level 2a	4.3	El Rechuelos
8 (L-52)	Point	Grid F35, Level 2b, 70 cm	4.4	Valle Grande
9	Debitage	Grid H32, Level 1-2a	4.2	Valle Grande
10 (Band 1)	Debitage	Grid H34, Level 2b	4.3	Valle Grande
10 (Band 2)	Debitage	Grid H34, Level 2b	7.2	Valle Grande

measurements of 3.49, 3.63, 4.67, and 9.13μ, while a single Armijo point yielded a 5.03μ measurement (Moore 1982). A few points from the Arch Joint Venture Project also yielded somewhat mixed results, with San Jose points measuring 4.1 and 6.4μ, Armijo points in the 4.1 to 9.2μ range, and En Medio points in the 1.8 to 4.5μ range. The single Jay point measuring 3.0μ is anomalous, being quite similar to the En Medio range. However, in general, En Medio points seem to fall in the 3.0μ range, Armijo in the 4 to 5μ range, and San Jose in the 4 to 6μ range (Vierra et al. 1983:74).

It is interesting to compare these samples with those obtained from Gobernador phase Navajo sites which, for the most part, yielded measurements in the 1.8 to 2.5μ range. The obsidian from Tapacito Pueblito, dated AD 1690, yielded measurements of 2.5μ, while those from Hooded Fireplace Pueblito, dated AD 1723, yielded measurements of 1.8 and 1.9μ (Marshall 1995:206). In comparison, most of the obsidian materials from Archaic contexts in the San Juan Basin have yielded hydration measurements in the 3.0 to 6.4μ range (Vierra et al. 1983:74).

Stratigraphic Context

The cultural deposits in the West Provenience of LA 50460 consist of a lightly charcoal-stained layer of sand from 30 to 70 cm below the ground surface. A few artifacts occur in the 0–30 cm level and in the 70–80 cm level, outside the zone of charcoal-stained soil, but these were probably displaced by rodent and other activity. Materials from the 50-cm-thick cultural deposit in the West Provenience were separated into upper 30–50 cm (Level 2a) and lower 51–80 cm (Level 2b) zones. The analysis of artifacts from the upper and lower

levels failed to reveal any significant variation. Most of the projectile points found in the deposit came from the middle 45–70 cm zone and showed no significant difference when grouped according to level designations. The highest density of artifact materials appears in the 50–70 cm zone, but no well-defined occupation surfaces or layers of artifact material could be identified. The higher incidence of bone in Level 2b is probably a result of enhanced preservation promoted by soil coverage and depth.

The West Provenience deposit appears to have been subjected to considerable disturbance and mixing, probably by rodents and insects. The mean radiocarbon date from the sample in the lower level is older, but the ranges overlap and both probably date to the same occupation. The cultural materials found in the West Provenience are extremely diffuse and not particularly abundant, suggesting that they could be the result of a single encampment or perhaps occasional use for a short period by a single band. Whatever the case, it was not a complex multicomponent occupation.

The deposits associated with the East Provenience are located in a rather thin zone from 20 to 40 cm below the ground surface and 30 m east of the West Provenience. The radiocarbon date and obsidian hydration samples from the East Provenience suggest that it was used a few hundred years after the occupation of the West Provenience. Compared with the West Provenience, the East Provenience has a much higher incidence of fire-heated stone and a lower incidence of bone and obsidian materials. These findings also suggest a different function and probably a different occupation.

Two components are well defined in the stratigraphic section at the Venado site (LA 45961). The upper or late component consists of a diffuse scatter of lithic artifacts in a zone 0–15 cm below the surface. No date samples were obtained from this level, but smaller corner-notched projectile points found on the surface appear to be arrow points suggesting an early Formative period occupation prior to the introduction of ceramics. Most of the obsidian hydration measurements are in the 3.1 to 3.4μ range and appear to be older than the Gobernador phase samples (1.8 to 2.5μ) from nearby Largo Canyon. This suggests that the site is probably an early Pueblo rather than an aceramic Navajo occupation.

Excavation of a series of backhoe trenches across LA 45961 resulted in the discovery of an isolated pit 1.0 m below the ground surface. The only cultural materials associated with the pit were three flakes and one small ground stone slab. The stratigraphic position of the pit, buried at a depth of 85 cm below the upper artifact scatter, clearly indicates that it represents an earlier occupational event. Above the pit is a sterile and very compact sand deposit which undoubtedly required a considerable amount of time for deposition. The radiocarbon dates obtained from the wood and maize in the pit vary somewhat, but the pit is clearly of late Archaic affinity. Excavations around the pit failed to reveal any associated cultural remains, and no other evidence of cultural material was found in other test trenches at the site. Therefore, it is believed that the feature is an isolated storage or roasting pit that was associated with a nearby agricultural field.

Excavations at LA 119580 failed to reveal any evidence of intact cultural remains. Most of the material was found on the surface and along the edge of the roadcut. The source of the material appears to have been a compact layer of sand overlying a loose sandy-bedrock formation. This layer was covered by a sand dune that contained no evidence of cultural remains. The apparent occupation surface yielded only a trace of artifacts and no materials suitable for radiocarbon

dating. The temporal affinity of the few chipped stone artifacts found at the site cannot be established.

Chapter 6

Chipped Stone Artifact Analysis

by Bradley J. Vierra

This chapter presents the results of the analysis of 858 chipped stone artifacts from LA 50460, LA 45961, and LA 119580. The lithic summaries document material selection, lithic reduction, and tool use. Material selection describes the variation in lithic materials used and the possible sources of these materials. Local materials are defined as those from known or probable sources within a 15 km (10 mile) radius of the site, and nonlocal as those from known or probable sources outside this catchment. Lithic reduction analysis provides information on core reduction techniques, stages of reduction represented, and evidence of tool production/maintenance. This includes describing the variation in cores, debitage, and retouched tools. The section on tool use presents information on tool function, including the presence/absence of use-wear.

LA 50460

A total of 573 chipped stone artifacts was analyzed from LA 50460. They consist of 5 cores, 548 pieces of debitage, 1 retouched flake, 4 bifaces, 9 projectile points (Figures 23 and 24), 2 endscrapers, and 4 manuports (mineral specimens).

Material Selection

Table 3 presents information on artifact type by material type. Most of the cores and debitage are made of orthoquartzite (37.9%), silicified wood (31.8%) and obsidian (18.3%), with lesser amounts of chalcedony, chert, and other materials. Only 6.1% of the debitage exhibits cortex, of which 38.2% is nodule (*n* = 13), 32.3% is tabular (*n* = 11), and 29.5% is waterworn (*n* = 10). Most of these lithic materials are presumably from local sources. The orthoquartzite is not the variety found in the Nacimiento Formation, but a tan material that has been identified in Largo Canyon where the Cuba Member of the San Jose Formation is exposed. Obsidian and Chuska (formerly known as Washington Pass) chalcedony are not locally available. Visual identification of the obsidian indicates that 76.1% is a dusty type possibly from Polvadera Peak (*n* = 80) and 23.9% a translucent variety from the Jemez Mountains (*n* = 25). X-ray fluorescence (XRF) analysis of 10 obsidian artifacts revealed equal numbers of Valle Grande and El Rechuelos (Polvadera) materials. A single core flake is made of Chuska chalcedony. Two undetermined flake fragments are made of a white and red chert that looks similar to Alibates chert, but is probably a silicified palm wood that is locally available.

The debitage assemblage contains a high percentage of fine-grained materials. Overall, 33.8% of the debitage is fine-grained (*n* = 187), 55.0% is medium-grained (*n* = 304), and 11.0% is coarse-grained (*n* = 61). Fine-grained materials are translucent, medium-grained materials that are smooth to the touch, and coarse-grained materials are grainy. Most of the fine-grained material is obsidian, along with some silicified

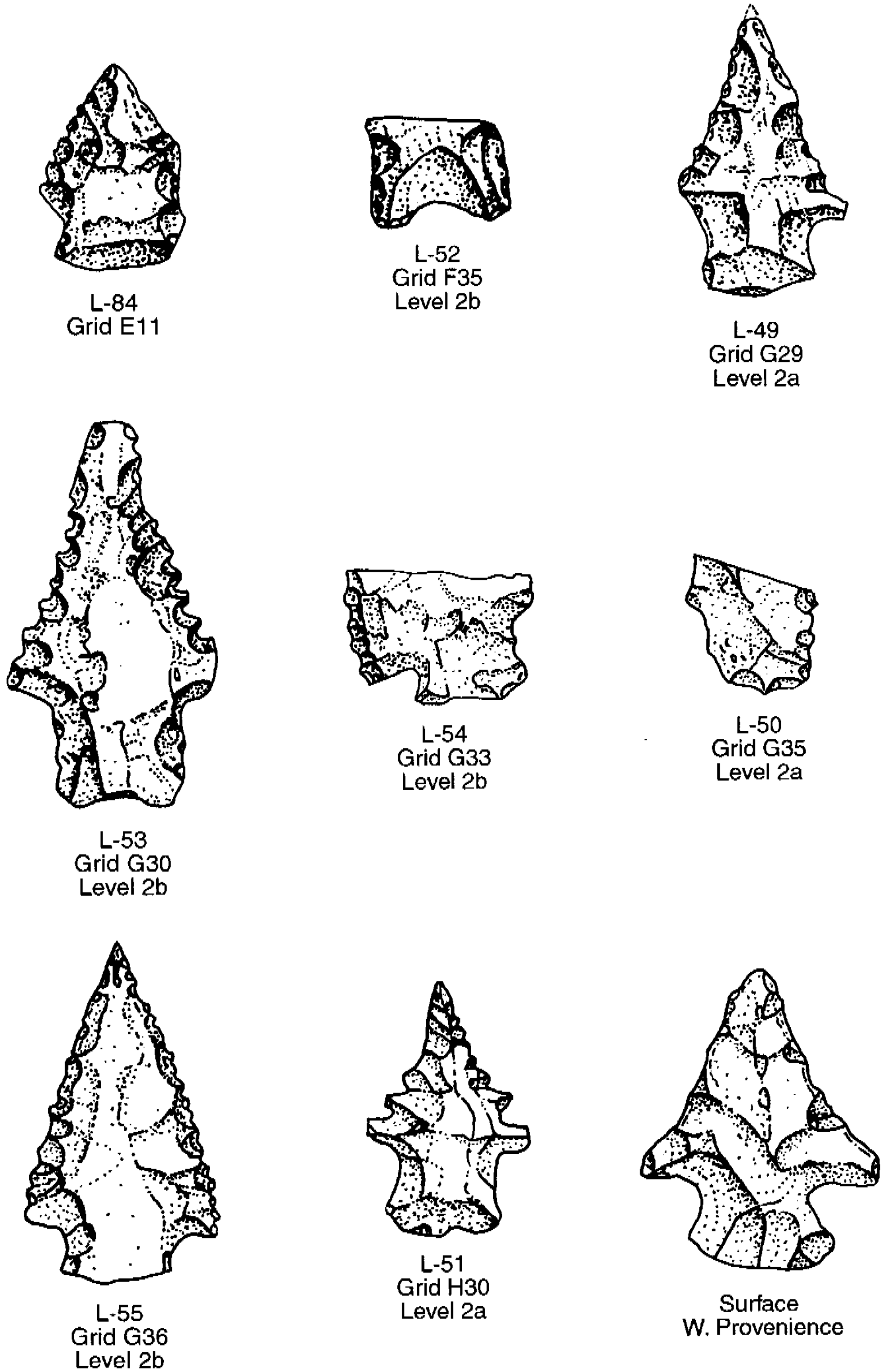

Figure 23. Projectile points, LA 50460 (actual size) (illustration by C. Marshall)

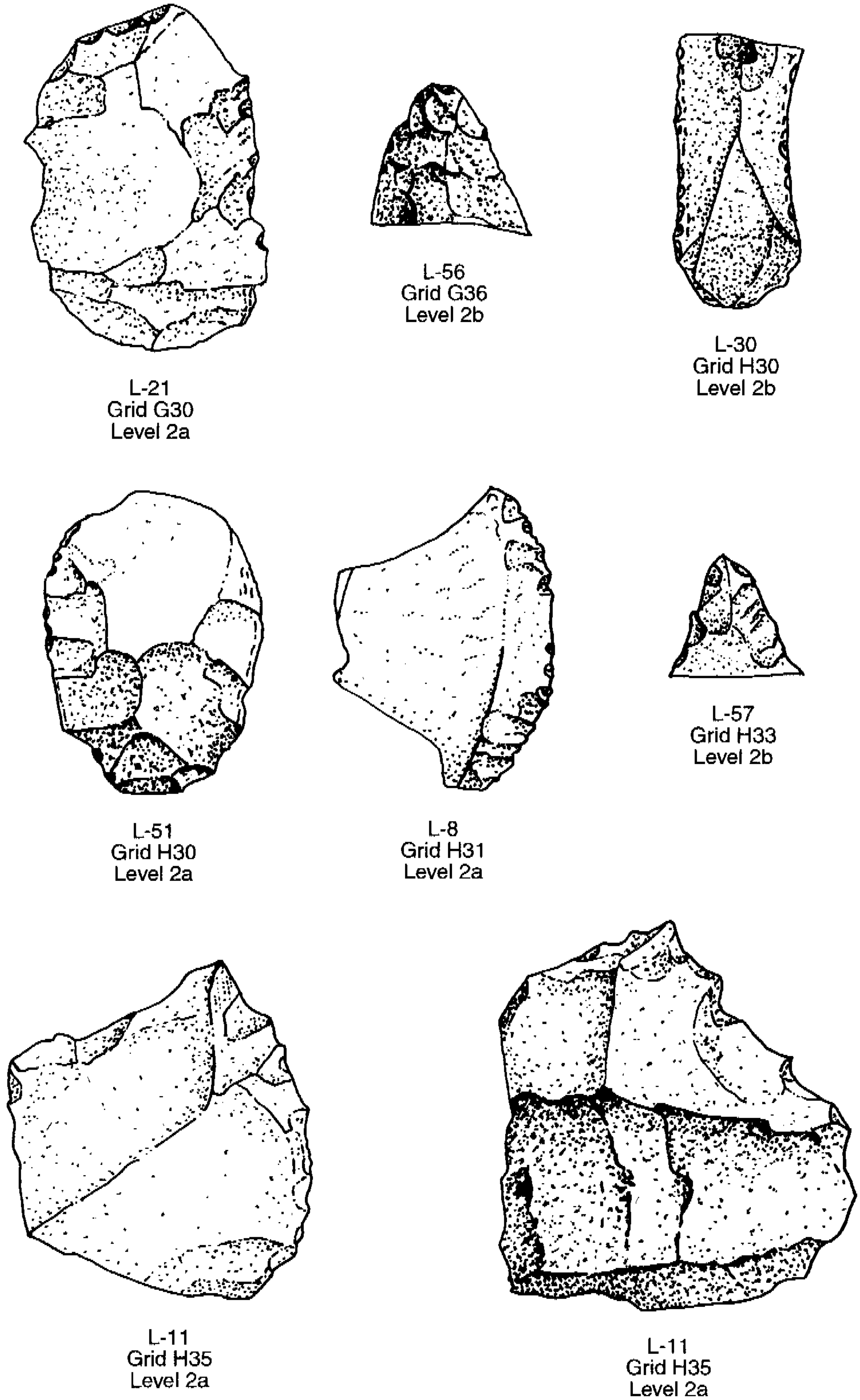

Figure 24. Chipped stone artifacts, LA 50460 (actual size) (illustration by C. Marshall)

Table 3. Artifact Type by Material Type (LA 50460)

	Obsidian	Orthoquartzite	Chalcedony	Chuska	Chert	cf. Alibates*	Silicified Wood	Quartzite	Quartz	Hematite	Limonite	Total
Core	0	3	1	0	0	0	1	0	0	0	0	5
Angular debris	0	3	0	0	0	0	14	0	0	0	0	17
Core flake	22	133	20	1	10	0	80	3	1	0	0	270
Biface flake	33	27	1	0	1	0	29	0	0	0	0	91
Uniface flake	0	1	0	0	0	0	0	0	0	0	0	1
Outrepassé flake	0	0	0	0	0	0	1	0	0	0	0	1
Core trimming flake	0	4	0	0	0	0	0	0	0	0	0	4
Und. flake fragment	10	13	0	0	1	2	12	0	0	0	0	38
Microdebitage	40	33	4	0	9	0	40	0	0	0	0	126
Retouched flake	0	0	0	0	0	0	1	0	0	0	0	1
Biface	0	0	0	0	0	0	4	0	0	0	0	4
Projectile point	5	0	0	0	1	0	3	0	0	0	0	9
Endscraper	0	1	0	0	1	0	0	0	0	0	0	2
Manuports	0	0	0	0	0	0	0	0	0	3	1	4
Total	110	218	26	1	23	2	185	3	1	3	1	573
%	19.2	38.0	4.5	0.2	4.0	0.35	32.3	0.5	0.2	0.5	0.2	

* probably a silicified palm wood of local origin

wood and chalcedony. Much of the silicified wood is chalcedonic, reflecting selection by the occupants of this higher quality material and not the splintery silicified wood so common in the San Juan Basin. Indeed, chalcedonic silicified wood is rare in the northern San Juan Basin lag gravels, which mostly contain medium- to coarse-grained materials (e.g., yellow silicified wood). On the other hand, fine-grained materials like these are more common in the southern San Juan Basin where they are associated with the Petrified Forest member of the Chinle Formation.

The retouched tools are primarily made of silicified wood, with some obsidian, chert, and orthoquartzite; however, all the bifaces are made of silicified wood, and most of the projectile points of obsidian.

The manuports consist of unmodified nodules of hematite ($n = 3$) and limonite ($n = 1$).

Lithic Reduction

The cores consist of three bidirectional cores and two core fragments. The bidirectional cores have single-faceted platforms with no obvious preparation. One bifacial core was made on a large orthoquartzite flake and the other is a bifacially worked tabular piece of orthoquartzite. The latter core was still usable, but the former had been discarded because of extensive stepping and because the opposing core face was exhausted. Both core fragments had broken during the reduction process; one may have been a unidirectional core. The whole cores have a mean length of 34 mm (sd = 11.7), width of 55.6

Table 4. Debitage Reduction Stages (LA 50460)

Material	Primary	Secondary Cortical	Secondary Noncortical	Tertiary	Cortical:Noncortical Ratio
Obsidian	0	1	21	33	0.01
Orthoquartzite	0	2	97	27	0.01
Chalcedony	1	2	9	1	0.30
Chuska	0	0	1	0	--
Chert	1	1	6	1	0.28
Silicified Wood	2	11	42	29	0.18
Quartzite	0	0	2	0	--
Quartz	0	1	0	0	--
Total	4	17	178	91	0.11
Percentage	0.01	0.05	61.3	31.3	

mm (sd = 7.5), thickness of 34.3 mm (sd = 22.6), and weight of 72.0 g (sd = 42.0).

The debitage primarily consists of core flakes (48.8%) with some biface flakes (16.5%), angular debris, undetermined flake fragments, microdebitage (22.8%), a uniface flake, an outrepassé, and a core trimming flake. These indicate both core reduction and tool production/maintenance activities. Table 4 summarizes the various stages of reduction represented by whole core flakes and all biface flakes. The stages of reduction are defined differently for this analysis than they are by some other Southwesternists. Primary reduction refers to core flakes with 100% dorsal cortex; secondary cortical reduction, to core flakes with a cortical platform and/or partial dorsal cortex; secondary noncortical, to core flakes with no cortex; and tertiary reduction, to tool retouch flakes (e.g., biface flakes).

Most of the assemblage is composed of secondary noncortical (61.3%) and tertiary (31.3%) flakes, with fewer secondary cortical and primary flakes. The very low overall cortical:noncortical ratio of 0.11 reflects an emphasis on the later stages of core reduction and tool production/maintenance. The flake:angular debris ratio is 23.8, with very little angular debris being present. Most of this was a by-product of reducing silicified wood.

The majority of the flakes have single-faceted platforms (64.1%; *n* = 175), with fewer multi-faceted (*n* = 58), collapsed/crushed (*n* = 20), cortical (*n* = 16), and dihedral (*n* = 4). Thirty-four (12.4%) of the platforms exhibit evidence of preparation by abrasion. Most of the core flakes are whole (58.1%; *n* = 157), with some proximal (*n* = 43), midsection (*n* = 13), distal (*n* = 54) and lateral (*n* = 3) fragments. The whole core flakes have a mean length of 23.9 mm (sd = 10.6) and weight of 3.1 g (sd = 6.5). The whole biface flakes (*n* = 47) have a mean length of 19.2 m (sd = 9.0) and weight of 0.8 g (sd = 1.5). The mean weight of the angular debris (3.0 g; sd = 5.4) is similar to that of the core flakes.

The retouched tools consist of a retouched flake, 4 bifaces, 9 projectile points, and 2 endscrapers. The retouched flake was made on a flake with a unidirectionally retouched dorsal lateral edge. Two of the bifaces are fragments broken during manufacturing. One is a tip and the other is possibly a base. The remaining two bifaces are whole, unfinished preforms. Both are ovoid and represent middle-stage bifaces with width:

Table 5. Projectile Point Metric (mm) and Descriptive Data (LA 50460)

FS No.	Material	Condition	Overall Length	Blade Length	Neck Width	Stem Length	Stem Width	Thick-ness	Weight (g)	Haft Type	Blade Shape	Base Shape
49	Obsidian	Distal	--	23.3	12.6	--	13.1	5.4	2.9	Stemmed	Serrated	--
50	Sil. Wood	Base	--	--	12.1	10.0	11.9	--	1.1	Stemmed	--	Convex
51	Obsidian	Whole	28.1	17.9	12.6	10.2	15.0	7.0	2.3	Stemmed	Serrated	Convex
52	Obsidian	Proximal	--	--	16.3	--	16.7	5.3	1.3	Stemmed	--	Concave
53	Obsidian	Whole	45.3	31.5	14.9	13.8	14.6	6.1	5.0	Stemmed	Serrated	Concave
54	Sil. Wood	Proximal	--	--	12.2	5.9	13.5	5.5	2.2	Stemmed	--	Straight
55	Sil. Wood	Distal	--	33.5	13.9	--	--	6.4	4.6	Stemmed	Serrated	--
84	Obsidian	Whole	24.1	15.2	12.6	8.9	14.6	5.0	1.9	Stemmed	Serrated	Straight
6	Chert	Base										Straight
Surface	Chert	Whole	35.0	26.0	13.0	9.0	16.0	7.0		Stemmed		Convex

L-49 West Provenience, Grid G29, Level 2a, 45 cm below surface datum
L-50 West Provenience, Grid G35, Level 2a, 50 cm below surface datum
L-51 West Provenience, Grid H30, Level 2a, 50 cm below surface datum
L-52 West Provenience, Grid F35, Level 2b, 70 cm below surface datum
L-53 West Provenience, Grid G30, Level 2b, 52 cm below surface datum
L-54 West Provenience, Grid G33, Level 2b, 50-70 cm below surface datum
L-55 West Provenience, Grid G36, Level 2b, 55 cm below surface datum
L-84 East Provenience, Grid E11, 20 cm below surface datum
L-6 West Provenience, Grid H30, Level 2a, 35-50 cm below surface datum
Surface: West Provenience

thickness ratios of 3.0 and 3.5, and edge angles of 55° and 60°, respectively. The endscrapers were made on thick flakes (13 mm and 24 mm), with steeply retouched distal ends (70°).

Metrical and descriptive information on the projectile points is presented in Table 5. Three of the points are whole, two are proximal fragments, and two are distal fragments; however, the distal fragments are only missing a small portion of the base. Typologically, the points appear to represent middle-late Archaic dart points (see discussion on projectile point typology in Chapter 12). Two of the points have concave bases and could be classified as San Jose (L-52 and L-53). Another five have straight to convex bases and could be classified as Armijo (L-49, L-51, L-54, L-55, and L-84). The remaining point is a small undetermined base fragment (L-50). The points generally exhibit finely serrated edges with some hafting polish. The breakage patterns and hafting polish reflect that most were broken during use. One of the points is not serrated but has beveled edges (L-49). Two of the points are heavily resharpened (L-51 and L-84).

Tool Use

Only ten flakes (1.8%) exhibit evidence of edge damage that could be attributed to use-wear. Most of them are obsidian flakes ($n = 7$). Six of the flakes have a single utilized edge, and four have two utilized edges. Most of the damaged edges are located along the lateral side of the piece ($n = 11$) with a mean acute angle of 40.9° (sd = 8.7; range = 30–55°). In contrast, two damaged edges are situated on the end of the piece with a mean edge angle of 35° (sd = 0.0). Lastly, one damaged edge represents a utilized projection.

Two projectile points are base fragments with snapped blades (L-52 and L-54) that were presumably broken during use. A third point also exhibits a snapped blade but may have been broken during manufacturing (L-50). An endscraper (L-90) also exhibits evidence of use with a heavily worn and rounded edge.

Table 6. Debitage Type by Area (LA 50460). The top value in the cell represents artifact counts, and the bottom value represents adjusted residuals. Significant ($p < 0.05$) positive values are shown in bold.

	Core Flake	Biface Flake	Und. Flake Frag-ment	Micro-debitage
West Prov.	211	78	24	100
	-0.3	1.8	-2.4	0.2
East Prov.	59	13	14	26
	0.3	-1.8	**2.4**	-0.2
Total	270	91	38	126

$\chi^2 = 8.2$, df = 3, $p = 0.04$

Intrasite Comparison

East and West Proveniences

The site can be divided into west and east proveniences. Sample sizes are large enough to compare debitage type and material type by area. Table 6 presents the information on debitage type by area; the difference between the areas is significant ($\chi^2 = 8.2$, df = 3, $p = 0.04$). Adjusted residuals were therefore calculated to determine which of the contingency table cells was contributing to the significant chi-square value. Adjusted residuals greater than 1.96 or −1.96 are significant at the 0.05 level. It appears that there are relatively similar proportions of core flakes, biface flakes and microdebitage in the areas, but there are relatively more undetermined flake fragments in the eastern section of the site.

Table 7 presents the information on material type. Again the difference is significant ($\chi^2 = 15.9$, df = 4, $p = 0.003$), with relatively more obsidian and chert in the West Provenience and

Table 7. Debitage Material Type by Area (LA 50460). The top value in the cell represents artifact counts, and the bottom value represents adjusted residuals. Significant ($p < 0.05$) positive values are shown in bold.

	Obsidian	Orthoquartzite	Chalcedony	Chert	Silicified Wood
West	90	154	23	21	135
	2.1	-2.8	1.3	**2.5**	-0.5
East	15	60	3	0	41
	-2.1	**2.8**	**-1.3**	-2.5	0.5
Total	105	214	26	21	176

$\chi^2 = 15.9$, df = 4, $p = 0.003$

more orthoquartzite in the East Provenience. In addition, 27.7% of the obsidian from the West Provenience was visually identified as Jemez obsidian. In contrast, no Jemez obsidian was identified in the East Provenience.

West Provenience Levels

The West Provenience can be divided into surface and upper and lower units. However, too few artifacts were recovered from the surface to include them in a contingency analysis. Table 8 provides information on debitage type by level. There is no significant difference in the distribution of debitage types by level ($\chi^2 = 6.3$, df = 3, $p = 0.096$). Nonetheless, the adjusted residual value for biface flakes from the lower level ($d = 2.1$) indicates that there are significantly more of these artifacts in this level.

Table 9 presents information on material type by level. Again, there is no significant difference between the levels ($\chi^2 = 9.1$, df = 4, $p = 0.059$); however, the adjusted residual value for chert from the lower level ($d = 2.6$) does seem to indicate that relatively more of this material is present in this level. In addition, there is very little Jemez obsidian in the upper unit (9.4%) in comparison with the lower level (41.6%).

Table 8. Debitage Type by Level (LA 50460). Significant ($p < 0.05$) positive values are shown in bold.

	Core Flake	Biface Flake	Und. Flake Frag-ment	Micro-debitage
Upper	139	37	21	64
	1.3	-2.1	1.4	-0.5
Lower	82	38	8	46
	-1.3	**2.1**	**-1.4**	0.5
Total	221	75	29	110

$\chi^2 = 6.3$, df = 3, $p = 0.096$

LA 45961

A total of 270 chipped stone artifacts was analyzed from LA 45961: 2 cores, 263 pieces of debitage, 1 graver, 2 projectile points, an endscraper, and a manuport (Figure 25).

Material Selection

Table 10 presents the information on artifact type by material type. Most of the cores and debitage is made of obsidian (36.1%) and chalcedony (25.7%), with less silicified wood, chert, and

Table 9. Debitage Material Type by Level (LA 50460). The top value in the cell represents artifact counts, and the bottom value represents adjusted residuals. Significant ($p < 0.05$) positive values are shown in bold.

	Obsidian	Orthoquartzite	Chalcedony	Chert	Silicified Wood
Upper	52	111	8	6	95
	-0.3	0.7	-1.2	-2.6	1.1
Lower	36	67	9	13	53
	0.3	-0.7	1.2	**2.6**	-1.1
Total	88	178	17	19	148

$\chi^2 = 9.10$, df $= 4$, $p = 0.059$

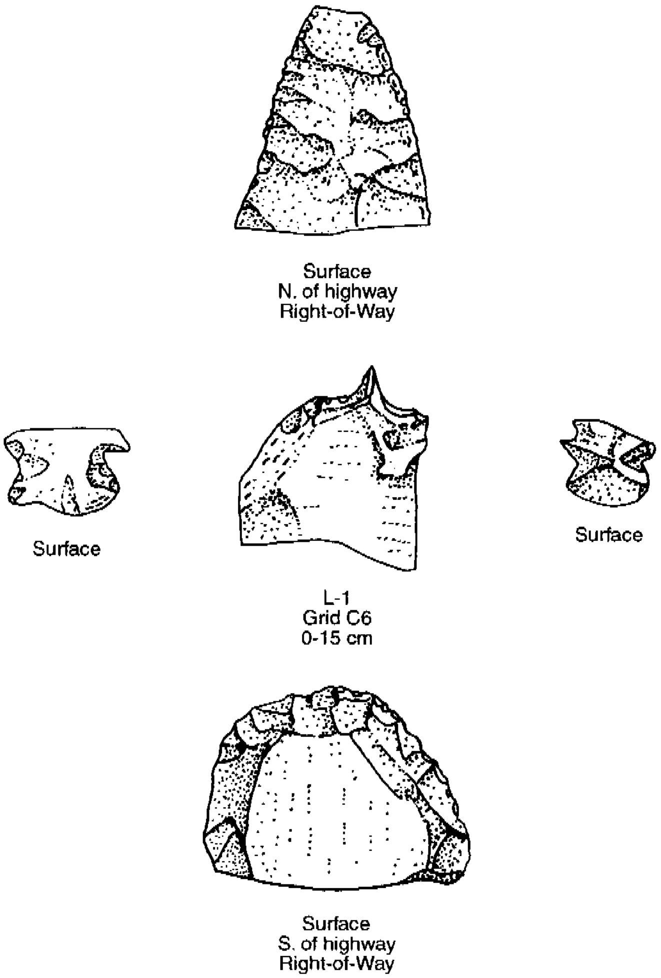

Figure 25. Chipped stone artifacts, LA 45961 (actual size)
(Illustration by C. Marshall)

Table 10. Artifact Type by Material Type (LA 45961)

	Obsidian	Orthoquartzite	Chalcedony	Chuska	Chert	Silicified Wood	Quartzite	Quartz	Hematite	Total
Core	0	0	0	1	0	1	0	0	0	2
Angular debris	0	0	1	0	7	3	0	0	0	11
Core flake	14	18	36	0	10	23	1	1	0	103
Biface flake	40	2	11	1	2	8	0	0	0	64
Core trimming flake	1	0	0	0	0	1	0	0	0	2
Pot lid	0	0	0	0	1	0	0	0	0	1
Hammerstone flake	0	0	0	0	0	0	1	0	0	1
Und. flake frag.	16	2	11	0	8	5	0	0	0	43
Microdebitage	26	1	10	0	1	0	0	0	0	38
Graver	0	0	0	0	0	1	0	0	0	1
Projectile point	0	0	0	0	1	1	0	0	0	2
Endscraper	0	0	0	0	0	1	0	0	0	1
Manuports	0	0	0	0	0	0	0	0	1	1
Total	97	23	69	2	30	44	3	1	1	270
%	36.1	8.6	25.7	0.7	11.1	16.3	0.7	0.4	0.4	

orthoquartzite. Only 7.9% of the debitage exhibits cortex, of which 68.1% is nodule (n = 15), 18.1% is waterworn (n = 4), and 13.8% is tabular (n = 3).

Most of these lithic materials are presumably from local sources; however, obsidian and Chuska chalcedony are not locally available. Visual identification of the obsidian indicates that 49.4% is a smoky type (n = 48), but it is unclear as to whether this is from Polvadera Peak or the Jemez Mountains. Visual identification also indicates that 44.3% is a translucent variety possibly from the Jemez Mountains (n = 43), and 6.1% could not be visually identified as to possible source (n = 6). XRF analysis of 5 obsidian artifacts from the site indicates that all come from the Valle Grande source. In addition, there is a single biface flake and core made of Chuska chalcedony, and an undetermined flake fragment made of a white and red chert similar to Alibates.

The debitage assemblage is dominated by fine-grained materials (70.4%, n = 186), with fewer medium-grained (n = 68) and coarse-grained (n = 9) materials. Most of the fine-grained material is obsidian and chalcedony along with some silicified wood. All but one of the retouched tools are made of silicified wood, with the other being chert. The manuport is an unmodified hematite nodule.

Lithic Reduction

The debitage primarily consists of cores (39.1%) and biface flakes (24.3%), with some angular debris, undetermined flake fragments, micro-

Table 11. Debitage Reduction Stages (LA 45961)

Material	Primary	Secondary Cortical	Secondary Noncortical	Tertiary	Cortical: Noncortical Ratio
Obsidian	0	0	4	40	--
Orthoquartzite	0	2	97	2	0.02
Chalcedony	1	1	11	11	0.09
Chuska	0	0	0	1	--
Chert	0	2	3	2	0.40
Silicified Wood	0	3	8	8	0.18
Quartzite	0	0	0	0	--
Quartz	1	0	0	0	--
Total	2	8	123	64	0.05
%	1.0	4.0	62.4	32.4	

debitage, core trimming flakes, a hammerstone flake and a pot lid. These items reflect both core reduction and tool production/ maintenance activities. Table 11 summarizes the various stages of reduction represented by the whole core flakes and the biface flakes. Most of the assemblage is composed of secondary noncortical flakes (62.4%) with fewer tertiary, secondary cortical, and primary flakes. The low overall cortical:noncortical ratio of 0.05 reflects an emphasis on the later stages of core reduction and tool production/maintenance. The flake:angular debris ratio is 19.0, with very little angular debris being present. Most of it was the by-product of chert reduction.

The majority of the flakes have single-faceted platforms (53.7%; n = 50), with fewer multi-faceted (n = 22), cortical (n = 11), collapsed (n = 8), and dihedral (n = 2). A total of 8.2% (n = 17) of the platforms exhibits evidence of preparation by abrasion. Most of the core flakes are whole (45.6%; n = 47) and distal fragments (34.9%; n = 36) with some proximal (n = 13), midsection (n = 5), and lateral (n = 2) fragments. The whole core flakes have a mean length of 20.9 mm (sd = 9.9) and weight of 2.6 g (sd = 4.9). The whole biface flakes have a mean length of 17.6 mm (sd = 7.9) and weight of 0.4 (sd = 0.5).

The retouched tools consist of a graver, two projectile points, and an endscraper. The graver is a unidirectionally retouched projection on a thin tabular piece of silicified wood. Both projectile points are midsection fragments and presumably were broken during manufacturing. The endscraper is a distal fragment. It was made on a thick flake (11 mm) with a steeply retouched edge (75°). The edge is slightly serrated. This artifact also appears to have been broken during manufacturing.

Tool Use

Only two flakes (0.7%) exhibit evidence of edge damage that could be attributed to use-wear. Both are located along lateral straight edges, with angles of 30° and 35°. The graver also exhibits some evidence of use-wear.

LA 119580

Only 15 pieces of debitage were analyzed from LA 119580.

Material Selection

Table 12 presents the information on artifact type by material type. Most of the debitage is a chalcedony with black mossy inclusions (73.3%), with some silicified wood and orthoquartzite. The dominance of chalcedony in the assemblage reflects the selection of mostly fine-grained materials for reduction. Only a single flake made of orthoquartzite exhibits cortex, and this is the nodular variety. All these materials are locally available.

Table 12. Artifact Type by Material Type (LA 119580)

	Ortho-quartzite	Chal-cedony	Silici-fied Wood	Total
Angular debris	0	1	1	2
Core flake	2	10	1	13
Total	2	11	2	15

Lithic Reduction

The majority of the debitage consists of core flakes (86.7%) with a few pieces of angular debris. As previously noted, only one core flake exhibits cortex. Therefore, the debitage assemblage primarily reflects the later stages of core reduction.

The majority of the flakes have single-faceted platforms (*n* = 6) and one has a one cortical platform. None of them exhibits any obvious evidence of preparation. There are more broken than whole core flakes, with four whole flakes, three proximal, two midsection, four distal, and a lateral fragment. The whole core flakes have a mean length of 22.7 mm (sd = 10.6) and weight of 3.9 g (sd = 7.7).

Tool Use

None of the debitage exhibits any obvious evidence of edge damage that could be attributed to use.

Chapter 7

Ground Stone and Hammerstones

by Michael P. Marshall

Thirty-six ground stone artifacts were recovered from the NM 44-North excavations. The presence of ground stone at both the Tancosa site (LA 50460) and the Venado site (LA 45961) indicates that seeds were processed at the camps and were part of the subsistence base. Evidence of corn and 10 burned Cheno-Am seeds was found in the early component occupation at LA 45961 within the fill of a pit. No macrobotanical materials were recovered from the late component of the site.

The only macrobotanical evidence of seeds at LA 50460 consists of a single burned *Chenopodium* seed that was found in the East Provenience. However, the absence of edible plant materials from LA 50460 is clearly the result of poor preservation rather than a reflection of non-use. It can be assumed, based on the relatively common incidence of ground stone at the site, that plant products were a part of the subsistence base.

Most of the manos from LA 50460 (10 of the 11 specimens) show considerable use and have well-defined faceted ground surfaces. Use wear varies from extensive to very extensive and suggests that the stones were curated tools that were probably used over a long period of time and were carried from camp to camp. It is very unlikely that these extensively used stones could have resulted from the short-term use of the LA 50460 encampment. The heavily used manos at LA 50460 contrast with the expedient use of thin, soft, and often small sandstone slabs as metates. These sandstone slab metates reflect the short-term nature of the LA 50460 encampment and the expedient use of the materials at hand. Well-used and larger metates, with well-defined grinding basins, would more likely be found at base camp locations with longer term and repetitive occupations.

The majority of the one-hand manos from LA 50460 are unshaped sandstone cobbles. Only two of the specimens, both from the East Provenience (L-96 and L-95), exhibit minor evidence of battering/shaping along the edges of the stone. Manos from LA 50460 are rather small, ranging from 7.5 to 10 cm in length, 6.1 to 8.6 cm in width, and 3.1 to 4.8 cm in thickness. Two bifacially ground and nine unifacially ground manos were found at LA 50460. The ground surfaces consist of well-defined faceted surfaces. Nine of the eleven manos from LA 50460 exhibit linear striations in a single direction across the grinding surface. These striations may occur along the long axis (4 examples) or the short axis (5 examples). Many of the grinding surfaces and surface striations extend over the edge of the stone. The linear nature of these striations indicates that the stones were used in a back-and-forth motion across a single axis rather than in a circular motion. The extension of the grinding surface over the edge of the stone suggests that some of the stones were also used in a rocking motion.

Two ground slab specimens recovered from LA 50460 appear to have been shaped for an undermined function. Both specimens (L-126 and L-120) came from Level 2b of the West Provenience. Both have shaped-ground edges and surfaces. One of the specimens is triangular (15 cm long) and the other is sub-triangular (17 cm in length). Both specimens have ground and thinned edges and are manufactured from very soft red-brown sandstone. Both faces of the objects seem to have been ground for the purpose of shaping the objects to the desired form. The edges are relatively sharp, but the stones are so soft that they would have little utility as a tool. No evidence of incising or pigments was seen on these or any other sandstone slabs or spalls found at the site. Incised and decorated stones have been found in Archaic sites in the Great Basin (Thomas 1983:246) and should be expected in Archaic components in the Colorado Plateau.

As noted above, most of the metates at LA 50460 are small sandstone slabs that show little evidence of use. Twenty-eight sandstone slab metates or metate fragments were recovered from LA 50460: 9 specimens came from the East Provenience and 19 from the West Provenience. Two of the metates were the typical slab-basin types often found on Archaic sites. One was found in the East Provenience in grid unit G11. This stone is 27.0 by 30.5 cm, 2.5 to 5.5 cm thick, and has a grinding basin measuring 15 by 17 cm. The other slab-basin metate was found on the surface of the highway roadcut in grid unit I22 between the East and West proveniences. Eight pieces of this stone or about one-half of the metate was found. This metate is estimated to have been about 40 cm long and 2.8 cm thick. Many of the other metate slab fragments are thin (1.3 to 3.0 cm thick) slabs which exhibit a lightly ground surface. All of these slabs are of soft brown sandstone and many appear to have been rather small (less than 20 cm in original length). The use of these small, soft and thin sandstone slabs for metates clearly indicates a short-term and expedient use of materials on hand.

The presence of cobble manos and slab and slab-basin metates at LA 50460 indicates that some hard seeds were processed at the camp. The two larger basin metates occurred within or near the East Provenience where intact hearths with fire-heated stone are present and the density of bone is low. The relatively high incidence of deer bone in the West Provenience suggests that this portion of the site was a hunting encampment. However, the presence of well-used manos and briefly used slab metates also indicates that plant products were processed at the camp.

Only three specimens of ground stone were recovered from LA 45961. Two are manos from the late component and one is a small ground slab fragment recovered from the lower pit structure of the early component. The only complete mano (L-76) was found in grid unit E10. It is a circular bifacially ground stone, 10 cm in diameter, that is unlike any of the stones found at LA 40561. The edge of the stone is shaped, unlike most of the LA 50460 specimens, and one of the ground surfaces exhibits battering marks.

The Ground Stone Artifacts

LA 50460, West Provenience

Twenty-one ground stone artifacts were recovered from the West Provenience of LA 50460. These specimens occur with an estimated density of 0.50 items per cubic meter of excavated soil and represent 0.5% of the lithic artifact sample. Ground stone materials recovered from the West Provenience consist of 9 one-hand manos, 6 slab-metate fragments, 4 ground slab/possible metate fragments, and 2 ground slab/palettes of undetermined function (Figures 26 and 27).

All of the manos are small sandstone cobbles. The complete specimens range from 7.2 to 9.5 cm in length. Most of the manos are well used and exhibit well-defined grinding facets. Seven of the manos have one ground face, one mano is bifacially ground, and one fragmentary specimen has one ground face and one broken face. One mano is only lightly used. Many of the manos exhibit faint striations across the short axis and, in one instance, the long axis of the stone. Ground surfaces extend over the edge of the stone in the direction of the striations, indicating that the stones were rocked or tilted as they were used. The single direction of the striations and facet edges indicates that the stones were used in a back-and-forth rather than a circular motion. The well-used and highly faceted manos from the West Provenience indicate that the stones were probably carried from camp to camp.

Twelve metate or metate slab fragments were recovered from the West Provenience. All of the metates are small slabs (0.6 cm to 2.8 cm thick) of soft to medium-hard brown sandstone material. One of the complete slabs is only 12 by 17 cm. Another slab is estimated to have been about 40 by 40 cm. However, it is clear that many of these ground slab metates were rather small and exhibit only minor evidence of grinding on one face. Metate use in the West Provenience was clearly expedient and involved short-term use of local and inferior materials.

Two triangular artifacts were found in Level 2b. Both artifacts (L-126 and L-120) are thin sandstone slabs that exhibit ground and shaped edges (Figure 27). These slabs do not appear to have been grinding implements, and they may represent some type of fetish stone or tool of undetermined function.

L-117, Mano Fragment
Grid Unit G36, Level 2a, 40 cm below datum
This fragmentary one-handed mano (Figure 26) is 8.6 cm in width and 4.8 cm thick. It is manufactured from a hard sandstone cobble. Both faces of the stone exhibit well-ground and heavily used surfaces. Faint striations occur on both faces: one across the long axis and the other across the short axis. One of the grinding surfaces is flat, while the other is slightly concave with the grinding extending over the edge of the stone.

L-122, Mano
Grid Unit H30, Level 2b, 65 cm below datum
This complete one-hand mano (Figure 26) is made from a fine-grained sandstone cobble. The stone measures 7.5 by 7.3 cm and is 4.1 cm thick. This small stone exhibits a single well-ground and extensively used face.

L-120, Mano
Grid Unit 31, Level 2b, 80 cm below datum
This one-hand mano was manufactured from a hard, fine-grained sandstone or quartzite cobble (Figure 26). The stone is 9.5 by 8.3 by 3.8 cm. It exhibits a single well-ground face. Faint striations occur on the ground face across the long axis of the stone. The grinding surface extends over the edge of the stone on one end of the long axis. The stone is fire-cracked. It exhibits a few battering marks on one edge in a 1.8 by 2.1 cm area. The stone was probably briefly used as a hammer.

L-118, Mano Fragment
Grid Unit G36, margin of Levels 2a and 2b, 50 cm below datum
The material of this one-hand cobble mano is a fine-grained hard sandstone (Figure 26). One surface of the stone is extensively ground. The

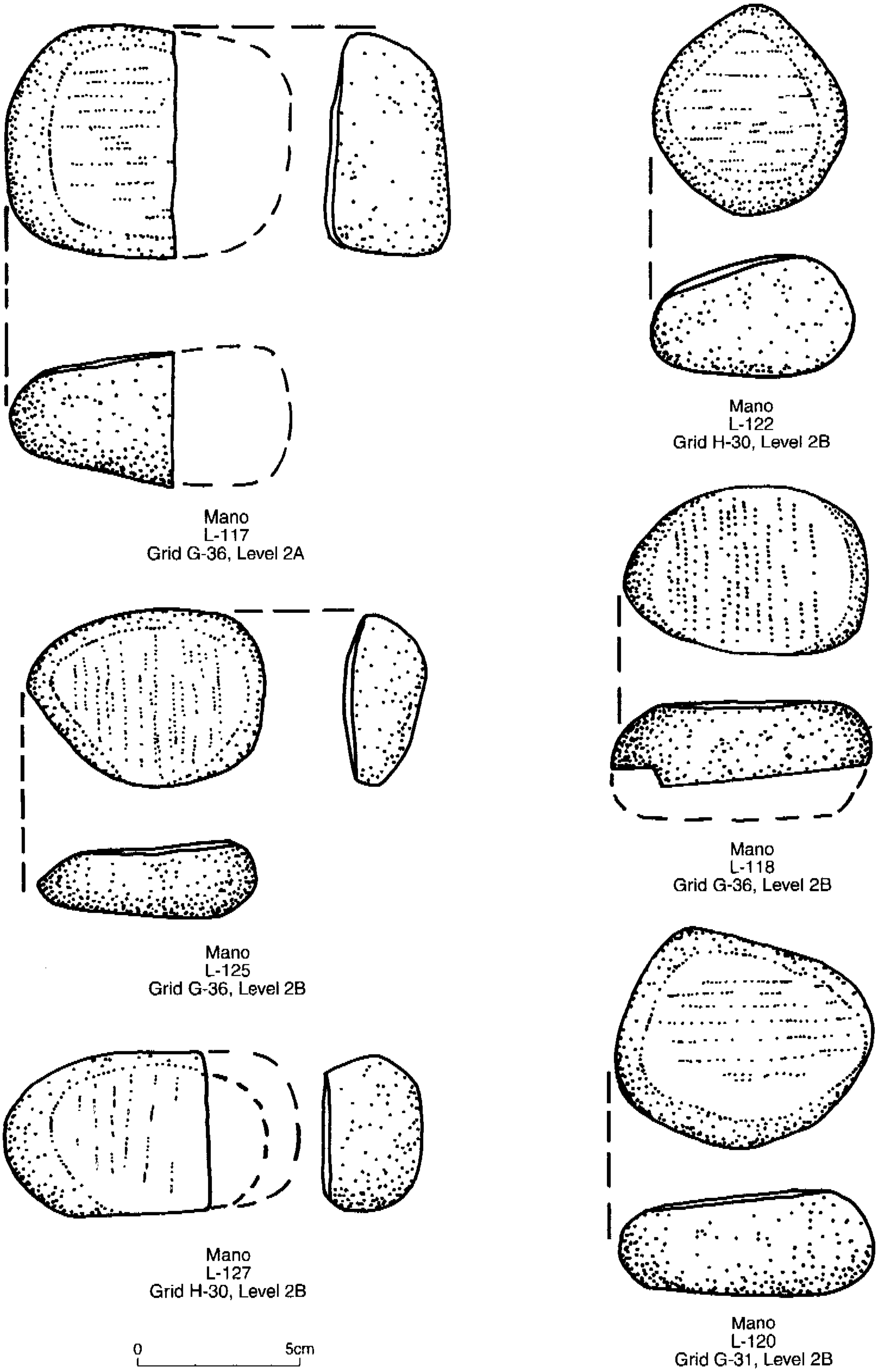

Figure 26. Manos from LA 50460, West Provenience

other face is fragmentary. The stone is 8.5 cm long, 6.2 cm wide, and the original thickness is unknown. Striations are visible on the grinding surface, extending across the short axis of the stone.

L-125, Mano
Grid Unit G36, margin of Level 2a-2b, 50 cm below datum
This small, well-used one-hand mano (Figure 26) is 8.6 by 6.4 by 3.1 cm. It is manufactured from a fine-grained, hard sandstone cobble. It exhibits extensive use on one face. Striations are visible on the grinding surface, running across the short axis of the stone.

L-127, Mano Fragment
Grid Unit H30, Level 2b, 65 cm below datum
This one-hand mano is manufactured from a fine-grained sandstone cobble (Figure 26). The stone is 6.1 cm wide and 3.6 cm thick. It exhibits an extensively ground surface on one face. The other face exhibits a light polish. Faint striations are visible on the grinding surface, across the short axis of the stone. The stone was extensively used and exhibits well-defined grinding facets. Some battering marks on the edge of the stone indicate that it was shaped.

L-129, Mano
Grid Unit H34, Level 2b, 50–75 cm below datum
This fragmentary one-hand mano (Figure 27) is a hard sandstone cobble. The length is 8.4 cm, width is fragmentary, and it is 4.8 cm thick. This stone exhibits a slightly ground surface on one face. It is different from the other manos found at the site, as they are heavily used.

L-116, Mano Fragment
Grid Unit H32, Level 2a, 45 cm below datum in NW corner of grid unit
This small fragment of a one-hand mano is 3.0 cm thick. It is manufactured from a medium-grained sandstone cobble. It exhibits an extensively ground face on one surface. Coarse striations are visible on the grinding surface.

L-121 Mano Fragment
Grid Units G30 and G31, Level 2B, 50–70 cm below datum
Four conjoinable fragments of this mano were recovered. The mano is manufactured from a medium-coarse, hard sandstone cobble. The original length is unknown. The width is 8.2 cm, and it is 4.0 cm thick. One face of the stone exhibits an extensively used, well-ground surface (Figure 27). Faint striations are visible on the grinding surface extending across the short axis of the stone.

L-115, Metate
Grid Unit G36, margin of Level 2a and 2b, 50 cm below datum
This thin, relatively hard sandstone slab is 12 by 12.5 cm and 1.5 cm thick. It may be fragmentary. The stone exhibits grinding on a single face. Faint striations are visible on the ground surface, extending across the short axis of the stone.

L-123, Sandstone Slab Fragment
Grid Unit G37, Level 2b, 50–75 cm below datum
This sandstone slab is 9.0 by 13.5 cm and 1.0 cm thick. It is probably a fragment of a small slab metate. The material is a soft brown-red sandstone. The stone exhibits grinding on a single face.

L-114, Ground Sandstone Spall
Grid Unit F35, Level 2a, 30–50 cm below datum
This small sandstone spall is 5.5 by 6.0 cm and 0.6 cm thick. It exhibits one well-ground surface. This spall is probably a fragment of a small sandstone slab metate.

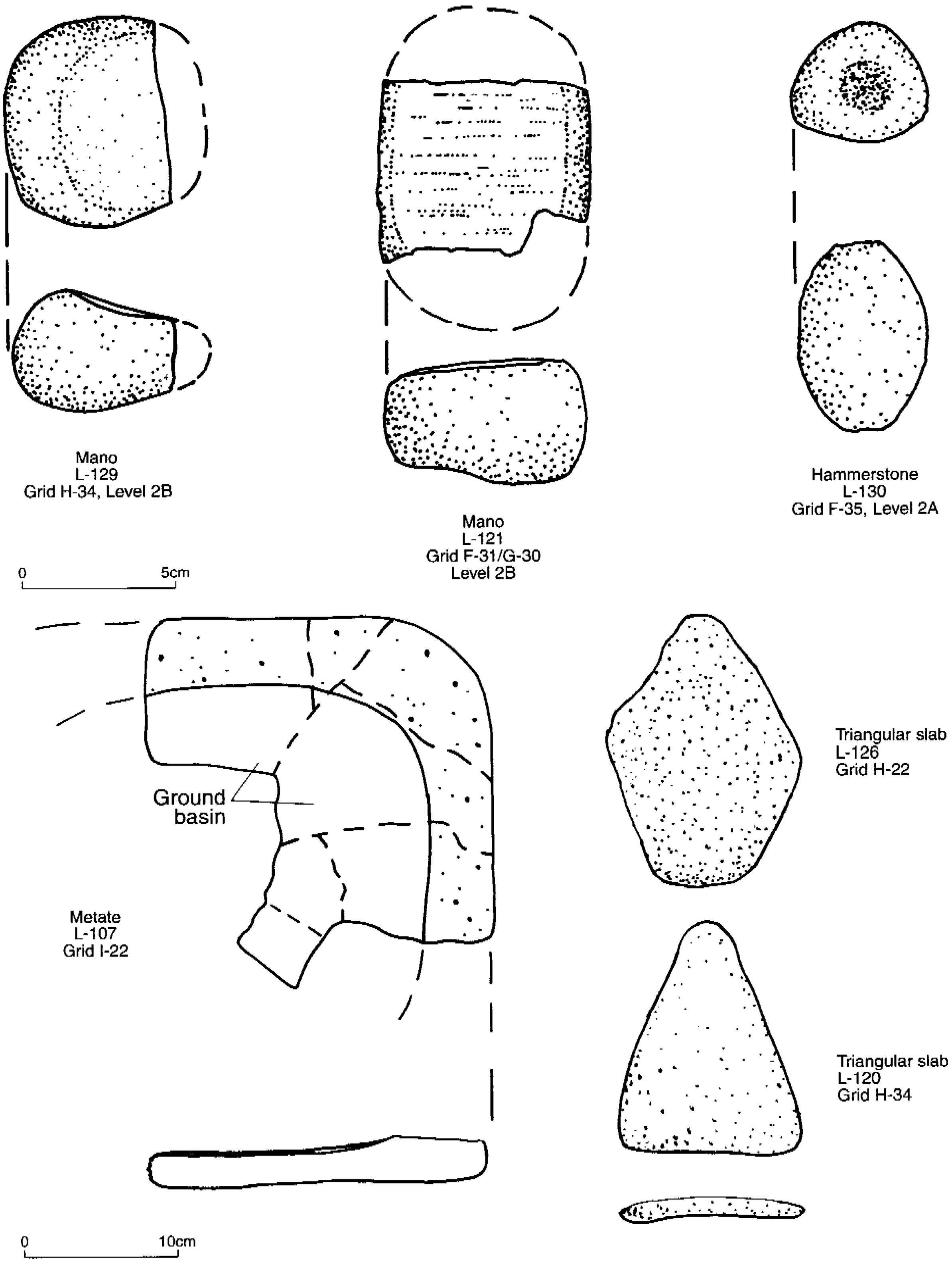

Figure 27. Groundstone and hammerstone from LA 50460, West Provenience

L-113, Sandstone Slab Fragment
Grid Unit H31, Level 2a, 30–50 cm below datum

This sandstone slab fragment is 7 by 9 cm and 1.3 cm thick. It is a medium-hard sandstone that is probably part of a slab metate. One face of the slab is lightly ground.

L-124, Sandstone Slab Fragment
Grid Unit G30, Level 2b, 50–75 cm below datum

This fragment of a sandstone slab metate is 3 by 9 cm and 3.2 cm thick. It is ground on one face and is manufactured from a soft brown-red sandstone.

L-108, Sandstone Slab Fragment
Grid Unit H29, Level 1, 0–20 cm below datum

This small slab fragment is 7 by 7 cm and 1.4 cm thick. The specimen is probably a fragment of a sandstone slab metate. It is ground on one face only and is made from a soft brown-red sandstone.

L-107, Metate Fragments
Grid Unit I22, Surface (exposed in roadcut)

Eight pieces of a slab-basin metate, six of which are conjoinable, were found in the roadcut. The total fragment size is 21 by 21 cm, which is probably about half of the original stone. The slab is 2.8 cm thick (Figure 27). It is manufactured from a medium-soft gray-brown sandstone. A carbonate patina is present on the grinding base. It is ground on a single surface and exhibits a distinct ground basin. The edges of the stone do not appear to have been shaped.

L-112, Metate Fragments
Grid Unit H32, Level 2a, 40 cm below datum

Four fragments of an exhausted sandstone slab metate were found. The largest fragment is 18.0 by 10.5 cm and 1.8 cm thick. The fragments are not conjoinable. This metate has a well-defined basin ground into one face. The material is a brown-red, soft sandstone.

L-111, Metate Fragment
Grid Unit G34, Level 2a, 30–50 cm below datum

This ground stone slab fragment is 6 by 7 cm and 2.3 cm thick. It is made from a soft brown-red sandstone. It is lightly ground on one face and is probably part of a sandstone slab metate.

L-110, Metate Fragments
Grid Unit H32, Level 2a, 45 cm below datum

Three sandstone slab fragments from one or two metates were found. Two of the specimens are from a 3.5-cm-thick slab that has a flat face with very slight evidence of grinding. The other fragment is 8 by 10 cm and 4.0 cm thick. It exhibits a well-ground surface on one face.

L-126, Shaped Sandstone Slab
Grid Unit H22, Level 2b, 50–75 cm below datum

This small, shaped sandstone slab (Figure 27) appears to be complete. It is 12 by 17 cm and 1.2 cm thick. It exhibits a slightly ground face on one surface. It is made from soft brown-red sandstone. The ends and one side of the stone are ground to somewhat pointed edges. The slab was intentionally shaped, but its function is undetermined. Careful examination of the slab surface revealed no evidence of pigments or incising.

L-120, Triangular Sandstone Object
Grid Unit H34, Level 2b, 50–75 cm below datum

This possibly nonutilitarian object is a shaped and lightly ground soft sandstone slab (Figure 27). It is 15 cm in length and 11.5 cm across the base. The slab is only 1.0 cm thick. The edges have been ground to form a triangle. One face is slightly convex and slightly ground but does not

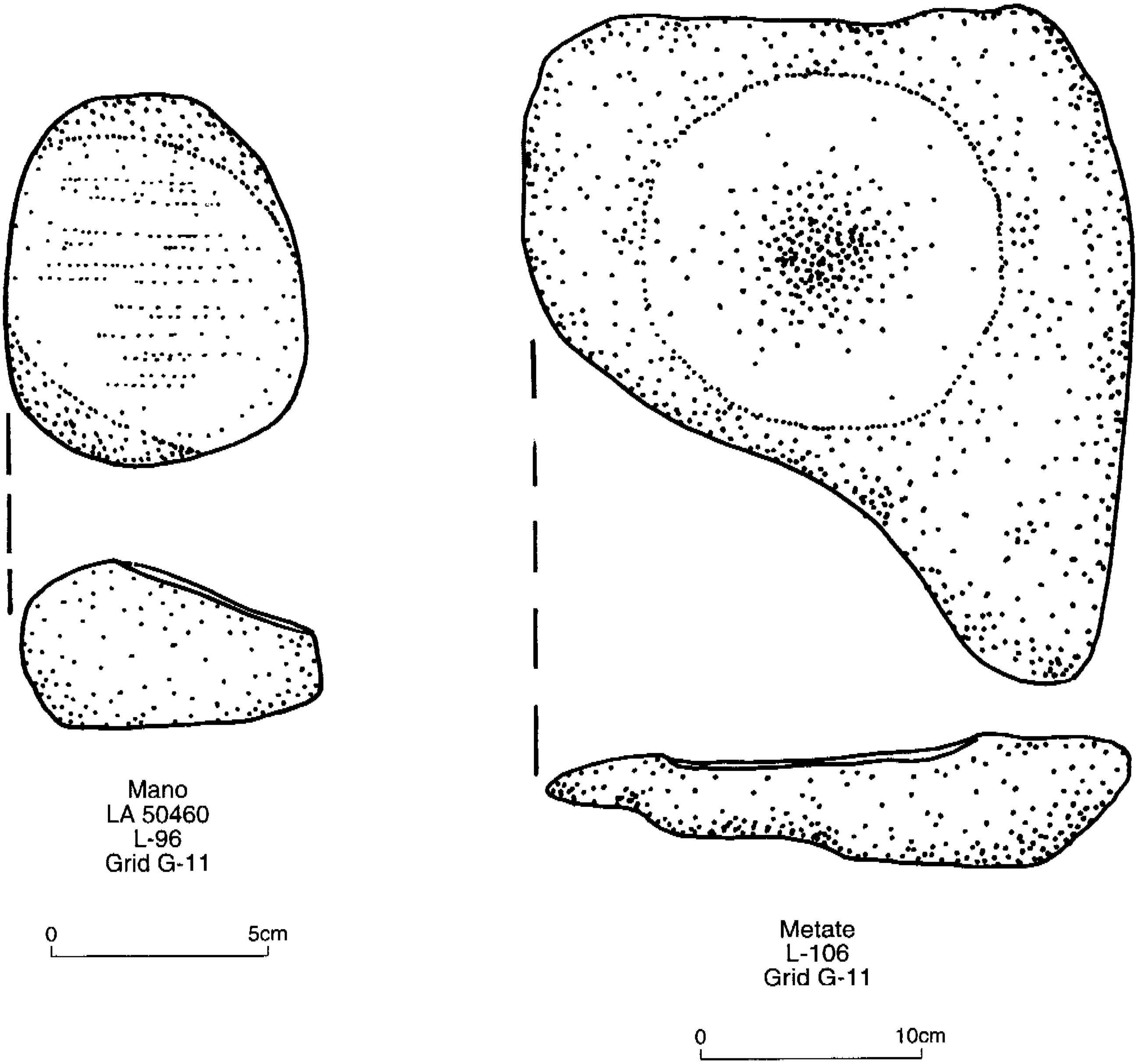

Figure 28. Mano and metate from LA 50460, East Provenience

appear to be a grinding base. This artifact may be some type of fetish. No evidence of pigment or incising is evident on the slab surface.

LA 50460, East Provenience

Twelve ground stone artifacts were recovered from the East Provenience of LA 50460. These specimens occur with an estimated density of 0.85 items per cubic meter of excavated soil and represent 9.0% of the lithic artifact sample. Ground stone recovered from the East Provenience consists of one complete slab-basin metate, six slab metate fragments, two ground

slab/possible metate fragments, and three one-hand manos.

The manos are small one-hand tools of sandstone and quartzite. The only complete specimen is 10.0 cm in length. Each of the manos is well used and exhibits a well-defined grinding facet. One is bifacially ground and the other two have a single well-ground surface.

A single complete metate, six metate fragments, and two other possible metate fragments were found in the East Provenience, all of which are slab or slab-basin types. The complete metate (Figure 28) is a slab-basin type, 30.5 by 27.0 cm, with a grinding basin measuring 15 by 17 cm. All of the metates are soft to medium-hard sandstone. A few exhibit well-ground basin surfaces, whereas others are only lightly ground.

L-105, Metate Fragment
Grid Unit E12, 30 cm below datum
This is a small sandstone metate fragment, 10 by 13 cm, which appears to be about one-third of the original specimen size. It is only 1.3 cm thick. The material is soft, medium-grained sandstone. A slight grinding basin is visible on one face. This is an example of the expedient use of a small sandstone slab as a metate.

L-104, Metate Fragment
Grid Unit F12, 40 cm below datum
This metate fragment is 10 by 16 cm and appears to be approximately one-quarter of the original stone. It is a soft sandstone slab that is only 1.5 cm thick. The material is medium-grained sandstone. The stone exhibits a well-defined grinding basin on one face. This fragment is another example of the expedient and probably short-term use of a thin sandstone slab as a metate.

L-100, Metate Fragment
Grid Unit E9, 27 cm below datum
This metate fragment is 10 by 12 cm. It is a medium-hard, 3.6-cm-thick sandstone slab. The stone exhibits a few pecking marks on the single ground face. A slight grinding basin is visible. This stone is one of the more substantial (thick and hard) of the metates found at LA 50460.

L-99, Metate Fragment
Grid Unit E12, NE ¼, 30 cm below datum
This metate fragment is 7 by 9 cm. It is a soft sandstone slab, 2.3 cm thick. A few pecked marks are visible on the single ground face.

L-97, Ground Slab, Probable Metate Fragment
Grid Unit E9, 23 cm below datum
This fragment of a sandstone slab metate measures 6 by 6 cm. The slab is 3.0 cm thick and is ground on one face. The material is a medium-hard, brown sandstone. A slight basin edge is visible on the grinding surface.

L-98, Ground Slab, Probable Metate Fragment
Grid Unit D10, Level 1, 20–40 cm below datum
This 6 by 8 cm ground slab fragment is 3.5 cm thick and has a single ground face. The surface is level with no evidence of a basin. The material is a medium-hard, brown sandstone.

L-95, Mano Fragment
Grid Unit D8, 34 cm below datum
This specimen consists of three fragments of a single one-hand cobble mano. The mano is a hard, medium-grained sandstone. The three fragments total 4 by 5 cm and the stone is 3.5 cm thick. The mano exhibits grinding on both faces, and both are extensively used. The stone is beveled to one side.

L-96, Mano
Grid Unit G11, Level 1, 20–40 cm below datum
This complete one-hand cobble mano (Figure 28) is 8 by 10 cm and 3.5 to 5.0 cm thick. It is a hard sandstone cobble that is ground on one face. It has been extensively used. It has a rounded contour on the ground face. Striations on the grinding surface are visible across the short axis.

L-101, Mano Fragment
Grid Unit D9, 30–40 cm below datum
This small mano fragment was made from a hard sandstone cobble. One face of the stone is heavily ground and faceted, indicating that it was used extensively.

L-103, Metate Fragment
Grid Unit H17, Surface
This specimen consists of approximately one-half of a sandstone slab metate that was found on the surface in a roadcut. The slab is 14 by 23 cm and is 2.8 cm thick. It is a soft, medium-grained sandstone slab. It is ground on one face and exhibits a slight basin edge, suggesting that about half of the stone is missing.

L-102, Metate Fragment
Grid Unit H7, Surface
This fragment of a sandstone slab metate is 9 by 9 cm and 4.0 cm thick. A slight basin is visible on the single grinding surface. The outside curvature of the stone suggests that it was small metate, less than 20 cm in maximum dimension.

L-106, Complete Slab-Basin Metate
Grid Unit G11, 32 cm below datum
A complete slab-basin metate (Figure 28) made from a soft tan-brown sandstone slab was found. The maximum dimensions are 30.5 by 27.0 cm. The slab ranges from 2.5 to 5.5 cm thick. A well-defined grinding basin is present on one face. This grinding area is 15 by 17 cm. The surface of the basin is pecked and lightly ground.

LA 45961

Three ground stone artifacts were recovered from LA 45961. One is a small ground slab fragment from the lower pit of the early component and two are manos associated with the late component. The estimated density of ground stone artifacts in the LA 45961 sediments is 0.63 specimens per cubic meter or 1.1% the total lithic artifact sample.

L-76, Mano
Grid Unit E10, Level 1, 15 cm below surface
This one-hand mano is nearly circular (Figure 29). It is 10 cm in diameter and 3.3 cm in maximum thickness. The stone is ground on both surfaces. It is a hard, medium-grained sandstone. One surface is flat and has pecking marks. These marks are deep, suggesting use of the stone as an anvil base or as a hammer used to strike a pointed object.

The other grinding surface is slightly concave and has faint striations across the stone. The concave surface also exhibits a few pecked marks, but the surface over the marks is ground. The edges of the stone exhibit some battering marks, indicating that the cobble was shaped.

L-16, Mano Fragment
Grid Unit E13, Level 1, 0–15 cm below the surface
This is a single fragment of a one-hand cobble mano. The material is a hard, medium-grained sandstone. It is ground on a single face. The stone is fragmentary but is 5.6 cm thick.

L-75, Ground Slab Fragment
Lower Pit Fill
This specimen appears to be a fragment of a small sandstone slab metate. The slab fragment is 1.0 cm thick and exhibits a single well-ground face. It is a medium-coarse and rather hard sandstone.

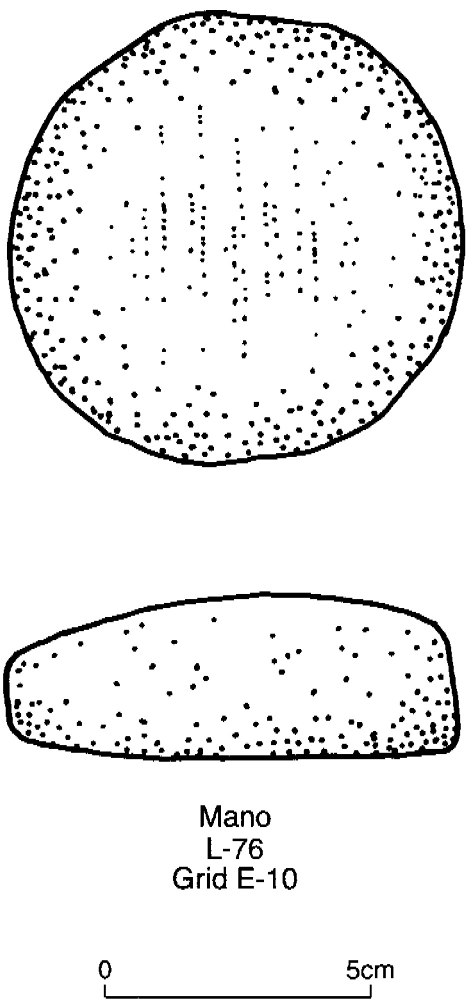

Figure 29. Mano from LA 45961

Hammerstones

Five hammerstones were recovered from the NM 44-North excavations. One quartzite cobble hammer was found at LA 45961. The other four hammerstones were found in the West Provenience at LA 50460. Two of the hammerstones from LA 50460 are soft sandstone and would not have been suitable for use in chipped stone reduction. However, the other two are hard quartzite cobbles that were probably used to manufacture chipped stone tools. A few cores and numerous core flakes occur in the LA 50460 assemblage, but most of the primary reduction of core material was completed elsewhere. This may account for the infrequency of hammerstone tools in the assemblage. The relatively high incidence of microdebitage and biface flakes at the site is a reflection of secondary tool manufacturing, much of which could have been completed with antler pressure flaking.

LA 45961

L-25, Hammerstone
Grid Unit G11, Level 1, 0–15 cm below surface
This quartzite cobble hammerstone is 9.4 by 6.1 cm and 5.2 cm thick. It exhibits extensive battering marks on one pointed end.

LA 50460, West Provenience

L-109, Cobble with Battering Marks
Grid Unit H36, Surface
This hemispherical sandstone cobble is 9.2 by 7.7 cm and 5.2 cm thick. It exhibits battering marks over a 4.5 cm diameter area on the spherical part of the stone. It appears to have been used as a hammer, but the location of the battering marks and the soft nature of the stone indicate it was not used in chipped stone reduction.

LA 50460, West Provenience

L-130, Hammerstone
Grid Unit F35 West ½, Level 2a, 45 cm below datum
This quartzite cobble hammerstone (Figure 27) is 7.2 by 5.5 cm and 4.6 cm thick. The cobble surface is slightly polished, and extensive battering marks are visible on both ends of the ovoid stone. This hammerstone has been extensively used. The battering marks on one end cover a 2.0 by 2.5 cm area; on the other end they cover a 1.5 by 2.4 cm area.

L-130, Hammerstone Fragment
Grid Unit G32, Level 2b, 50–70 cm below datum

This is a fragment of a quartzite cobble hammerstone and possible fire-cracked rock. The stone exhibits a small area of battering marks on one edge.

L-131, Fire-cracked Hammerstone Fragment
Grid Unit G30, Level 2b, 50–70 cm below datum

This is a 6 by 8 cm fire-cracked fragment of a hard sandstone cobble. The stone exhibits a few battering marks in a 1.8 by 2.1 cm area. The stone was probably briefly used as a hammer.

Fire-Heated Stone

by Michael P. Marshall

Observations regarding the nature, amount, and possible use of the fire-heated stone or fire-cracked rock (FCR) recovered from the NM 44-North excavations are presented in the following notes. Fire-heated stones are one of the most common cultural materials found in southwestern Archaic sites. This contrasts to the near absence of heated stone in Paleoindian contexts (Huckell 1996:328), which indicates fundamental differences in the preparation of food between the focal hunting economy of the Paleoindian cultures and the broad-spectrum hunting-and-gathering economy of the Archaic cultures. These differences are also reflected in the absence of ground stone in Paleoindian contexts and its common occurrence in Archaic contexts.

The presence of heated stone can imply different activities such as stone boiling, baking, steaming, or parching of food products and for radiant heating in sweathouses (Akins 1985). Some heated stones may also be hearth linings or props. Comal slabs were frequently used as griddles for heating flat bread, grain cakes, and other foodstuffs, and for parching seeds. Baking was conducted in both subterranean and surface ovens and hearths of various types. Heated stones may also have had other uses, such as the preparation of raw materials or other esoteric (medicinal, ceremonial) purposes. Specific information regarding fire-heated stone in San Juan Basin archaeological sites is scarce. However, ethnographic data indicate that the analysis of heated stone might be useful for understanding feature and site function and subsistence practices (Brown 1998).

Variation in the type and frequencies of heated stone may indicate activities that required stones with different heating characteristics. Previous research has demonstrated that certain rock types behave differently when heated, for example, slowly or quickly (Duncan and Doleman 1991; Schutt et al. 1991:313). Basic analysis should include counts and volume estimates according to discrete provenience and sample units and according to the volume of the cultural fill (Akins 1985:17; Duncan and Doleman 1991:344). The type and shape of rock should be recorded, and information regarding the origin of the heated stone materials should be noted. Also, a record regarding the context of the stone within the cultural fill and whether it contains charcoal, ash, or oxidized soils is useful.

The presence-absence and type-frequencies of heated stone or fire-cracked rock are important aspects of a cultural material assemblage and should be recorded in both survey and excavation contexts. It is curious that such an important and readily visible aspect of Archaic site assemblages has not been utilized more in the analysis of site types.

The size and frequencies of heated stones from the East and West Proveniences of LA 50460 and LA 45961 are tabulated here. Only traces of fire-heated stone were found at LA 119580, and

Table 13. Size and Frequency of Fire-heated Stone in LA 50460, East Provenience

Type	≤3.0 cm	3.1–5.0 cm	5.1–10.0 cm	10.1–15.0 cm	15.1–25.0 cm	Total	%
Angular Sandstone	66	111	168	43	15	403	90.4
Tabular Sandstone	0	9	22	5	1	37	8.3
Angular Quartzite	0	6	0	0	0	6	1.3
Total	66	126	190	48	16	446	
%	14.8	28.2	42.6	10.8	3.6		

heated stone does not appear to have been an important aspect of the site's use.

All fire-cracked rock was recorded during the excavations and was discarded in the field. The heated stone was recorded according to 2 by 2 m grid units and stratigraphic level. Material type (sandstone, quartzite, silicified wood) and location were recorded, as well as size (in the following groups: 3 cm or less, 3.1–5.0 cm, 5.1–10 cm, 10.1–15 cm, and 15.1–25 cm). Heated stones larger than 15 cm were rare, and no heated stones larger than 25 cm were found in the excavations. The measurements were made across the longest axis of the specimen. The shape of the stones, including angular or tabular forms, was also recorded. Many of the smaller stones are fragments of what were originally larger rocks that were broken during the heating process. Therefore, estimates of the overall volume of heated stone relative to the amount of cultural fill from which they were obtained are the most meaningful measurements.

Estimated volumes of stone vary significantly in the size groups of tabular versus angular stones. Estimated volumes of angular and tabular stones used in this analysis are listed in Table 13 and should be considered approximate. In order to compare the total volume of fire-heated stone within various proveniences and between sites, it is necessary to estimate the total volume of cultural fill from which the stones were removed. If the stones are unevenly distributed within the cultural deposits or provenience areas, this should be factored into the volumetric measures of the cultural fill container.

LA 50460, East Provenience

The East Provenience of LA 50460, in contrast to the West Provenience, exhibits a relatively high concentration of fire-cracked rock. A sample of heated stone material from a 70 square meter area, with an estimated 14.4 cubic meters of fill, included 446 stones with a total estimated volume of 2.25 cubic meters of stone material (Tables 13 and 14). However, most of the fire-heated stone was found in two concentrations, designated Features 2 and 3 (Figure 10). Most of the stone in Feature 2 was concentrated in a 2.5 by 4.5 m area within a zone of cultural fill 20 cm thick (2.25 cubic meters of cultural fill). Within Feature 2, there was an estimated 0.84 cubic meters of heated stone or 0.37 cubic meters of heated stone material per cubic meter of cultural fill (i.e., 37% of the fill was stone).

Most of the heated stone within Feature 3 was concentrated in a 3 by 3 m area and within a zone of cultural fill 20 cm thick (1.8 cubic meters of cultural fill). Within Feature 3, there was an estimated 1.34 cubic meters of heated stone or

Table 14. Fire-heated Stone Frequencies and Estimated Volumes in LA 50460, East Provenience

Material/Size	C8	C9	D8	D9	E9	E11	E12	F10	F11	F12	D10	E8	E10	F8	F9	D11	G9*	G10*	H8*
Angular Sandstone†																			
3 cm or less	4	3	15	14	5				3			7	6	2	1	1	2		3
3.1–5 cm	6	12	12	17	5	5	5		17	16	1	4	1	2	3		1	3	1
5.1–10 cm	19	12	10	24	5	8	5		46	33		2	1			1			2
10.1–15 cm		2	4	6	3	1	1		8	18									
15.1–25 cm				4				1	7	3									
Tabular Sandstone																			
3.1–5 cm			1	6	1			1											
5.1–10 cm			2	1		4	5		2	4			3		1				
10.1–15 cm						1	1		1	2									
15.1–25 cm										1									
Angular Quartzite																			
3.1–5 cm					1									1				4	
Total (n = 446)	29	29	44	72	20	19	17	2	84	77	1	13	11	5	5	2	3	7	6
Estimated Volume (cc)‡	1043	1080	1328	3984	783	639	496	402	6505	5715	16	190	101	6	56	53	24	56	77

* Grid units G9, G10, and H8 are partial grid units

† Angular sandstone: 403 artifacts or 90.4% of the sample
Tabular sandstone: 37 artifacts or 8.3% of the sample
Angular quartzite: 6 artifacts or 1.3% of the sample

‡ Estimated cubic centimeters (22,554 cc or 2.25 cubic meters) based on:

	Angular Stone	Tabular Stone
3 cm or less	4 cc each	1 cc each
3.1–5.0 cm	16 cc each	2 cc each
5.1–10 cm	49 cc each	4 cc each
10.1–15 cm	144 cc each	7 cc each
15.1–25 cm	400 cc each	20 cc each

Table 15. Size and Frequency of Fire-heated Stone in LA 50460, West Provenience

Material	≤3.0 cm	3.1–5.0 cm	5.1–10.0 cm	10.1–15.0 cm	15.1–25 cm	Total	%
Angular Sandstone	34	24	15	3	1	77	39.1
Tabular Sandstone	21	44	35	6	0	106	53.8
Angular Quartzite and Silicified Wood	0	8	6	0	0	14	7.1
Total	55	76	56	9	1	197	
%	27.9	38.5	28.4	4.6	0.6		

Table 16. Frequencies of Fire-heated Stone in LA 50460, West Provenience, Level 2a

Material/Size	H33	H25	H31	G28	G29	H34	D33 Test	G35
Angular Sandstone								
3 cm or less		2				1		
3.1–5 cm	3		1		2	1		
5.1–10 cm				2		1		
10.1–15 cm	1							
15.1–25 cm							1	
Tabular Sandstone								
3 cm or less								2
3.1–5 cm			3		1		1	
5.1–10 cm	1		4		2		1	1
10.1–15 cm					2		1	
Quartzite and Silicified Wood								
3.1–5 cm					1			
5.1–10 cm	1		1	1				
Total ($n = 38$)	6	2	9	3	8	3	4	3
Estimated volume ($N = 924$ cc)	245	8	83	39	61	69	413	6

Total excavated area: 29 square meters; total estimated volume of cultural fill is 5.8 cubic meters. Total of 6.55 stones per cubic meter (very low density) or a volume of 159.3 cc of fire-heated stone per cubic meter of cultural fill. No concentrations were observed.

0.74 cubic meters of heated stone per cubic meter of cultural fill (i.e., nearly 74% of the cultural fill in Feature 3 was heated stone).

Areas adjacent to Features 2 and 3 within the East Provenience of LA 50460 were nearly devoid of heated stone; only occasional fragments were found. The overall density of heated stone per cubic meter of cultural fill in the East Provenience was only 0.15 cubic meters of stone for each cubic meter of fill. However, as noted above, most of this material was concentrated in two smaller areas where densities were much higher. In any event, it is clear that densities in the East Provenience are much higher (nearly 31 times higher) than the density of heated stone from the West Provenience. This significant variation among the LA 50460 components indicates very different use of the site areas.

The heated stone in both the East and West Proveniences is predominately soft angular sandstone with lesser quantities of tabular sandstone and traces of angular quartzite and silicified wood. All of the materials were probably obtained from nearby sources, although quartzite cobbles are uncommon in the area and may have been imported from local but more distant sources. Sandstone constitutes 98.4% of the sample from the East Provenience, while angular quartzite represents 1.3%. The majority of the sandstone material from the East Provenience is angular to subangular (403 specimens, 90.4%); tabular sandstone slabs and small slabs (37 specimens) represent 8.3% of the sandstone sample.

Heated stones from the East Provenience ranged in size from 2.0 cm to 25 cm. Most of the smaller specimens are probably fragments of what were once larger stones. In terms of size, the most common fragments from the East Provenience ranged from 3.1 to 10.0 cm with lesser quantities of stone in the 3 cm or less and 10.1–15 cm range, and only 16 specimens within the 15.1–25 cm group.

LA 50460, West Provenience

The West Provenience of LA 50460 exhibits a relatively low concentration of fire-cracked rock. The heated stone from a 104 square meter area with an estimated 52 cubic meters of fill (Tables 15–19) consisted of 197 stones with an estimated volume of 0.26 cubic meters. These stones were diffusely scattered throughout the cultural sediments and occurred with a low density of 0.005 cubic meters per square meter of cultural fill. The density of fire-heated stone in the West Provenience is much lower than that of the nearby East Provenience.

Most of the heated stone from the West Provenience is soft sandstone similar to that found in the East Provenience. However, there is a much higher incidence of tabular stone (53.8%) in the West Provenience in contrast to the East Provenience (8.3%) (Tables 13 and 15). Also, the heated stone from the West Provenience tends to be smaller than that from the East Provenience, with 66.4% of the sample being 5 cm or less in size, compared with 42% of the sample in the East Provenience. Therefore, not only is overall density of heated stone lower in the West Provenience, but the West Provenience has a much higher incidence of small tabular sandstone spalls, compared with the predominance of slightly larger, angular sandstone elements from the East Provenience. These differences are, no doubt, a reflection of the differing uses of heated stone between the two components. It is possible that the predominant slab elements in the West Provenience are fragments of comal or cooking stones, whereas the angular, slightly larger stones in the East Provenience were used for baking. The use of these stones for stone boiling is unlikely since most are quite soft and would

Table 17. Frequency of Fire-heated Stone in LA 50460, West Provenience, Level 2b

Material/Size	H34	H32	H36	F35	H28	G28	G30	G36	G29	H35	G37	H31	H30
Angular Sandstone													
≤3 cm	2	1		12		1	11			1		1	
3.1-5 cm	2		1		2	1	1	1	2			1	
5.1-10 cm	2	1					1					1	
10.1-15cm		2											
Tabular Sandstone													
≤3 cm				2				6					2
3.1-5 cm				5				5		1		2	3
5.1-10 cm			1	3				4				3	5
10.1-15cm								2			1		
Quartzite													
3.1-5 cm				2		1							
5.1-10 cm								1					
Total (n = 96)	6	4	2	24	2	3	13	19	2	2	1	8	10
Estimated volume (cc) (N = 1076 cc)	138	341	23	101	32	28	109	102	32	8	13	98	51

Total number of stones: 96 in 52 square meters or 1.8 stones per square meter.
Estimated cubic meters of cultural fill: 13.0 cubic meters or 7.9 stones per cubic meters of cultural fill.
Density of fire-heated stone is low and distribution is diffuse with slight concentrations in grid units F35, G30, and G36.

easily fracture from thermal shock. However, the few quartzite and silicified wood specimens found in both proveniences could have been used in stone boiling.

The high incidence of deer bone in the West Provenience, together with the low incidence of heated stone, contrasts with the low incidence of faunal remains and high incidence of heated stone in the East Provenience. Both components contain ground stone indicative of seed processing. The large quantity of angular heated stones in the East Provenience may have been used to cook plant products or small animals, whereas the small quantity of tabular heated stones in the West Provenience were probably used as comal or griddle stones to prepare flat bread from ground seeds. The deer meat in the West Provenience was probably roasted on an open fire.

Table 18. Frequencies of Fire-heated Stone in the LA 50460, West Provenience, Level 2a-2b (mixed) and Surface Samples

	Level 2a-2b Samples					Surface Samples					
Material/Size	H32	E30 ¼	G35	H37	H29	H35	H29	I23	I30	I12	H18
Angular Sandstone											
3 cm or less			1		1						
3.1–5 cm	2		3					1			
5.1–10 cm	3		2							1	1
Tabular Sandstone											
3 cm or less			1	6		2					
3.1–5 cm	8	2	7	2		1	1		3		
5.1–10 cm	1		3	4	1	1	1				
Quartzite											
3.1–5.0 cm		1			2	1					
5.1–10 cm					1	1					
Total ($n = 65$)	14	3	17	12	5	6	2	1	3	1	1
Estimated Volume (cc) ($N = 789$ cc)	218	24	201	48	92	15	65	16	12	49	49

Table 19. Number and Estimated Volume of Fire-heated Stone in LA 50460, West Provenience

Location	N	Volume (cc)	Cultural Fill (cm)
Level 2a	38	924	5.8
Level 2b	96	1076	13.0
Level 2a-2b/surface	65	789	12.75
Total	199	2789	31.55

Total density is very low, 6.78 stones per cubic meter of cultural fill or 88.4 cc of heated stone per cubic meter of cultural fill.

LA 45961

Heated stone materials occur in limited quantities at LA 45961 and consist of 19 specimens from the surface and 39 specimens from excavated context (Tables 20–22). The total volume of heated stone from the site is .092 cubic meters. The 39 heated stones that were found in the 4.8 cubic meters of cultural fill represent only 0.01 cubic meters per cubic meter of fill. No hearths or concentrations of heated stone were found in the site, although the presence of minor quantities of heated stone does suggest hearth use at the location. Nonetheless, heated stone was clearly not an important part of the LA 45961 site use.

The predominant heated stone material type is soft angular sandstone (86.2%) with minor

Table 20. Size and Frequency of Fire-heated Stone from LA 45961

Material	≤3.0 cm	3.1–5.0 cm	5.1–10.0 cm	Total	%
Angular Sandstone	7	38	5	50	86.2
Tabular Sandstone	2	1	0	3	5.2
Angular Quartzite and Silicified Wood	1	3	1	5	8.6
Total	10	42	6	58	
%	17.2	72.4	10.3		

Table 21. Frequency of Fire-heated Stone from LA 45961, Surface

Material/Size	C5	C15	D9	D10	D12	E2	E5	E7	E9	E10	F8	F17	G5	C15
Angular Sandstone														
3 cm or less	1										1	2		
3.1–5 cm	1	1		1		2	1		1		1			1
5.1–10 cm			1							1				
Tabular Sandstone														
3 cm or less									1				1	
Silicified Wood														
3 cm or less					1									
5.1–10 cm								1						
Total (n = 19)	2	1	1	1	1	2	1	1	2	1	2	2	1	1
Estimated Volume (cc) (N = 280 cc)	20	16	49	16	2	32	16	16	18	49	20	8	2	16

Table 22. Fire-heated Stone from the LA 45961 Excavated Grid Units (0–15 cm below surface)

Material/Size	D9	D11	D16	F11	F12	F13	G11	G13
Angular Sandstone								
3 cm or less	1	2						
3.1–5 cm	2	3	2	1	5		1	15
5.1–10 cm						2	1	
Tabular Sandstone								
3.1–5 cm								1
Angular Quartzite								
3.1–5 cm		1				1		1
Total (n = 39)	3	6	2	1	5	3	2	17
Estimated Volume (cc) (N = 645 cc)	36	58	32	16	80	100	65	258

Estimated volume of fill: 4.8 cubic meters, or 134 cc of heated stone per cubic meter of fill

quantities of tabular sandstone (5.2%) and quartzite or silicified wood (8.6%). The great majority of the sandstone material is angular; only minor quantities of tabular sandstone material are present. The heated stone recovered from the site tends to be in the smaller size range. All of the stones are under 10 cm and the most frequent size group is 3.1 to 5.0 cm, which represents 72.4% of the collection. The high frequency of small angular sandstone elements suggests that the heated stones were mostly used for baking or radiant heat. Comal use was probably infrequent since only 3 tabular specimens (5.2% of the sample) were found. It is unlikely that the soft sandstone materials were used for stone boiling. However, there are a few specimens of harder quartzite and silicified wood that could have been used for that purpose.

Chapter 9

Macrobotanical Analysis

by Paul Knight

In the winter of 1998, a paleoethnobotanical analysis was conducted on flotation samples collected from two Archaic sites (LA 45961 and LA 50460) located along NM 44 between Cuba and Bloomfield in New Mexico. Both of these sites were encountered within the existing highway right-of-way during surveys for proposed widening of the roadway.

LA 45961 is a multicomponent site with occupations dating to the late Archaic and early Formative periods. Two components have been identified at LA 45961. The earliest or lower component is of late Archaic period affinity. Two radiocarbon samples obtained from the early component yielded dates of ca. 620 BC and 80 BC. The later component was not dated but appears to be of early Formative period affinity. Both of the flotation samples from the site were taken from the fill of a pit associated with the early component. LA 45961 is 2,079 m (6,820 ft) in elevation. The site is situated on a low ridge in lower pinyon-juniper woodland.

LA 50460 is also a multicomponent site of early Archaic period affinity. The earliest occupation of the site is in the West Provenience and has been radiocarbon dated to 5510 BC and 5710 BC. The later component is in the East Provenience and has been radiocarbon dated to 5140 BC. LA 50460 is 2,050 m (6,725 ft) in elevation. The site is located in the Great Basin shrubland community type.

Seventeen flotation and charcoal samples were analyzed during this study: 2 from LA 45961 and 15 from LA 50460. A summary of the data from all of these samples appears in Table 23.

None of the samples had been pre-floated, and all contained very large volumes (Tables 23 and 24). The two samples from LA 45961 were 26,500 cc and 16,650 cc, respectively. The average size for the 15 samples from LA 50460 was 7,166 cc, with the largest being 14,600 cc and the smallest being 3,700 cc. These large samples were deemed necessary as both of the sites were Archaic in age, and it was anticipated that the preservation of organic material would be marginal. All of the samples from both sites had recoverable light float, and some samples had measurable heavy float.

LA 45961 yielded two samples whose combined volume was 43,150 cc (43.15 liters). The recovered yield from these two samples was 411 cc of organic material. Munsell charts used for estimating proportions of fragments indicate that approximately 10% of the float material recovered from the sample (or approximately 41 cc) consisted of carbonized plant remains. The remainder of the sample consisted of modern roots and rodent droppings. Less than 0.01 of 1% of the total volume of the sample contained recoverable carbonized plant materials, or approximately 0.0095%. Approximately 1 liter of material was floated for each 1 cc of carbonized plant material recovered.

Table 23. Summary of Data from LA 45961 (top) and LA 50460 (bottom)

FS	Sample Volume (cc)	Light Fraction Weight (g)	Heavy Fraction Weight (g)	Wood Fragments: Juniper	Pinyon	Sagebrush	Corn: Cupules	Cobs	Kernels	Carbonized Seeds (n)	LA 45961 Sample Provenience
16	26,500	43.6	0.38	2	1	6	696	1	1	7 Cheno-Am	Large pit fill, 40–50 cm below rim
17	16,650	37.7	6.5				265		1	4 Cheno-Am	Lower pit fill, 80–90 cm below rim
Macro				5	15	1		1	1		
Total	43,150	81.3	6.88	7	16	7	961	2	3	11 Cheno-Am	

FS	Sample Volume (cc)	Light Fraction Weight (g)	Heavy Fraction Weight (g)	Wood Fragments: Juniper	Pinyon	Sagebrush	Sacaton	Wolfberry	Carbonized Seeds (n)	LA 50460 Sample Provenience
1	11,200	6.1		1			2		1 Cheno-Am	East Provenience, grid unit E10
2	3,700	1.35								East Prov., E11
3	5,100	9.4	0.1			1	2			West Prov., G36, Level 2b
4	14,600	10		2						East Prov., F11
5	6,600	6.8	0.35	1			1			West Prov., G36, Level 2b
6	4,500	6.6		1						West Prov., G36, Level 2a
7	6,200	4.8								West Prov., G37, Feature 1, Level 2b
8	7,900	2.6								West Prov., H34, Level 2b
9	8,600	7.9								West Prov., G36, Level 2b
10	7,800	7.05	0.1	2		1	3			West Prov., H25, Levels 2a/2b
11	9,100	10.4					1			West Prov., G35, Level 2a, 50 cm bd
12	3,800	5.7					4			West Prov., G35, Feature 1, 50 cm bd
13	6,200	3.65								West Prov., H35, Feature 1, 40–60 cm bd
14	5,100	11.1						3		East Prov., F12
15	7,100	3.1								East Prov., D9
Subtotal	107,500	96.55	0.45	7		2	13	3		
Macro 1				5	1		4			
Macro 2				3	2					
Subtotal				8	3		4			
Total				15	3	2	17	3	1 Cheno-Am	

Table 24. Volume of Flotation Samples and Recovered Float Material from LA 45961 and LA 50460

FS	Volume (cc)	Volume of Recovered Material (cc)	Estimated % of Original Sample Volume	Total Volume of Carbonized Material (cc)
16	26,500	200	10	20
17	16,650	211	10	21
LA 45961 Total	43,150	411		41
1	11,200	15	5–10	0.75–1.5
2	3,700	9	5–10	0.45–0.9
3	5,100	14	5	0.7
4	14,600	35	5	1.75
5	6,600	28	5	1.4
6	4,500	22	5	1.1
7	6,200	9	2	0.45
8	7,900	10	1	0.1
9	8,600	27	2	0.54
10	7,800	17	5	0.85
11	9,100	18	1–2	0.36
12	3,800	21	1	0.21
13	6,200	16	2	0.32
14	5,100	22	1	0.22
15	7,100	15	2–5	0.75
LA 50460Total	107,500	278		9.95–12.35

Fifteen samples were analyzed from LA 50460 (Table 24). The average sample volume was 7,166 cc, with an average of 18 cc of float material being recovered from each sample. The vast majority of the light float was composed of modern or near modern root parts. Most of the flotation sample contained only minute, fragmentary pieces of carbonized wood. Less than 0.01 of 1% of the total volume of the sample contained recoverable carbonized plant material.

The incidence of carbonized plant material was even lower in the samples from the West Provenience at LA 50460. Only 278 cc of float material was recovered from more than 107 liters of floated material. This represents only 0.2% of the total volume. Most of this recoverable float was modern roots and rodent droppings. It is estimated that no more than 10% of the 278 cc of float material (approximately 28 cc) contained carbonized plant materials. This represents 0.02

of 1% of the material floated. The actual recovered carbonized material from all of the LA 50460 samples was estimated to be between 9.95 and 12.35 cc, which represents 0.0009% of the 107,500 cc of floated material. This implies that approximately 8–10 liters of material were floated for each cubic centimeter of carbonized plant material recovered.

Current Environment

The habitat around LA 45961 and LA 50460 is dominated by Great Basin shrub communities intermixed with the fringes of juniper and pinyon-juniper woodland. LA 45961 is dominated by *Artemisia* intermixed with scattered *Pinus edulis* and *Juniperus monosperma.* The vegetation is primarily shrubby with an abundance of big sagebrush *(Artemisia tridentata)* intermixed with blue grama grass *(Bouteloua gracilis).* Five woody species were found at or near the site: big sagebrush, rabbitbrush *(Chrysothamnus nauseosus),* alkali sacaton *(Sarcobatus vermiculatus),* one-seed juniper *(Juniperus monosperma),* and pinyon pine *(Pinus edulis).* Ponderosa pine do occur in the general area, but not in proximity to the sites. LA 50460 occurs in Great Basin shrubland, and the only trees in the area are located on hillsides far east of the site.

In addition to the dominant woodland species, a number of shrubby and herbaceous vascular plant species were noted in the area. A list of these species is presented in Table 25. Each of the five woody species around LA 45961 *(Pinus edulis, Juniperus monosperma, Atriplex canescens, Chrysothamnus nauseosus, and Opuntia imbricata)* are of sufficient size and abundance to produce fuel woods capable of sustaining a substantial fire. Four species of woody plants were noted near LA 50460. Two of these species, *Artemisia tridentata* and *Sarcobatus vermiculatus,* are currently abundant enough to be used for a fire. The remaining species, *Lycium pallidum* and *Juniperus monosperma,* are either scarce or remote enough from the site so as not to be easily available.

Methods

The 17 flotation samples submitted for analysis were taken in bulk soil samples during excavation. These samples were extremely large, ranging from 3.7 to 26.5 liters. None of them had been pre-floated. The parent material of the samples consisted of very fine sands which may have been eolian deposited. The samples, although tinged with a charcoal stain, were generally free of any visible large carbonized material.

It quickly became apparent that only small portions of each sample could be floated at one time, or the fine sands and root materials present in the samples would clog up the filter screen. Consequently each of the samples was broken down into one-liter subsamples. These subsamples were then placed in a five-gallon bucket to which approximately four gallons of water were added. The mixture was heavily agitated for about one minute and then allowed to sit for five minutes while the sand settled to the bottom.

The liquid portion of the material (containing water, carbonized plant parts, modern roots, and other buoyant materials) was then slowly poured through a screen of chiffon. The chiffon was held stationary within a large embroidery ring that sat atop a 2-inch-deep circular metal frame with a ¼-inch wire mesh on the bottom. This metal frame held the chiffon stationary while the liquid portion of the sample was poured through it. The chiffon had a pore size of 0.15 mm, which was more than adequate to collect any anticipated identifiable organic material.

Once the sample was poured through the chiffon, the screen was removed from its holder and

Table 25. Vascular Plant Species Noted near LA 45961 and LA 50460

LA 45961	LA 50460
Amaranthus graciezens	*Amaranthus graciezens*
Allium sp.	*Artemisia tridentata*
Agropyron smithii	*Atriplex canescens*
Aristida longiseta	*Bouteloua gracilis*
Artemisia tridentata	*Bromus japonicus*
Atriplex canescens	*Chenopodium dessicatum*
Bouteloua gracilis	*Chrysothamnus nauseosus*
Bromus japonicus	*Cryptantha* sp.
Chenopodium dessicatum	*Hilaria jamesii*
Coryphantha vivipara	*Juniperus monosperma* (distant)
Cryptantha sp.	*Lycium pallidum*
Gutierrezia sarothrae	*Melilotus officinalis*
Hilaria jamesii	*Oryzopsis hymenoides*
Juniperus monosperma	*Sarcobatus vermiculatus*
Leucelene ericoides	*Sporobolus cryptandrus*
Melilotus officinalis	
Opuntia imbricata	
Opuntia phaeacantha	
Oryzopsis hymenoides	
Pinus edulis	
Plantago purshii	
Salsola kali	
Sarcobatus vermiculatus	
Sencio douglasii v. *longilobus*	
Sporobolus cryptandrus	

placed on thick blotter paper to absorb the excess moisture. After about ten minutes, the screen containing the float material was placed on top of a ¼-inch-diameter wire mesh screen to air dry. This process was repeated for each of the one-liter components of the original sample. In the case of sample F-16, 26 such samples were processed in this manner.

Once the floated material had dried, it was passed through a series of graduated sieves ranging from 0.5 mm to 2 mm to segregate the material by

size, which allowed greater visibility during the microscopic analysis stage. Once the samples were screened, they were transferred to a white platform anchored within the field of view of a 20× stereoscopic microscope. The float material was agitated and thinly spread out on the platform. The sample was then systematically searched, using a fine camel-hair brush to move about the fragments of carbonized material and modern root parts.

Once an identifiable plant part was encountered, it was transferred to a petri dish along with other material collected from the sample. Upon completion of the sorting, the recovered botanical material was transferred to the microscope platform and studied in detail. Charcoal specimens were initially scanned under a 20× stereoscopic microscope. In some cases, higher-power magnification was required, and thin-sections were viewed under a compound microscope. Once analysis was complete, the material was transferred back to the original bags in which it had been submitted.

In addition to analysis of the light float material, all of the sand and heavy float left in the five-gallon bucket was analyzed. The heavy float and sand from each of these subsamples was collected from the bottom of the bucket and assembled into a pile to air dry on top of a large sheet of plastic. This aggregate sample was quite large and in some cases consisted of several cubic feet of material. The material was gathered by scoop in one-liter portions and transferred to a large sheet of white paper. The material was then sorted by hand utilizing an 8-inch-diameter stationary magnifying lens. This heavy float was devoid of any trace of carbon staining but occasionally did contain large pieces of charcoal. Numerous fragments of charcoal and corncobs were found by carefully sorting through this dried sand. Apparently, the cracks and crevices of these larger pieces of carbonized material had been so infiltrated with the fine sand that they were too heavy to float and could only be recovered by careful analysis of the sand refuse from the flotation process.

It was clear from the onset of the analysis that the carbonized plant material retrieved from the samples would be used for carbon dating. In order to avoid any possible modern contamination, the samples were handled with extreme care. The samples were stored and analyzed in a smoke-free environment, and surgical rubber gloves were utilized at all times when handling sample materials or individual pieces of charcoal. The petri dishes and platform of the microscope were washed with distilled water after each sample was completed to avoid any possible contamination between samples.

LA 45961, Early Component

The early component at LA 45961 is a late Archaic site (dated to between 620 and 80 BC) located on a low hill adjacent to NM 44. The site occurs at the transition of the pinyon-juniper woodland and the Great Basin shrubland community. The primary feature of this component was a pit about 90 cm deep. This pit was filled with darkly stained soil. There were obvious macrobotanical remains (carbonized wood and *Zea mays* cob fragments) in the fill of the pit. Two large flotation samples were taken. Both of these samples were taken from the pit fill. There were no other features or diagnostic materials at the site.

Results of Flotation Analysis

Two flotation samples (F-16 and F-17) and 23 macrobotanical specimens from LA 45961 were examined during this study (Table 23). Both of the samples came from a large pit (approximately 90 cm deep) which was discovered 1.0 m below the surface. The pit was filled with fine sand, and

its soils were stained with carbon materials. The fine organic stain in the soil suggested good potential for recovery of carbonized plant materials. Sample F-16 was collected from materials in the middle portion of the pit, approximately 40–60 cm below the rim. Sample F-17 was collected from the bottom of the pit, approximately 60–90 cm below the rim. The 23 macrobotanical specimens were collected at various depths during the excavation. These samples consisted of 21 pieces of carbonized wood, 1 carbonized corncob fragment, and 1 carbonized fragmentary corn kernel.

Carbonized Wood

Carbonized wood fragments were identified both in the macrobotanical remains collected during excavation and in the more minute remains recovered during the flotation analysis. In all, 30 identifiable carbonized wood remains were collected from the site. These wood fragments represented three different species of vascular plants: one-seed juniper, pinyon pine, and big sagebrush. *Pinus edulis* was the most common (16 of the 30 pieces of wood recovered). Both *Juniperus monosperma* and *Artemisia tridentata* were represented by seven pieces of wood. All three of these woody species still occur in the general project area.

Native Seed Remains and Foliar Material

Both samples F-16 and F-17 contained carbonized seed remains. Eleven seeds representing two genera *(Chenopodium* and *Amaranthus)* were recovered from the site (Table 23). F-16 contained seven seeds, all of which were badly burned. Six of these seeds belonged to members of the genus *Chenopodium* (two of which were tentatively identified as *C. dessicatum).* The remaining seed belonged to the genus *Amaranthus* and was tentatively identified as *A. graciezens.* Both genera, *Chenopodium* and *Amaranthus,* including *C. dessicatum* and *A. graciezens,* still occur in the general project area.

Cultigens

Zea mays was the only cultigen retrieved from the site, and fragments of *Zea mays* proved to be the most common carbonized plant material recovered from the pit. These remains consisted of cob fragments, cupules, and kernels (Figure 30). The two cob fragments are rachis segments, one from the end of a cob and the other from the middle of a cob. A total of 961 corn cupules (696 from F-16 and 265 from F-17), 2 fragmentary corncobs (one from each sample), and 2 corn kernels (one from each sample) was recovered from the samples. The material was highly carbonized but well preserved, often exhibiting minute details of the cupule structure and subtending bracts. Radiocarbon analysis of the cupules and cob fragments indicated the material was from 2570 BP ± 120. This would place the corn in the late Archaic period between 740 and 500 BC.

Although there have been substantial finds of corn in previous excavations, the data on Archaic corn in New Mexico are generally spotty. Perhaps the most extensive recovery of Archaic corn occurred at Bat Cave (Catron County, NM) which is discussed by Mangelsdorf and Smith (1949) and is currently believed to date to 1600 BC. The oldest Bat Cave material included intact cobs that averaged 7.3 cm in length with an average of 10.7 kernel rows per cob. The kernels at Bat Cave were also corneous and were likely capable of popping when exposed to heat (Mangelsdorf 1974). Archaic maize has been described as morphologically distinct from later Anasazi types. The Archaic specimens are usually brown pop/flint maize considerably harder and smaller than later corn (Simmons 1986).

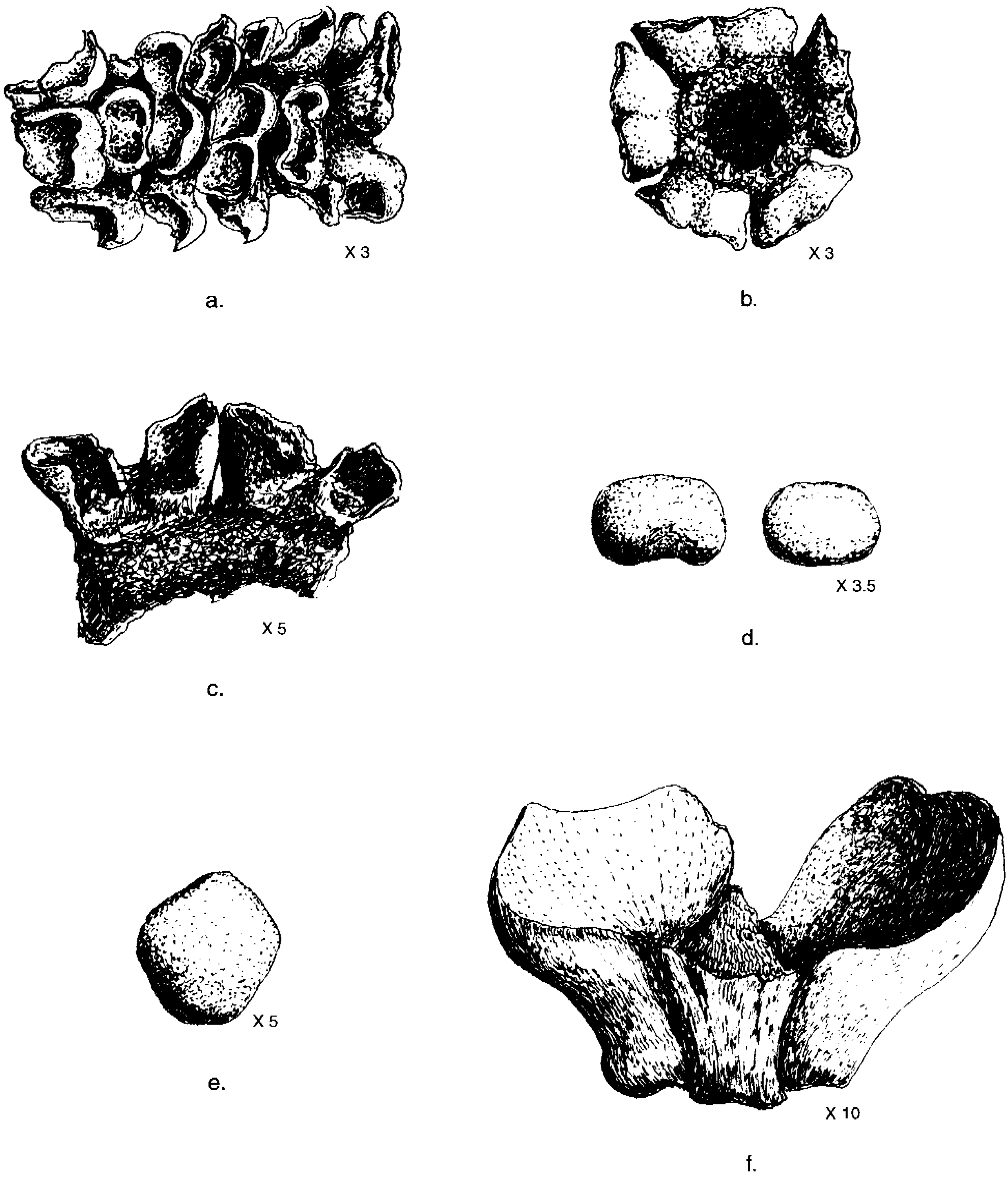

Figure 30. Corncobs and kernels from the pit feature, LA 45961 (illustration by P. Knight)

Corncobs

Two fragments of corncobs were recovered from the site. Both had ten rows of kernels, which corresponds with Archaic corn found in Bat Cave and described by Mangelsdorf (1974). Fragment 1 is approximately 1.7 cm long and 0.8 cm wide. It is complete in cross-section (Figure 30 32a, b). Many of the cupules are appended with highly indurate bracts that appear to partially enclose the kernel (Figure 30f). The average cupule width on Fragment 1 is 2.5 mm, and the average height is 1.9 mm. The cupule width:height ratio is 1.3.

Fragment 2 is 1.2 cm long and 1.1 cm wide and is incomplete in cross-section. The average cupule width is 2.8 mm, and the average cupule height is 2.0 mm. The cupule width:height ratio is 1.4. Although there are fragments of subtending bracts, they are much less obvious than in Fragment 1. The cupule width:height values for both cob fragments suggest a slightly rectangular kernel. The value of 1.3 falls between those reported by Brown (1999) for two Archaic cob samples found in the San Juan Basin. Those two cobs had cupule width:height ratios of 1.96 and 1.06.

Corn Cupules

In addition to the cob fragments, 961 corn cupules were recovered from the flotation samples. Many are fragmentary, but 30 nearly complete cupules were recovered. Measurements of length and width were taken for each of these cupules. The cupules recovered from the float sample were considerably larger than those on the cob fragments. The cupules recovered from the float samples ranged from 2.9 to 5.5 mm in width and 1.3 to 4.4 mm in length. The average width of all the cupules recovered from the float samples was 4.2 mm, and the average length was 2.6 mm. The width:height values for these cupules was 1.61. This width:height ratio, as with the cob fragments, suggests a slightly rectangular kernel. As previously mentioned, many of the cupules tapered upward into indurate bracts which appear to have partially enclosed the kernels (Figure 30c, f). Based on observations of numerous Archaic (3400–900 BC) materials, Mangelsdorf (1974) found early cultivated corn to be predominantly 8-rowed Maiz de Ocho, with a small percentage of 10-rowed corn. These early cobs had indurate floral bracts that partially surrounded the kernel. Many of the cupules recovered from LA 45961 bear remnants of indurate floral bracts that also appear to have partially enclosed the kernels (Figure 30c, f).

Kernels

Two fragmentary kernels were recovered from LA 45961 (Figure 30d, e), but only one of these kernel fragments was sufficiently intact to measure. This kernel was approximately 5 mm wide and 4 mm in height. Its overall appearance resembled flint or popcorn, but the specimen was too badly burned and fragmented to make a positive determination. The second kernel fragment was part of a longitudinal section and was approximately 2.5 mm tall. This kernel resembled popcorn in outline.

Summary and Conclusions

Currently the habitat at LA 45961 is dominated by Great Basin shrubland species on the fringes of a pinyon-juniper woodland. The vegetation is primarily shrubby with an abundance of big sagebrush intermixed with blue grama grass. The carbonized plant remains recovered from this site indicate that the environment surrounding the site was probably quite similar during site occupation. All of the woody species as well as the native herbaceous species recovered from LA 45961 can be found in the general site area today. The primary fuel wood utilized at LA 45961 was pinyon, but there was also an abundance of one-seed juniper and big sagebrush.

The most important materials recovered from LA 45961 were the abundant fragmentary *Zea mays* remains: 961 cupules, 2 fragmentary corncobs, and 2 fragmented kernels. These remains are part of a rare sample of corn recovered from Archaic period sites. Both the cob fragments and the corn cupules exhibit primitive traits such as indurate bracts partially enclosing the kernels. These traits are consistent with Archaic corn recovered from Bat Cave in Catron County, New Mexico, and other dry cave sites in northern Mexico. The cobs recovered from LA 45961 are ten-row, and the kernels appear to be a flint/popcorn type. The cupule width/length is also consistent with cobs recently recovered at other Archaic sites in the San Juan Basin (Brown 1999). The corncobs and cupules recovered from this site were dated to the late Archaic at approximately 620 BC. The corn recovered from LA 45961, although not found in contexts with artifacts or diagnostic features, still provides valuable data contributing to our understanding of early maize development in New Mexico.

LA 50460

LA 50460 is located on a low rise on the south side of NM 44. The site vegetation was dominated by sagebrush intermixed with greasewood. Although there were no juniper or pinyon trees present on the site, a few scattered juniper trees were noted on the low rises approximately ½ mile east of the site. Most of the area surrounding the site is typical of Great Basin Shrubland and consists of xerophytic shrubs intermixed with a variety of grasses and herbs. Portions of the area adjacent to the site had been previously disturbed by a gas pipeline. The site was heavily affected by pocket gopher and mice activities.

Results of Flotation Analysis

Fifteen flotation samples from LA 50460 were examined. These samples ranged from 3,700 to 11,000 cc. Radiocarbon dating indicates that this site was occupied during the early Archaic between 7670 and 7090 BP or approximately 5720–5140 BC. Although many of the flotation samples had pronounced organic staining, there were very few identifiable carbonized plant remains. It appears that most of the carbonized material had been reduced (by the action of time and the elements) to smaller than a millimeter. The vast majority of the samples was composed of modern roots. Eight to ten liters needed to be floated to recover 1 cc of carbonized plant material.

Carbonized Wood

Virtually all of the samples had carbon residue, but only 10 of the 15 samples contained identifiable pieces of wood. Considering the volume of float material studied, the carbonized wood was very small and scarce. Two macro samples were also analyzed. This material was quite large and easily identifiable. The wood fragments from the flotation samples and the macro remains consisted of five different species of vascular plants: *Juniperus monosperma, Pinus edulis, Sarcobatus vermiculatus, Artemisia tridentata,* and *Lycium pallidum.* In all, 25 pieces of wood were identified in the flotation samples from LA 50460. The most common woods recovered were juniper and greasewood.

Fifteen identifiable pieces of carbonized wood were recovered from macro samples. Juniper represents more than half of the material recovered. *Sarcobatus* accounts for more than a

quarter of the wood recovered. Pinyon was the rarest. The macro sample taken from the east side of the site in grid units E9, E10, D8, and D9 is the only record of pinyon within LA 50460.

Native Seed Remains, Leaves, and Other Recovered Materials

Prehistoric Remains

Only one of the samples contained a carbonized seed. Sample 1 from Grid E10 in the East Provenience contained one carbonized Cheno-Am seed. This seed was too badly burned to enable a more specific identification. The recovery of a Cheno-Am seed is not surprising since *Chenopodium* and *Amaranthus* are often the most common seed remains recovered from Archaic sites.

Modern Plant Remains

Modern seeds and other plant materials (leaves and roots) were found in a number of the samples. Five of the samples (F-1, 3, 7, 9, and 12) contained modern seeds and/or leaves. Two types of modern seeds, Indian ricegrass *(Oryzopsis hymenoides)* and *Cryptantha,* were recovered. Seeds from both of these species were found in four of the five samples with modern seed remains. In some cases, the glumes surrounding the ricegrass seed were still green. In addition to Indian ricegrass seeds, F-7 also contained modern *Artemisia tridentata* leaves. These leaves were still green. Sample F-12 contained hundreds of modern Indian ricegrass seeds intermixed with ant remains. Modern roots made up most of the volume of the floated materials recovered from nearly all of the samples. Many of the samples consisted of about 99% modern roots intermixed with only tiny fragments of carbonized material.

Rodent Remains

In addition to the modern seed and leaf remains, many of the samples contained rodent droppings or mouse bones. Specifically, samples F-1, 2, 3, 12, 14, and 15 contained rodent droppings. Samples F-3, 8, and 9 contained mouse bones. All of the samples with modern plant remains also contained either rodent droppings or rodent bones. Clearly the site has been subject to significant rodent activity.

Insect Remains

Three of the samples contained identifiable insect remains. Samples F-2, F-4, and F-12 all contained ant parts. Samples F-4 and F-12 also had numerous beetle remains. It is likely that ants contributed to the presence of modern seeds in the samples. In particular, F-12 contained hundreds of modern Indian ricegrass seeds. These seeds were intermixed with numerous ant body parts.

Unidentified Cinder or Resin Material

During the flotation process, a black, heavy float fraction separated out from the lighter material. This heavy float settled just above the sand layers in the flotation bucket and could only be removed by pouring off the fine sand and silt material at the bottom of the bucket. A centrifuge was utilized to separate this black material from the fine sand and silt in which it occurred. Twelve of the fifteen flotation samples (F-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, and 14) contained this material. Under the microscope, this black material initially looked like cinders and, in fact, closely resembled coal cinder. Subsequent analysis of the material revealed that it also had characteristics of a resinous material.

Several explanations are possible. First, it could be coal cinder that was dumped in the area and then moved onto the site by rodents or ants. Second, perhaps the material is naturally present in the soil. Third, it may be from the original construction of NM 44. Finally, it may be a tar-like sealing material that was used in the construction of a pipeline that passes through the

site. In order to determine if the material was found outside the site boundary, a sample was taken within the highway right-of-way, on the same side of the road, approximately 200 m southeast of the site. This sample contained material similar to that found on the site as well as globules of tar. Although there still has been no clear determination, the current data suggest that the black material recovered from the site is most likely related to the asphalt utilized during the construction of the pipeline. This material could have easily been moved through the site by rodents and ants.

Summary and Conclusions

LA 50460 was devoid of any cultigens and contained only scant carbonized plant remains. Although more than 107,500 cc were floated, only an estimated 9–12 cc of carbonized plant material were recovered. For every 8–10 liters of material floated, only 1 cc of carbonized plant material was collected.

One badly burned seed recovered from sample F-1 was identified as Cheno-Am. A number of *Oryzopsis hymenoides* and *Cryptantha* seeds were also recovered from the site, but all of them were recent in origin.

Nearly a quarter of the samples contained either modern seeds or leaves. All of the recovered float material consisted primarily of modern roots. Two-thirds of the flotation samples had either ant parts or rodent droppings or bones. The large number of rodent remains suggests that the site has been subject to biological churning. Such activity can move recent plant materials into earlier occupation levels.

Small fragments of wood were found in most of the samples. The majority of these fragments were so small (generally smaller than 3 mm) that they were difficult to identify. In all, 26 pieces of wood were identified in the flotation samples from LA 50460. The most common woods recovered were *Juniperus monosperma* and *Sarcobatus vermiculatus*. *Juniperus monosperma* no longer occurs at the site. Although there are junipers about 1.2 miles to the east, they are thinly distributed. Pinyon pine was not in view of the site. It would, however, take only a slightly wetter climate to allow the establishment of pinyon and juniper at the site. The presence of pinyon charcoal and the abundance of juniper suggests that at the time of occupation, there must have been at least some pinyon and juniper trees near the site.

A black resinous or cinder material was recovered from 80% of the samples. This material was also found in a sample location outside the site perimeter. This material has not yet been identified, but it is most likely associated with the installation of a gas pipeline that passes through LA 50460.

Discussion

Flotation samples from two sites (LA 45961, LA 50460) were submitted for analysis. LA 45961 was represented by two large flotation samples, both of which contained carbonized Cheno-Am seeds as well as substantial numbers of corn cupules, a few corncob fragments and two corn kernels. The carbonized corn remains recovered from the site were dated to the late Archaic period and were similar in morphology to other Archaic corn materials found in New Mexico and adjacent Mexico. The corn recovered from LA 45961 had 10-row cobs and appeared to be either a popcorn or flint corn. All of the corn was found in one feature at the site, and no diagnostic material was present. Although the site can not be attributed to a specific cultural phase, the dating of the carbonized corn fragments assigns this material to the late Archaic and provides a basis

for comparison of this material with other Archaic corn samples from the area.

The recovery of *Chenopodium* and *Amaranthus* seeds is not uncommon in late Archaic or Puebloan sites in the San Juan Basin. A number of species of *Chenopodium* and *Amaranthus* occur in the area surrounding the site, and it is likely that these species were abundant during the time of occupation of LA 45961. The seeds were recovered from the same pit as the corn, suggesting that the pit was used for roasting or storing not just cultigens, but also native plants.

In addition to an abundance of carbonized corn remains, the two samples for LA 45961 also contained 30 identifiable carbonized wood fragments. These wood fragments were identified as one-seed juniper, pinyon, and big sagebrush. All three of these woody species are currently common in the area, and any modern fire constructed with locally available materials would likely be dominated by these species. The wood fragments recovered from LA 45961 suggest that the environment surrounding the site at the time of its occupation was similar to what can be found at the site today.

Unlike at LA 45961, cultigens were completely absent from LA 50460. This is not surprising as the site has been dated to 7090–7670 BP, long before maize agriculture has been documented in the southwestern United States. Although the excavation of LA 50460 uncovered numerous stone tools associated with plant processing, only one carbonized Cheno-Am seed was recovered. The heavily stained soil yielded very little carbonized organic material. In general, preservation at LA 50460 was poor, and enormous volumes of material needed to be floated to recover small amounts of carbonized material. Even with this volume of floated material, only one carbonized seed was recovered. Analysis of other early Archaic sites indicates that this is not a unique situation and further suggests that hundreds of liters of material should be floated if a statistical sample of carbonized material is to be recovered. Most of the material recovered from LA 50460 consisted of minute pieces of carbonized wood too small for identification (generally smaller than 2 mm). These fragments, and even smaller, near-microscopic fragments, resulted in the samples' dark organic stain. Since some of the wood fragments were large, the duration and intensity of the fire were apparently not sufficient to consume the material. The scarcity of large pieces suggests that physical processes acting on the soil (freezing, thawing, leaching, and organic churning) slowly decomposed the carbonized wood fragments to a fine fraction which gradually diffused through the soil and produced the dark staining. In addition, there is substantial evidence of biological processes such as churning by rodents, insects, and root action. Many of the samples from LA 50460 contained remains of rodents or ants. Some of these samples also contained modern seeds or leaves. It appears that LA 50460 experienced substantial bio-mixing as a result of the rodent activity in the area. All of these processes combined to reduce the quantity and quality of material recovered from the site.

The area surrounding LA 50460 is currently dominated by the Great Basin shrubland community. In particular, sagebrush and greasewood provide most of the biomass. The identifiable wood remains did contain both greasewood and sagebrush, but also a large number of juniper and pinyon wood fragments. Neither of these species is currently found at the site, although scattered juniper can be observed approximately ½ mile east of the site. The pinyon and juniper charcoal suggests that the environment at the time of occupation may have been slightly different than it is today. Based on the charcoal recovered, it is likely that the site was located at the transition between pinyon-

juniper woodland and shrubland (more like the habitat surrounding LA 45961). It would take only a slightly wetter climate to allow pinyon and juniper to occupy the habitat at LA 50460. The presence of a transitional pinyon-juniper woodland/shrubland would be more consistent with the numerous artifacts and bones related to hunting recovered from the site. Open sagebrush shrubland is not very productive habitat for deer or other large mammals, whereas the transition woodland/shrubland zone often supports large deer populations as well as greater numbers of birds and small mammals.

In summary, the data from these two sites suggest that recovery of identifiable plant materials from Archaic sites requires the sampling of large volumes of soil. Ten liters per feature proved minimal for recovery of material from LA 50460. The removal of the entire contents of features such as pits and hearths may be necessary to acquire statistically valid samples. Another problem is contamination. LA 50460 contained large numbers of uncarbonized Indian ricegrass seeds. This species, although present in the area, is not abundant on the site. The presence of this apparent contaminant raises the question as to how old this contamination might be, and how long such seeds may persist in a site. Since bio-mixing appears to be a significant problem in many Archaic sites, reference surface samples should be collected to document the existing seed and foliar materials in the A-horizons of the soil. These materials can be compared with suspect modern remains recovered from the floats to ascertain if the contamination corresponds with existing flora. If the material is not modern (as evidenced by differences between the surface samples and the float samples), the contaminants themselves could be of sufficient age (perhaps hundreds of years) to provide additional data on changes through time in the vegetation on site. This information would be useful in the analysis of other, later sites which might occur in the area.

The results of this study imply that a more extensive methodology of flotation sample collection should be implemented when dealing with Archaic sites that appear to have poor preservation. Without such vigorous methods, only fragmentary data can be expected from these sites.

Pollen Analysis

by Jannifer Gish

Seven pollen samples were evaluated from two archaeological sites, LA 45961 and LA 50460, located near Counselors Trading Post in northwest New Mexico. The samples from LA 45961 were recovered from a pit feature associated with the early site component. This component was dated to the late Archaic period, 620 to 80 BC. Samples obtained from LA 50460 were recovered from charcoal-stained cultural sediments in both the East and West proveniences. Radiocarbon analyses indicate that both components date to the early Archaic period. The goals of the pollen study were to provide information about the past environment, plant use, and activities at the two sites.

Both sites are situated in shrub-dominated scrubland vegetation, or Great Basin desertscrub as classified in Brown (1982). Common shrubs at or near the sites include big sagebrush *(Artemisia tridentata)*, rabbitbrush *(Chrysothamnus nauseosus)*, greasewood *(Sarcobatus vermiculatus)*, four-wing saltbush *(Atriplex canescens)*, snakeweed *(Gutierrezia sarothrae)*, and wolfberry *(Lycium pallidum)*. Scattered pinyon *(Pinus edulis)* and juniper *(Juniperus monosperma)* trees occur at LA 45961 but are locally absent at LA 50460. Ponderosa pines *(Pinus ponderosa)* are present at higher elevations in the region, but not near either site. Cholla cactus *(Opuntia imbricata)* grows at both sites, and prickly pear cactus *(Opuntia phaecantha)* also occurs at LA 50460. Numerous species of grasses and a variety of herbaceous plants are common locally and regionally.

Processing and Analysis Techniques

The seven pollen samples were processed chemically at Texas A & M University. In brief, the samples were treated with hydrochloric acid to remove carbonates, and hydrofluoric acid to remove silicates, followed by zinc bromide flotation (specific gravity 2.00) to separate organic materials from inorganic heavy minerals. The polliniferous residues were then subjected to acetolysis (nine parts acetic anhydride to one part sulfuric acid). Distilled water rinses were repeatedly used as appropriate during the processing, with glacial acetic acid rinses preceding and following acetolysis. Treatments with potassium hydroxide completed the chemical steps. The residues were rinsed several times with distilled water, then stained with safranin, dehydrated in alcohol, and transferred to one-dram glass vials for preservation in glycerine.

Two tablets of *Lycopodium* tracer spores were added to each sample during the chemical processing in order to calculate the concentration of pollen per milliliter of soil. Each tablet contained about 13,500 spores. Pollen concentrations were calculated from the following formula:

$$\frac{\text{total spores added} \times \text{pollen count}}{\text{sample volume} \times \text{total spores in the count}}$$

Identifications of the pollen grains were made at 400× magnification under a binocular research microscope. The botanical nomenclature used for the pollen taxa designations, and elsewhere in this report, primarily follows Kearney and Peebles (1960). All seven samples yielded counts of combined arboreal and nonarboreal pollen (AP and NAP), although preservation was better at LA 45961 than LA 50460. Five samples yielded counts of 200 grains, but the pollen sums in two subsurface samples from LA 50460 were limited to 100 grains and 50 grains (Samples 7 and 5, respectively). The pollen results are expressed as percentages in Table 26.

After the counts were completed, the slide for each sample was scanned at 100× to detect additional large-pollen taxa that were not observed during the counts. Taxa observed in scanning are indicated by an "X" on Table 26. The most notable observations in scanning for this study were the maize pollen grains in the two subsurface samples from LA 45961.

Pollen aggregates also were recorded. These are clumps of the same pollen type that can have environmental or ethnobotanic implications. From an environmental perspective, aggregates can reflect the proximity of source plants and, therefore, local or regional vegetation. This is the case even for wind-pollinated plants, because pollen aggregates do not loft as effectively as disaggregated grains. From an ethnobotanic perspective, aggregates can reflect cultural introduction of plant parts into contexts and, therefore, utilized plants. To avoid over-representation of any particular taxon, aggregated occurrences are tallied as single grains in the actual pollen counts. The aggregates also are listed separately at the bottom of Table 26. The designation "a" signifies one aggregate, and "b", two to five aggregates. The number, as in "Ar-2b", indicates the largest aggregate recorded in the count; in this case, only 2 grains. In general, aggregates were quite small in these samples, although a few larger ones of 15 and 16 grains were seen in scanning. These are designated by parentheses on Table 26. Only the largest aggregate is listed, because the aggregates are relative to the total number of pollen grains on the slide, not the number of grains in the count.

Pollen Results

In the following discussion, LA 45961 is considered first, then LA 50460. Each surface pollen record is described, and then evaluated as an analog for the modern vegetation at the site. The subsurface records are then described and evaluated in terms of their environmental and ethnobotanic implications.

LA 45961

At LA 45961, a surface control sample (Sample 2) and two samples from a food-processing or food-storage pit were studied. Sample 4 was collected from the middle fill of the pit and Sample 3 from the basal fill.

The surface pollen record is dominated by sagebrush pollen with pinyon-type pine and juniper pollen of secondary value (Table 26). The Cheno-Am category is represented by a moderate value, followed by the Low- and High-Spine Compositae taxa. Among the NAP, other categories are represented by values of 3.5% (grass family) or less. Greasewood and prickly pear cactus *(Platyopuntia)* pollen are some of the notable occurrences. Among the AP, other taxa also are represented by values of 3.5% (ponderosa-type pine) or less.

This pollen record correlates fairly well with the modern vegetation at or near the site. The

Table 26. Pollen Results from LA 45961 and LA 50460

	LA 45961			LA 50460			
Site Area					East	East	West
Feature or Grid Unit	—	Pit	Pit	—	F-11	G-11	H-34
FS Number	2	4	3	1	5	6	7
Context	surface	fill	base	surface	fill near FCR	fill near metate	fill
Depth below present surface (cm)	0–1	140–150	190	0–1	30–40	35	60
Spore Count	8	25	67	7	123	141	149
Pollen Concentration	33750	10800	4030	38571	549	1915	906
Arboreal Pollen							
Abies (Fir)	X						
Picea (Spruce)	X			X	2.0	0.5	
Pseudotsuga (Douglas-fir)	X						
cf. *Pinus edulis* (Pinyon-type)	17.5	1.5	6.5	14.0		5.5	1.0
cf. *P. ponderosa* (Ponderosa-type)	3.5	0.5	1.0	2.5		0.5	
Pinus (Pine fragments/3)	1.5		0.5	1.5	2.0	0.5	1.0
Juniperus (Juniper)	16.0	6.0	4.0	12.5	10.0	2.0	3.0
Quercus (Oak)	1.0	1.0		0.5		0.5	
Nonarboreal Pollen							
Low-spine Compositae (Ragweed group)	10.5	13.5	10.0	9.5	16.0	16.0	22.0
High-spine Compositae (Sunflower group)	8.5	6.5	5.5	4.0	10.0	6.5	6.0
Artemisia (Sagebrush)	22.5	45.5	52.0	33.0	24.0	33.0	42.0
Cheno-Am (most goosefoot family plus amaranth)	11.5	22.0	16.5	13.5	20.0	27.5	20.0
Sarcobatus (Greasewood)	0.5			1.0	2.0		2.0
Gramineae (Grass family)	3.5	2.0	2.5	4.0	6.0	3.5	1.0
cf. *Ephedra nevadensis* (Joint-fir)	0.5			1.0			
cf. *E. torreyana* (Joint-fir)	0.5	1.0					
cf. *Acalypha*						0.5	
cf. *Euphorbia* (Spurge-type)			0.5				
cf. *Gilia* (Gilia-type)	1.0			X			
cf. *Eriogonum* (Wild buckwheat-type)			0.5	1.5		0.5	
Platyopuntia (Prickly pear)	0.5			0.5			
Zea (Maize)		X	X				
Unidentified	0.5	0.0	0.0	0.0	2.0	1.5	1.0
Indeterminate	0.5	0.5	0.5	1.0	6.0	1.5	1.0
Total Grains Counted	200	200	200	200	50	200	100

	LA 45961			LA 50460			
Site Area					East	East	West
Feature or Grid Unit	—	Pit	Pit	—	F-11	G-11	H-34
Aggregates	(Ped-15)	Ch-6a	Ar-3a	Ar-2a	—	Ju-2a	—
a - 1	Ar-2a		Gr-2a			Lo-2a	
b - 2 to 5	(Ar-8)				Ar-2b		
	(Ch-16)					Ch-4a	

Abbreviations: Ar - *Artemisia* Gr - Gramineae Lo - Low-Spine Compositae
Ch - Cheno-Am Ju - *Juniperus* Ped - *Pinus edulis*-type

prevalence of sagebrush is well reflected in the pollen rain, as is the local presence of saltbush, which is subsumed in the Cheno-Am category. The on-site distribution of greasewood shrubs is not strongly evident in the pollen count, but a 0.5% value was recorded. The High-Spine Compositae taxon includes snakeweed and rabbitbrush. Plants in the Low-Spine category were not noted as being present at the site, but many are common elements in scrubland communities. The pollen representations of other herbaceous plants and the grass family also are consistent with natural components of scrubland plant communities.

The occurrence of prickly pear cactus pollen implies some presence of these plants in the site vicinity, although they were not noted in the floristic description of the site. The cacti are insect- or self-pollinated, and the pollen does not commonly make its way into the soil where cacti grow, even when the plants are abundant. A surface pollen sample subsumes an unknown number of years of pollen rain. Perhaps prickly pear cacti were present at the site previously, with some residual pollen still on the surface.

Among the AP, both the pinyon-type pine and juniper values coincide with the scattered presence of these conifers in the site vicinity. The much lower ponderosa-type pine value testifies to the greater distance to source plants. Ponderosa pine trees are wind-pollinated, so the pollen can blow into a locality from substantial distances.

Most of the pollen categories that are well represented in the surface record also subsume wind-pollinated plants. This includes all the arboreal taxa, and the Low-Spine Compositae, sagebrush, and Cheno-Am categories among the NAP. Other wind-pollinated NAP taxa are greasewood, the grass family, and joint-fir. Wild-buckwheat-type subsumes both wind-pollinated and insect- or self-pollinated plants. The remaining NAP taxa are insect- or self-pollinated. Wind-pollinated categories can reflect pollen influx from regional and extra-regional, and local, source plants. When moderate to high values, or large or abundant aggregates, of such taxa are recorded, however, local source plants are implied. Insect- or self-pollinated categories mostly reflect pollen influx from local plants. Overall, the proportions of the pollen categories in the surface record for LA 45961, and the taxa variety, correlate very well with the modern vegetation at the site. Consequently, the record provides a good analog for evaluating the subsurface records.

Both of the subsurface records are dominated by sagebrush pollen. The Cheno-Am values also are somewhat higher than in the surface sample.

Arboreal pollen values are correspondingly suppressed. Maize pollen was recorded in both of the pit samples, in scanning (Table 26).

The maize pollen clearly reflects cultural activities, as maize has been domesticated to the point that the plants cannot survive outside cultivation. Given the presence of maize, it is possible that the values of other taxa represented in the two records are also influenced by cultural activities. The sagebrush, Cheno-Am, and grass categories are possibilities (note aggregates in one or both records). Perhaps branches or greens (herbage) from plants represented in these taxa were used as lining and layering materials in the pit to protect maize that was processed or stored in the feature. Direct use of edible plant parts also could be reflected. Sagebrush fruits and seeds, and the greens and seeds of many chenopodiaceous plants, and seeds of many grasses, are all edible (Kirk 1970:141, 56–63, and 177–189). On the other hand, the higher NAP values might be natural. If so, they would suggest greater predominance of scrubland vegetation at the site in the past, with only regional, but no local, presence of arboreal conifers. It is difficult to identify which of these scenarios explains the higher NAP values in the subsurface records. Perhaps a combination of influences is evident. Still, the use of maize is clearly demonstrated.

Other potential economics could be sagebrush, chenopods, and grasses. Even a larger variety of utilized plants could be represented. Joint-fir, for example, can be used for tea, and wild buckwheat produces edible seeds (Kirk 1970). These and other categories, however, also reflect plants that commonly occur naturally in scrubland communities. In the absence of high values and/or large or abundant aggregates, use of the plants is not inferred. The most certain economic plant at LA 45961, then, is maize. This implies activities in the site vicinity during late spring/early summer, summer, and fall for the planting, maintenance, and harvest of a crop. Such activities could have been conducted on an intermittent basis; continuous use of the site location throughout the growing season is not necessarily indicated.

LA 50460

At LA 50460, a surface control sample (Sample 1) and three samples from charcoal-stained levels in the fill of the site were evaluated. Two of the subsurface samples were collected from the east part of the site: Sample 5 was associated with fire-cracked rock, and Sample 6 was adjacent to a metate. Sample 7 was collected from general cultural fill in the west part of the site.

The surface pollen record is dominated by sagebrush pollen with pinyon-type pine and juniper pollen of secondary value (Table 26). A moderate value of Cheno-Am pollen was recorded, followed by Low-Spine Compositae. Among the NAP, other categories are represented by values of 4.0% (High-Spine Compositae group and the grass family) or less. Greasewood and prickly pear cactus *(Platyopuntia)* pollen are some of the notable occurrences. Among the AP, other taxa are represented by values of 2.5% (ponderosa-type pine) or less.

This pollen record correlates only partly with the modern vegetation at, or near, LA 50460. The predominance of sagebrush at the site is well reflected in the pollen record, as is the presence of other shrubs such as saltbush (included in the Cheno-Am category) and snakeweed (included in the High-Spine Compositae taxon). Rabbitbrush also occurs nearby and is another source for the High-Spine Compositae pollen. The 1.0% value of greasewood pollen coincides with the presence of greasewood shrubs near the site. To this extent, then, the NAP representations correspond closely to the modern abundances of shrubs at or near the site. With respect to the arboreal taxa,

however, the values of pinyon-type and juniper pollen are higher than one would expect given the local absence of these arboreals in the vicinity of the site. The arboreal values actually are comparable to those at LA 45961 where both pinyon and juniper were present in the modern vegetation. At LA 50460, on the other hand, the nearest junipers are on low rises one-half mile from the site, while the nearest pinyon trees are even farther away. The surface pollen record at LA 50460, then, has a more mixed aspect of local and regional source plants. Hence, it is a fairly weak analog for addressing the environmental implications of the subsurface pollen record.

Two of the three subsurface samples are dominated by sagebrush pollen (Table 26). In Sample 6, the Cheno-Am category is secondary to sagebrush, followed by Low-Spine Compositae pollen. In Sample 7, the Low-Spine Compositae and Cheno-Am categories are comparable and secondary to sagebrush. Sample 5 exhibits less than 5.0% difference between the values of sagebrush and Cheno-Am pollen. A moderate value of Low-Spine Compositae pollen also was recorded in Sample 5. The High-Spine Compositae and grass categories are consistent in all three records, with values ranging from 6.0 to 10.0% for the composite taxon and 1.0 to 6.0% for grass. Other NAP taxa are represented by values of 2.0% or less. The arboreal pollen values appear suppressed relative to the NAP categories in the three samples. Juniper values vary from 2.0 to 10.0%, with pinyon-type pine values from 1.0 to 5.5%. No pinyon-type pine pollen was recorded in Sample 5, but this record might be somewhat skewed owing to the scarcity of pollen in this sample, as reflected by the low pollen sum of only 50 grains. Other AP taxa in the three samples are represented by values of 2.0% or less.

These three subsurface samples from LA 50460 are strongly indicative of a sagebrush-dominated scrubland plant community. Probably saltbush and greasewood also were present locally, in addition to sagebrush. This plant community is comparable to the modern vegetation at the site. As noted above, the surface pollen record from this site exhibited higher arboreal pollen values than are consistent with scrubland vegetation. The surface record reflected a mix of local and regional pollen and is not a strong analog for correlating vegetation and pollen rain. Hence, although the three subsurface samples differ sharply from the surface sample, the contrast in pollen rain does not imply a difference in vegetation. Rather, the subsurface pollen samples, together with the description of the modern plant community at the site, suggest lengthy continuity in the vegetation at this locality.

No diagnostic ethnobotanic taxa were represented in the three subsurface samples from LA 50460. Consequently, the kinds of plants that might have been utilized at the site were not apparent in the pollen results.

Conclusions

The palynological results provided information about the vegetation and environment at both sites, and some insight into the kinds of plant use and activities at LA 45961, but not at LA 50460. Both sites seem to have been characterized by sagebrush-dominated scrubland vegetation. This scrubland probably was similar to the shrub-dominated vegetation that existed at both sites at the time of the excavations. Given the middle Archaic age of LA 50460, and late Archaic age of LA 45961, substantial continuity is indicated for the vegetation in the study region.

Diagnostic ethnobotanic pollen taxa were not identified at LA 50460. At LA 45961, however, maize pollen was recorded in the two samples from a pit. This pit could have been used for

processing or storing maize, which reflects a late summer or fall activity. The planting of maize, however, implies lengthier occupation at the site. Activities at LA 45961 would have occurred from late spring/early summer to late summer or fall. The planting, maintenance, and harvest of a maize crop could have been conducted on an intermittent basis by periodic visits to the site and do not necessarily imply continuous use of the locality for an entire growing season. The site dates to about 620 BC to 80 BC (2570–2033 BP). The presence of maize is consistent with findings at other late Archaic sites in northwest New Mexico. At LA 61838 and LA 61896 near La Plata, for example, maize pollen was recorded in structures dating to the En Medio phase (800 BC to AD 400) (Gish 1991:684). Even this minimal comparison provides some insight into the picture of late Archaic subsistence practices on a broader scale. LA 61838 and LA 61896 are located about 70 miles from LA 45961. Hence, the maize pollen at LA 45961 further documents the widespread nature of maize farming in northwest New Mexico and the greater Four Corners area by the late Archaic period.

Chapter 11

Archaeofaunal Analysis

by Marie E. Brown and Kenneth L. Brown

Vertebrate faunal remains, consisting of 514 specimens, were recovered from LA 50460 (Table 27). The archaeofaunal assemblage is attributed to the early Archaic period based on the radiocarbon dates of 7670 BP ± 130, 7460 BP ± 180, and 7090 BP ± 190. The discussion commences with a description of the research methods. This is followed by brief summaries of the natural histories of the specifically identified taxa. Then the archaeofaunal assemblage is examined to discern faunal patterns based on four site proveniences (West Provenience Surface and Levels 1 and 2a–2b; West Provenience Level 2a; West Provenience Level 2b; and the East Provenience). Lastly, conclusions are presented.

Research Methods

The faunal identifications were made by Kenneth L. Brown with the aid of comparative specimens in his possession. Occasionally, published osteological references were consulted. All of the vertebrate faunal remains recovered from LA 50460 were examined. No sampling was conducted. Refits were determined and fresh breaks were mended whenever possible to increase identification and maximize processing information. In addition, all freshly broken fragments from the same bone in a single provenience unit were counted as one specimen. This and the refits reduced the sample size. Basic information recorded for each specimen—a complete bone or tooth or a fragment thereof—included the taxon, element, side, fragmentation and portion, weathering, burning, gnawing, and evidence of butchering and working.

Taxonomic identifications were made only to the lowest level of specificity (e.g., order, family, genus, species) warranted by each specimen. As a result, many specimens were identified only to a size category (e.g., small mammal, large mammal). Very small mammals are mouse-size; small, rabbit-size; medium, coyote-size; and large, deer-size. The placement of a specimen into a size category was based primarily on the thickness of the compact (cortical) bone, the size of the specimen, and the possible element represented. In several instances, the specific taxonomic identification—genus or species—was uncertain because of the presence of two or more osteologically similar species in the project area. In such cases, only the listing of alternatives (e.g., coyote/dog, deer/pronghorn) was possible.

After the variables were recorded and entered into the computer, MNIs (minimum number of individuals) were calculated for the archaeofaunal assemblage. Both minimum and maximum MNI are presented. The minimum type considers the site's assemblage as a whole and assumes that all specimens of a specific taxon could represent the same individual, regardless of provenience unit (assuming that the number of specimens of a particular element does not exceed the number in an individual). The

Table 27. Vertebrate Faunal Remains from LA 50460

	West						East		Total	
	Surface, Levels 1 and 2a–2b		Level 2a		Level 2b					
	n	MNI	n	MNI	n	MNI	n	MNI	N	MNI*
Sylvilagus audubonii (Desert cottontail)			1	1	14	1			15	2
Lepus californicus (Black-tailed jackrabbit			1	1	30	1			31	1
Cynomys gunnisoni (Gunnison's prairie dog)	2	1			16	2	2	1	20	2
Thomomys bottae (Botta's pocket gopher)					16	2			16	2
Perognathus sp. (Pocket mouse)			1	1					1	1
Dipodomys sp. (Kangaroo rat)	1	1	1	1					2	1
Canis latrans/C. familiaris (Coyote/Dog)	1	1			1	1			2	1
Odocoileus hemionus (Mule deer)	10	1	2	1	10	1			22	2
Odocoileus/Antilocapra americana (Deer/Pronghorn)	5	1	10	1	34	-			49	
Mouse-size mammal			3	-	2	-			5	
Deer-size mammal	108	-	48	-	169	-	26	-	351	
Total	127	5	67	6	292	8	28	1	514	12

*Minimum MNI based on total assemblage

maximum type considers the site's assemblage according to provenience units and assumes that specimens of a specific taxon from different provenience units represent different individuals. In this study, the calculation of MNIs only considered taxon, element, side, portion, and age, which was based on the degree of bone fusion, tooth eruption and wear, and porosity—overall ossification—of bone specimens. The bones of very young mammals are distinctly spongier—less ossified—than those of adults.

Natural History

The following are brief descriptions of the natural history of identified faunal genera and species.

Mammalia–Mammals

Family Leporidae (Rabbits, Hares)

Sylvilagus audubonii (Desert Cottontail)

Desert cottontail *(Sylvilagus audubonii)* remains occur in two of the four site proveniences (West Levels 2a and 2b). Of the three cottontail species known in New Mexico, the desert cottontail is the most widespread, occurring throughout the state (Bailey 1931:54; Findley et al. 1975:89). It is found primarily at elevations below the coniferous forests, in the Lower and Upper Sonoran zones (Bailey 1913:18, 33; 1931:54). It inhabits deserts, grasslands, brushy areas, pinyon-juniper woodlands, and riparian zones. The desert cottontail also frequents cultivated fields and the dense vegetation adjoining such

fields. Brush or shrubs are necessary for resting and hiding (Bailey 1931:54–60; Chapman and Willner 1978:2–3; Clark and Stromberg 1987:80; Findley 1987:57; Zeveloff 1988:92). The desert cottontail subsists mainly on grasses, forbs, cacti, and shrubs (Bailey 1931:55–56; Chapman and Willner 1978:3; Chapman et al. 1982:102). Cultivated plants, including corn, are also eaten (Bailey 1931:55–56; Chapman et al. 1982:101). Much of the cottontail's water requirements are provided by its food (Bailey 1923:71–72; Chapman et al. 1982:102; Findley 1987:57; Zeveloff 1988:92).

Predation by a variety of animals—bobcats, coyotes, foxes, raccoons, skunks, raptors, snakes—is the major cause of cottontail deaths and it is the primary regulator of cottontail abundance (Chapman et al. 1982:106–107; Clark and Stromberg 1987:78–79; Ingles 1941:236; Zeveloff 1988:88, 92). The cottontail, however, is an r-selected mammal. Its high mortality rate is offset by a high reproductive rate. Breeding generally occurs from mid- or late winter through late summer. A female may have as many as six litters per year (Chapman et al. 1982:94; Clark and Stromberg 1987:78, 81; Findley 1987:57–58; Hoffmeister 1986:131, 137; Zeveloff 1988:93).

Lepus californicus (Black-tailed Jackrabbit)
Black-tailed jackrabbit *(Lepus californicus)* remains were identified in two of the four site proveniences. The black-tailed jackrabbit is the only jackrabbit that occurs in the project area. It is also the most common jackrabbit in New Mexico, occurring throughout the state below the ponderosa forest zone (Findley 1987:55; Findley et al. 1975:93–94). This leporid is usually found at elevations below 6,000 ft (1,829 m), in the Lower and Upper Sonoran zones (Bailey 1913:18, 33; 1931:48). It inhabits deserts and open shortgrass prairies with scattered shrubs. In addition, this jackrabbit is very adaptable to agricultural conditions. Areas of heavy brush or woods are avoided (Dunn et al. 1982:133; Findley 1987:54–55; Findley et al. 1975:93–94; Hoffmeister 1986:140–141; Zeveloff 1988:98). "They are found in mesquite, sagebrush, desertscrub, into open pinyon-juniper" (Hoffmeister 1986:141). The black-tailed jackrabbit is most common, however, in open, treeless habitats (Findley 1987:55).

The jackrabbit usually feeds at night on grasses, mesquite, and herbs. Cultivated crops are also consumed. This leporid, like the cottontail, depends on succulent or green vegetation for water. Surface water, however, is drunk when available. The breeding season extends from mid- or late winter to late summer. A female may have as many as seven litters per year. Because the black-tailed jackrabbit is an r-selected species, the yearly number and size of litters per breeding female help to offset the high mortality rates. Jackrabbit predators include snakes, eagles, hawks, owls, coyotes, foxes, bobcats, and skunks (Clark and Stromberg 1987:87; Dunn et al. 1982; Findley 1987:56; Hoffmeister 1986:141–142; Zeveloff 1988:99–100).

Family Sciuridae (Squirrels and Allies)
Cynomys gunnisoni (Gunnison's Prairie Dog)
Three of the four site proveniences also contain identified remains of the Gunnison's prairie dog *(Cynomys gunnisoni),* an Upper Sonoran species (Bailey 1913:32, 1931:120, 127). This prairie dog inhabits open plains and desert grassland areas where the soil is compact and well drained (Cockrum 1982:84). It lives in smaller colonies than the black-tailed prairie dog. Colonies of Gunnison's prairie dogs may contain as few as three or four to as many as 50 individuals. Burrows average about 1 m deep and may interconnect with adjacent burrows (Findley 1987:68; Hoffmeister 1986:196–197). Water requirements are provided by the consumed plants (Bailey 1931:128). The burrowing activities of prairie dogs can severely impact

buried cultural deposits if their colonies are established in a buried site. The potential for faunalturbation is great.

Family Geomyidae (Pocket Gophers)

Thomomys bottae (Botta's Pocket Gopher)
Botta's pocket gopher *(Thomomys bottae)* was identified in one of the four site proveniences (Table 27). This rodent occurs in a variety of habitats, from dry deserts to mountain meadows and from loose sands and silts to compact clays. It is widely distributed in the grassy areas of the desert and is found at elevations ranging from sea level to 11,000 ft. Many vegetation zones are included within this elevation range (Findley et al. 1975:144–145; Hoffmeister 1986:223; Zeveloff 1988:164–165). The pocket gopher subsists on a wide variety of herbaceous plants, grasses, bulbs, tubers, roots, and cacti. It also consumes crops (Chase et al. 1982:250; Findley 1987:75–76; Hoffmeister 1986:223-225; Zeveloff 1988:161, 165).

The pocket gopher lives a solitary life almost entirely underground. Depending on soil conditions, burrow systems can vary from less than 30 cm to more than 1 m in depth (Hoffmeister 1986:224). The main tunnel has been measured to depths of 1.5 m below the surface (Felthauser and McInroy 1983:557). Feeding tunnels parallel the surface and average between 10 and 30 cm in depth (Chase et al. 1982:246; Findley 1987:75; Hoffmeister 1986:225; Zeveloff 1988:161, 165). Because the pocket gopher is highly fossorial, it mixes and deepens the soil. A single individual can displace one to three tons or more of soil annually (Kennerly 1964:428; Richens 1966:533). Consequently, the impact of faunalturbation on the cultural deposits of archaeological sites yielding remains of this burrower should be considered. Recent research has focused on the effects of pocket gopher burrowing activities on the distribution of archaeological materials (Bocek 1986, 1992; Erlandson 1984; Johnson 1989).

Family Heteromyidae (Kangaroo Rats, Pocket Mice)

Perognathus sp. (Pocket Mouse)
Remains of the pocket mouse *(Perognathus* sp.) were identified in one of the four site proveniences (Table 27). The project area is within the ranges of two pocket mouse species (Findley et al. 1975:160, 165). The silky pocket mouse *(P. flavus)* inhabits deserts, grasslands, and juniper woodlands. It is found in sagebrush-cactus associations. Although it occurs on a variety of soils, dry, sandy to loamy, loose, friable soils are preferred for its shallow burrow system which consists of various tunnels and side chambers (Clark and Stromberg 1987:131–132; Findley 1987:79–80, 84; Findley et al. 1975:159–160; Hoffmeister 1986:272; Zeveloff 1988:172–173).

The Plains pocket mouse *(P. flavescens)* lives in sandy deserts and grasslands (Findley et al. 1975:164–165; Zeveloff 1988:169). It has been recorded, however, "in well-developed pinyon-juniper woodlands, on rocky, brushy hillsides, and in other such atypical places; it was not restricted to sandy soil" (Findley et al. 1975:164). This species also occurs along the margins of grainfields. Burrows are shallow, paralleling the surface at a depth of 15 to 20 cm. Although its diet consists primarily of seeds, the pocket mouse also eats insects and cultivated grains (e.g., wheat, oats) (Bee et al. 1981:111–112; Findley 1987:79–80, 84; Jones and Birney 1988:180; Zeveloff 1988:169–170).

Because pocket mice are small and nocturnal, their presence in the assemblages is considered intrusive. They may have been attracted to food storage areas where they were killed as pests. The pocket mouse was probably an unlikely food source except during times of severe food stress.

***Dipodomys* sp. (Kangaroo Rat)**
Kangaroo rat specimens were identified in two of the four site proveniences (Table 27). Two kangaroo rat species occur in the project area. The Ord's kangaroo rat *(Dipodomys ordii)* is found throughout New Mexico (Cockrum 1982:101; Findley et al. 1975:175). It is a solitary, nocturnal, desert-dwelling burrower that lives in a variety of habitats. In the northern portion of the Southwest, it lives in open pinyon-juniper areas and in areas just below this zone. It occurs on alluvial fans, on flats, and in shifting sands. This rodent prefers friable soils, especially sand (Bee et al. 1981:117–118; Clark and Stromberg 1987:137–139; Findley et al. 1975:174; Hoffmeister 1986:298–299; Zeveloff 1988:181–182).

The banner-tailed kangaroo rat *(Dipodomys spectabilis),* which occurs throughout most of New Mexico (Cockrum and Petryszyn 1992:184; Findley et al. 1975:181), inhabits arid and semiarid grasslands. Because of the complexity and depth of its burrow system, it prefers heavy soils (Bailey 1931:262; Findley 1987:82–83; Findley et al. 1975:180–181; Hoffmeister 1986:306; Zeveloff 1988:186). "Large mounds, composed of soil and vegetation, up to 4 feet high and 15 feet wide, surround the burrows" (Zeveloff 1988:186).

Family Canidae (Dogs, Coyotes, Wolves, Foxes)
Canis latrans/Canis familiaris (Coyote/Dog)
Canid remains were recovered from two of the four site proveniences (Table 27). The genus *Canis* is potentially represented in these archaeofaunal assemblages by two species. The dog *(Canis familiaris)* is closely associated with humans. Based on a radiocarbon date of about 8400 BC, the earliest known domestic dog remains in North America are from Jaguar Cave, Lemhi County, Idaho (Lawrence 1967:44, 1968:43). "Since dogs were domesticated from an Old World, not a New World stock, and since the remains discussed are of a small animal with typical dog characters, domestication must have taken place at a considerably earlier date" (Lawrence 1967:44). When humans entered North America by way of the Bering Strait, they were accompanied by their dogs, which were probably the first domesticated animals. The domestic dog probably descended from the wolf *(C. lupus).*

> The wolf has perfected hunting habits that would not have been lost on early human hunters who observed their game-getting practices. Both wolves and humans were pack, or team, hunters early on, and it is likely that these similar tactics for obtaining prey were influential in bringing about the initial stages of association between the two species. This hunting association and the fact that both hominids and large canids have mutually compatible social organizations eventually led to taming and, ultimately, to domestication (Olsen 1985:xi).

Prehistoric dog remains in North America are assigned to at least four size categories: a large wolflike northern form; the Plains Indian dog (known in the Southwest as the large Pueblo dog); the small, short-faced Pueblo dog; and the small, long-faced Pueblo dog (Allen 1920:503; Olsen 1974:343, 1985:35). As recorded by Solis in the 1760s (1931:61), the Caddo had hybrid dogs, called *jubines,* that were mixtures of dogs and coyotes or wolves.

The canid remains from LA 50460 appear to be coyote-size specimens. The coyote *(C. latrans)* is found throughout the Southwest where it occupies a wide range of habitats. "Broken country, interrupted by rocks, brush, clumps of pinyon-juniper or other vegetation, makes excellent habitat for coyotes" (Hoffmeister

1986:462). Dens are usually dug in the ground. Brush-covered slopes, riverbanks, and rock ledges serve as den sites. Hybrids have been reported between the coyote and the domestic dog. Much of the coyote diet consists of rabbits, rodents, and carrion, but birds, deer, sheep, juniper berries, cactus fruit, and insects are also eaten (Bee et al. 1981:165; Cockrum 1982:24; Findley et al. 1975:281–282; Hoffmeister 1986:462–464; Zeveloff 1988:248–249).

Family Cervidae (Deer, Wapiti [Elk])
Odocoileus hemionus (Mule Deer)
Definite deer (*Odocoileus hemionus*) remains were recovered from three of the site proveniences (Table 27). The mule deer, a browser, is found at all elevations and in a variety of habitats—brushy and wooded areas, broken country, and open plains. It inhabits the Upper Sonoran, Transition, and Canadian zones (Bailey 1913:32, 43, 47). As a result, deer consume a varied diet. In the northern portion of New Mexico, the mule deer lives in the yellow pine forest or in the spruce-fir zone from early spring until early winter when it moves down into the pinyon-juniper zone. It is a browser that feeds mainly on oak, juniper, pinyon, cliffrose, bitterbrush, fir, ponderosa pine, and aspen. When grazing, mule deer prefer forbs over grasses. Cultivated crops are also consumed (Bee et al. 1981:220–221; Cockrum and Petryszyn 1992:164; Findley 1987:140–141; Findley et al. 1975:328–329; Hoffmeister 1986:542–543; Zeveloff 1988:326–327).

Family Antilocapridae (Pronghorn)
Antilocapra americana (Pronghorn)
No pronghorn *(Antilocapra americana)* remains were identified in the archaeofaunal assemblage from LA 50460; however, several deer/pronghorn elements occur in three of the four site proveniences. Although pronghorn formerly occurred throughout the Southwest, intensive hunting greatly reduced their numbers by the early 1900s. Since that time, however, they have been expanding within their former range. Pronghorn were once almost as numerous as bison. They inhabit arid and semi-arid grasslands, subsisting on browse such as sagebrush, buckbrush, and rabbitbrush. Prickly pear cacti, forbs, grasses, and cultivated crops are also eaten. Most, or all, of the necessary water is obtained from the plants consumed. Pronghorn congregate in large herds (e.g., 100 individuals) during the winter but disperse into smaller groups in the spring. The pronghorn uses its great speed (up to 60 miles per hour) to elude predators such as bobcats and coyotes (Findley 1987:144–145; Findley et al. 1975:333–334; Hoffmeister 1986:549, 551–552; Jones et al. 1985:318; Zeveloff 1988:334–336).

The Archaeofaunal Assemblage

As stated previously, the archaeofaunal assemblage is divided into four provenience units: West Provenience Surface and Levels 1 and 2a–2b; West Provenience Level 2a; West Provenience Level 2b; and East Provenience.

West Provenience Surface and Levels 1 and 2a–2b

Four taxa—prairie dog, kangaroo rat, coyote/dog, and deer—occur in this provenience (Table 28). The prairie dog is represented by an adult right femur and calcaneum. The femur is eroded, like most of the assemblage, indicating it is probably associated with the prehistoric occupation. The kangaroo rat is represented by a complete but eroded adult sacrum. The dog/coyote is represented by a right distal radius shaft of an adult. The shaft is eroded. The radius is similar in size to that of a coyote or medium-size dog.

The deer is represented by the greatest number and variety of elements. The only meat-yielding

Table 28. Faunal Remains from LA 50460 West Provenience (Surface, Level 1, and Level 2a–2b)

Taxon	Element	Side	Charred	Calcined	Weight (g)	Notes
Cynomys gunnisoni	Femur	Right				adult
	Calcaneum	Right				adult
Dipodomys sp.	Sacrum	Axial				adult
Canis latrans/C. familiaris	Radius	Right				adult
Odocoileus hemionus	Scapula	Right				
	Lunate	Right				
	Main metacarpal	Right				
	Main metatarsal	Right				
	Ischium	Right				
	Femur, proximal	Left				
	Calcaneum	Left				
	Astragalus	Left				
	1st phalange	Left				
Odocoileus/Antilocapra americana	Tooth fragment					
	Radius	Right				
	Main metacarpal			1		
	Astragalus	Left				
	3rd phalange					
Deer-size mammal	Caudal vertebra	Axial				
	46 long bone fragments		11		28.18	mean = 0.6126
	62 miscellaneous fragments		1		19.73	mean = 0.3182

elements are a right scapula fragment, a right ischium fragment, and a proximal left femur shaft. The remaining elements are all from the lower front and hind legs (i.e., metapodials, lunate, calcaneum, astragalus, and first phalange). The lower limb elements represent primary butchering refuse. The scapula, ischium, and femur fragments probably represent secondary butchering or food refuse.

Deer/pronghorn specimens include a cranial and lower front and hind limb elements. The metacarpal fragment is calcined, indicative of disposal in an extremely hot fire. These skeletal elements are low-meat-yielding and probably represent initial butchering refuse. Prairie dog, kangaroo rat, and dog/coyote are each represented by one individual, and deer and deer/pronghorn are also represented by one individual each (Table 28).

This provenience has a low frequency of identified elements (15%). This low frequency and the splintered condition of many of the deer-size fragments strongly suggest fractioning of long bones for marrow extraction. The occurrence of only one burned specimen, a calcined deer/pronghorn metacarpal fragment, and the large size of the bone fragments indicate bone refuse was not generally discarded into fires or processed for grease.

Table 29. Faunal Remains from LA 50460, West Provenience (Level 2a)

Taxon	Element	Side	Calcined	Weight (g)	Notes
Sylvilagus audubonii	Innominate	Right			carnivore gnawed
Lepus californicus	Humerus	Right			
Peragnathus sp.	Scapula	Left			
Dipodomys sp.	Innominate	Right			
Odocoileus hemionus	Lower M_1M_2				
	Radius	Left			adult
Odocoileus/Antilocapra americana	3 cheek teeth				
	6 scapula fragments				
	Metapodial, distal condyle				
Mouse-size mammal	Cervical vertebra	Axial			
	Femur shaft	Left			
	Long bone fragment			0.09	
Deer-size mammal	17 long bone fragments		1	14.94	mean = 0.8788
	31 miscellaneous fragments			11.31	mean = 0.3648

West Provenience Level 2a

Five taxa—cottontail, jackrabbit, pocket mouse, kangaroo rat, and mule deer—occur in West Provenience Level 2a (Table 29). The cottontail is represented by a right innominate fragment (the acetabulum with portions of the ilium, ischium, and pubis). The innominate exhibits carnivore damage, a single puncture on one side probably produced by a raptor. The specimen is similar to that illustrated and described by Hockett (1991) during a study of raptor-damaged leporid bones from the Great Basin. The uneroded condition of the innominate also indicates the specimen is not associated with the Archaic occupation. Jackrabbit is represented by an eroded right humerus fragment. The pocket mouse is represented by a left scapula fragment. The specimen is not eroded, indicating it may not be associated with the Archaic component. The kangaroo rat is represented by an eroded nearly complete right innominate. Mule deer elements include a lower first or second molar fragment and a proximal left radius fragment. The latter's articular end is fused. Deer/pronghorn specimens include cheek teeth, scapula fragments, and a metapodial distal condyle. Cottontail, jackrabbit, pocket mouse, kangaroo rat, mule deer, and deer/pronghorn are each represented by one individual (Table 29).

The bone distribution for Level 2a is similar to that for the provenience described above. The West Provenience Level 2a collection has a low frequency of identified specimens (24%). This frequency, in addition to the splintered condition

of many of the deer-size fragments, strongly suggests the long bones were processed for marrow extraction. The occurrence of only one burned specimen, a calcined long bone fragment, and the large size of the bone fragments indicate bone refuse was not discarded in fires or processed for grease.

West Provenience Level 2b

Level 2b in the West Provenience yielded the largest portion of the faunal assemblage ($n = 292$, 57%). Six taxa—cottontail, jackrabbit, prairie dog, pocket gopher, dog/coyote, and mule deer—were identified in the West Provenience Level 2b sample (Table 30). Cottontail is represented by a cranium with teeth, a right maxilla without teeth, an innominate fragment, and a left femur. The innominate exhibits carnivore damage, a single depression on one surface probably produced by a raptor (cf. Hockett 1991). Jackrabbit is represented by a cranium with teeth, right and left articulated mandibles with teeth that probably articulate with the cranium, a lumbar vertebra, and a right tibia fragment. Both mandibles exhibit damage probably inflicted by a raptor. The puncture pattern is similar to that identified by Hockett (1989) during a study of leporid remains from southern California. Cottontail and jackrabbit are each represented by one individual. The condition of the leporid specimens suggests they are intrusive.

Prairie dog is represented by a maxilla without teeth, an auditory bulla, two left mandibles with teeth, two left innominate fragments, and a left tibia fragment. Pocket gopher elements include a cranium without teeth, a premaxilla with teeth, a left maxilla with teeth, a right maxilla with teeth, and a left mandible with teeth. Prairie dog and pocket gopher are each represented by two individuals and are considered intrusive.

Dog/coyote is represented by the distal end of a right humerus. Mule deer elements include a left scapula, right humerus and radius, left cuneiform, three metacarpal fragments, a right cuboid, and first and second phalanges. With the exception of the scapula and humerus, the specimens represent low-meat-yielding elements of the lower limbs and feet and are indicative of primary butchering refuse. The scapula and humerus probably represent secondary butchering or food refuse. Deer/pronghorn elements also include mostly cranial and lower limb portions that are low-meat-yielding. Meat-yielding specimens include a right humerus. The refuse pattern is similar to that of the identified mule deer specimens. The only burned element is a calcined third phalange. Dog/coyote and mule deer are each represented by one individual (Table 30).

This provenience has a high frequency of identified elements (58.6%), suggesting fewer long bones were broken to remove marrow. Most of the specimens from this provenience appear to be either intrusive leporids and rodents or initial deer butchering refuse. The paucity of burned specimens and large fragment sizes indicate few bones were discarded into fires or processed for grease.

East Provenience

Prairie dog, the only identified taxon in the East Provenience (Table 31), is represented by a single nearly complete right humerus. The proximal epiphyseal end is unfused, indicating an immature individual. The specimen is eroded and is probably associated with the Archaic component.

This provenience has a low frequency of identified elements (7%). This low identifiability, in addition to the large size of the deer-size bones, indicates the long bones were probably processed for marrow extraction. Although there

Table 30. Faunal Remains from LA 50460, West Provenience (Level 2b)

Taxon	Element	Side	Charred	Calcined	Weight (g)	Notes
Sylvilagus audubonii	Cranium with teeth	Axial				
	Maxilla without teeth	Right				
	Innominate	Left				adult, carnivore gnawed
	Femur	Left				adult
Lepus californicus	Cranium with teeth	Axial				adult
	Mandible with teeth	Right				adult
	Mandible with teeth	Left				adult
	Lumbar vertebra	Axial				
	Tibia	Right				
Cynomys gunnisoni	Maxilla without teeth	Right				
	Auditory bulla	Right				
	2 mandibles with teeth	Left				
	2 innominates	Left				
	Tibia	Left				
Thomomys bottae	Cranium without teeth					
	Premaxilla with teeth	Right				
	Maxilla with teeth	Left				
	Maxilla with teeth	Right				
	Mandible with teeth	Left				
Canis latrans/C. familiaris	Humerus, distal	Right				
Odocoileus hemionus	Scapula	Left				
	Humerus	Right				
	Radius	Right				
	Cuneiform	Left				
	2 main metacarpals					
	Main metacarpal	Right				
	Cuboid	Right				
	1st phalange	Left				
	2nd phalange	Left				
Odocoileus/Antilocapra americana	Mandible without teeth	Right				
	17 cheek teeth					
	Upper cheek tooth					
	Humerus	Right				
	Radius	Right				
	Scapholunar fragment					
	4 main metapodial fragments					
	Main metacarpal					
	Tibia, distal	Right				
	1st phalange	Left				
	2nd phalange					
	2nd phalange	Left				

Taxon	Element	Side	Charred	Calcined	Weight (g)	Notes
	2nd phalange	Right				
	3rd phalange	Right		1		
	Long bone				3.55	
Mouse-size mammal	Lumbar vertebra	Axial				
	Long bone				0.24	
Deer-size mammal	104 long bone fragments		7	5	59.79	mean = 0.5749
	64 miscellaneous fragments			1	16.61	mean = 0.2595

Table 31. Faunal Remains LA 50460, East Provenience

Taxon	Element	Side	Charred	Calcined	Weight (g)	Notes
Cynomys gunnisoni	Ulna	Right				immature
Deer-size mammal	14 long bone fragments		2	1	12.61	mean = 0.9007
	12 miscellaneous fragments		1	1	2.81	mean = 0.2342

are more burned specimens (3 charred, 2 calcined) in the East Provenience compared with the other proveniences, there is little evidence to indicate the bone was processed for grease.

Small vs. Large Mammal Exploitation

One recurring pattern among the four sample groups involves the large versus small mammalian remains. This early Archaic assemblage appears to contain more remains of deer-size taxa (Table 32). As previously indicated, many of the mouse- and rabbit-size remains appear to be intrusive. In terms of frequency of deer-size remains, the four areas are, in descending order, West Provenience Surface and Levels 1 and 2a–2b; West Provenience Level 2a; West Provenience Level 2b; and the East Provenience (Table 32). The West Provenience Level 2b sample has the highest percentage of identified elements. The predominance of deer-size compared to rabbit-size faunal remains suggests a greater reliance on larger herbivores during the early Archaic period. This pattern is believed to shift toward a greater reliance upon rabbit-size game during the later Archaic and Anasazi periods.

Conclusions

Excavations at LA 50640 yielded 514 vertebrate faunal specimens from four proveniences. The identified taxa are indicative of primarily grassland, desertscrub, scrubland, and pinyon/juniper environments. All identified taxa are mammalian, and all were available locally. The presence of low- and high-meat-value elements in the assemblage supports this conclusion. These remains represent butchering debris and food refuse generated from complete carcasses of small and large game brought to the site. The predominance of deer-size remains indicates large herbivores, principally deer, were a primary source of meat. The paucity of burned specimens indicates butchering and food refuse was not usually discarded into fires.

Table 32. Very Small, Small, Medium, and Large Mammal Remains from LA 50460

	West						East		Total	
	Surface, Levels 1 and 2a–2b		Level 2a		Level 2b					
	n	%	n	%	n	%	n	%	N†	%
Very small, Mouse-size		0.0	4	6.0	2	0.7		0.0	6	1.2
Small, Rabbit-size	3	2.4	3	4.5	76	26.1	2	7.1	84	16.3
Medium, Coyote/Dog-size	1	0.8			1	0.3			2	0.4
Large, Deer-size	123	96.8	60	89.5	213	72.9	26	92.9	422	82.1
Total	127	100.0	67	100.0	292	100.0	28	100.0	514	100.0

† minimum MNI based on total site assemblage

The eroded and pitted condition of most of the assemblage indicates an environment that was not conducive to the preservation of organic remains. A few leporid and rodent remains lack severe erosion, suggesting they are not associated with the early Archaic occupation.

Calculation of minimum MNI based on the total site assemblage and maximum MNI based on the four different sample areas yielded quite different results. Total minimum MNI is 12 and maximum MNI is 20 (Table 28). The taxon that shows the greatest difference between the two MNI types is prairie dog, with a minimum MNI of 2 and a maximum MNI of 4. Taxa not exhibiting substantial differences include cottontail, pocket gopher, and pocket mouse. Given the large body size, the minimum MNI of 2 and maximum MNI of 3 for mule deer indicates this taxon provided the greatest share of food of all the identified taxa. The small quantities of leporids and rodents indicate their minor contributions to the diet, or they may be intrusive. The absence of reptilian and avian taxa and the contribution of mule deer in the assemblage indicate this early Archaic occupation represents a specialized short-term camp site in which the inhabitants focused on procurement of mule deer. The absence of bone implements also reflects a short-term specialized encampment.

Chapter 12

Discussion

by Michael P. Marshall

Lithic Material Types

Nonlocal Material Types

The presence of nonlocal lithic material types in archaeological sites helps identify the distance and range of resource exploitation or trade contacts. Nonlocal lithic material types that occur in the NM 44-North sites include Jemez Mountain obsidian from the Polvadera and Valle Grande sources and traces of chert from the southern Chuska Mountains. The presence of nonlocal lithic material in Archaic sites has been suggested to be a possible measure of hunter-gatherer mobility under the premise that most raw materials are collected during subsistence related movements as documented ethnographically for hunter-gatherer populations (Vierra 1994:121). However, certain exotic materials with limited or unique distributions may have been the subject of special expeditions or mining activities, well outside the normal range of hunter-gatherer populations, and exotic materials were often traded for considerable distances.

Obsidian from the Jemez Mountain sources at Polvadera (El Rechuelos) and Valle Grande is relatively common in Archaic sites in the San Juan Basin. Obsidian from both sources was found at LA 45961 and LA 50460. In contrast, Grants Ridge and Horace Mesa obsidian materials (Shackley 1998) occur only in traces in the eastern San Juan Basin (Elyea 1999:9), and none was found in the NM 44-North samples. Obsidian from the San Antonio source in northern New Mexico (Shackley 1995) has not been identified in the San Juan Basin.

Archaic sites in the San Juan Basin have a decidedly higher incidence of obsidian than Anasazi sites, which is considered to be a reflection of the greater mobility and range of Archaic populations. A marked decrease in the presence of Jemez obsidian in the late Archaic period Armijo and En Medio phases in the San Juan Basin is believed to indicate a shift in mobility patterns, perhaps reflecting an increase in the sedentism of populations involved in early maize agriculture (Vierra 1994:125–127).

The relative frequencies of obsidian materials within the NM 44 sites are presented in Table 33. The percentages of obsidian at LA 50460 (19.1%) and LA 45961 (36.1%) are rather high in comparison with other eastern San Juan Basin sites. In a recent study of sites along the MAPCO pipeline in the eastern San Juan Basin, only 3% of the total Archaic assemblage was obsidian. However, the San Pedro phase site San Luis de Cabezon (LA 110946) contained 12.9% obsidian, and the highest incidence of obsidian material (18.9%) at a site in this region was found at LA 25851, another MAPCO site. The relatively high incidence of obsidian at LA 50460 and especially LA 45961 indicates that both populations had frequent access to the Jemez Mountain uplands

which could have been within their seasonal round or range.

Note that the frequencies of obsidian at LA 50460 and in the upper and lower levels of the West Provenience are similar whereas there is a smaller incidence of obsidian in the East Provenience. This difference is consistent with other attributes and with the radiocarbon dates, which substantiate that the East Provenience is a distinct temporal component.

Both Valle Grande and Polvadera (El Rechuelos) materials occur at LA 45961 and LA 50460. The Polvadera source is 80 km west-southwest of LA 50460 and 88 km west-southwest of LA 45961. The Valle Grande source is 65 km southwest of LA 50460 and 73 km southwest of LA 45961. The obsidian was either collected as part of the seasonal round when the populations frequented the Jemez Mountain uplands or they were collected during special expeditions to the area which would have required a few days. The mining of obsidian from the Jemez Mountain sources was probably within the seasonal range or logistical collection zone of populations in the eastern San Juan Basin.

Because of its excellent siliceous properties, obsidian was often traded and has been found at great distances from its source. In Arizona, materials have been found in archaeological contexts up to 270 km from the source (Shackley 1985). Occasional Jemez Mountain obsidian has been found in Paleoindian sites in the Llano Estacado, 500 km southwest of the source, and a single Eden point of Polvadera obsidian was found at a site in Wyoming. Obsidian artifacts from the Jemez Mountain area have also been found in Archaic sites in southeastern Utah and at Arrenosa Shelter in Val Verde County, Texas (Baugh 1997:253, 255). Jemez Mountain obsidian has also been found in protohistoric sites in Wyoming, Kansas, and Texas.

Table 33. Obsidian in the NM 44-North Sites

Assemblage	% Obsidian
LA 50460	
Entire Sample	19.2
West Provenience	21.3
West Prov., Level 2a	19.1
West Prov., Level 2b	20.2
East Provenience	12.6
LA 45961, Late Component	36.1
LA 119580	None

It is clear that the high-quality obsidian materials in the LA 45961 and LA 50460 assemblages were selected for the manufacture of formal tools. Indeed, 5 of the 10 projectile points from LA 50460 are obsidian. Most of the obsidian materials in both collections are biface flakes and microdebitage that is the result of biface tool manufacturing.

In the LA 50460 collection, 66.4% of the obsidian materials are either biface flakes or microdebitage. Obsidian core flakes are infrequent (20%), and no obsidian cores were found. This is a reflection of the distance from the source. Primary reduction of the materials undoubtedly occurred at the source, and bifaces and preforms were transported for further reduction and use elsewhere. In contrast, local lithic materials appear to have been the subject of primary reduction on or near the NM 44 sites. Core flakes represent 53% of all other (nonobsidian) material types at LA 50460. A similar pattern is evident in the LA 45961 collection where obsidian biface flakes and microdebitage represent 68% (66 of the 97 specimens) whereas biface flakes and microdebitage of all other material types (36 of 172 specimens) represent only 20.9% of the samples.

Table 34. Chipped Stone Material Types (Percentages)

Material Type	LA 50460		LA 45961	LA 119580
	West	East	Late Component	
Orthoquartzite	36.4	50.0	8.6	13.3
Silicified Wood	31.9	34.2	16.3	13.3
Chalcedony	5.4	2.5	25.7	73.3
Chert	5.0		11.1	
Obsidian	21.3	12.5	36.1	
Quartzite	Trace		1.4	
Washington Pass		0.8	0.7	

Chert from the southern Chuska Mountains is rare in Archaic sites in the eastern San Juan Basin. In the MAPCO pipeline project, which crossed the eastern basin, only two sites (LA 25864 and LA 18426) contained traces of the Chuska material (Elyea 1999). Similar traces of chert were found in the NM 44-North sites. The distance to the Chuska Mountain source from the NM 44-North sites is approximately 125 km. One specimen (a core flake) was found at LA 50460 (0.2% of the sample of 569 chipped stone specimens) and two specimens (a core and biface flake) were found at LA 45961 (0.7% of the sample of 268 chipped stone artifacts). The incidence of Chuska chert increases in the southwest portion of the San Juan Basin nearer the source, especially in Anasazi sites west of Chaco Canyon.

Local Material Types

Local chipped stone materials constitute 78.7% of the LA 50460 West Provenience assemblage, 86.7% of the LA 50460 East Provenience assemblage, 63.1% of the LA 45961 assemblage, and 100% of the LA 119580 assemblage. Most of the local materials are probably available in gravel deposits that occur in the general project area (Table 34).

The gray-tan orthoquartzite has been identified in the Cuba Member of the San Jose Formation. A quarry for this material is located in the lower Largo Canyon (Vierra 1995:123), and it probably occurs over a wide area in the Largo drainage system. Orthoquartzite is the predominant material in the LA 50460 collection, but it occurs with only minor frequencies at LA 45961 and LA 119580. The East and West components of LA 50460 have relatively high frequencies of orthoquartzite and silicified wood and a low incidence of chalcedony. The chert found in the West Provenience (21 pieces of debitage) contrasts with the absence of chert in the East Provenience. As noted elsewhere, obsidian occurs in a much higher frequency in the West Provenience than in the East Provenience. In general, the obsidian in the West Provenience displaced the use of orthoquartzite; the highest incidence of orthoquartzite in the NM 44-North samples is in the East Provenience.

The chipped stone from the late component at LA 45961 is dominated by nonlocal obsidian and local chalcedony. Chalcedony and chert are much more common than in the LA 50460 sample, and there is significantly less orthoquartzite and silicified wood. The acquisition and selection of

raw materials for chipped stone tools at LA 45961 are clearly different than at LA 50460. The higher frequencies of chalcedony and chert at LA 45961 are more consistent with the general pattern of Anasazi material type use than they are with the typical Archaic (Vierra et al. 1983:65) and may be a reflection of the considerably later temporal affiliation of the late component at LA 45961, which is believed to have been during the late Archaic–early Formative period.

The frequencies of material types at LA 119580 have little statistical significance since only 15 artifacts are represented in the collection. However, all of the materials at this limited activity area were obtained from local sources.

Projectile Point Typology

LA 50460

Nine projectile points were recovered from the LA 50460 excavation: eight from the West Provenience and one from the East Provenience. Also present in the collection is a single point which was found on the surface. The projectile points include a rather mixed assemblage of stemmed–concave base and corner-notched forms (Figure 23). Three radiocarbon samples obtained from the site date both components to the sixth millennium BC. Dates of this age in the San Juan Basin are normally associated with projectile points of the Jay and Bajada types. However, most of the projectile points from LA 50460 show no similarity to the early Jay and Bajada forms of the Oshara Tradition. The projectile points recovered from LA 50460 are, instead, a mixed collection of a concave base–parallel stemmed form and corner-notched types with expanding stems and concave bases.

Two of the projectile points from LA 50460 (L-52 and L-53) have concave bases and short parallel stems resembling San Jose types. However, none of the specimens exhibit basal edge grinding, which is considered to be a distinctive attribute of San Jose materials. Three points exhibit blade edge serrations that are common on San Jose forms. However, two of these forms are corner-notched with concave bases, unlike San Jose types. One point (L-55) has fine serrations measuring 6 per centimeter and two points (L-51 and L-53) have coarse serrations measuring 4 per centimeter.

Six of the points from LA 50460 have straight or convex bases and are corner-notched forms that have characteristics similar to Armijo or perhaps Elko types. Two have straight parallel stems with concave bases (L-52 and L-53) which are more similar to San Jose types.

A few of the points from LA 50460 exhibit some similarity to the Pinto and Elko types of the Great Basin area which have been dated in Utah at Cowboy Cave and Sudden Shelter to the sixth and seventh millennia BC. Pinto and Elko types were found in the lowest strata of Sudden Cave, dating to 7900–6800 BP (Jennings et al. 1980), and Elko points in association with Northern Side-notched types were found in strata at Cowboy Cave dating to 7200–6300 BP (Schroedl and Coulam 1994). Similar projectile points appear to be associated with the Desha complex in northern Arizona, which is dated to 7700–7200 BP (Lindsay et al. 1968).

Northern Side-notched points (including types known as Sudden Side-notched and San Rafael types) have been identified in the San Juan Basin and surrounding areas (Acklen 1993; Baker and Winter 1981; Beckett 1973; Hogan et al. 1991; Turnbow 1997, and others). In many instances, these side-notched points have been identified as Chiricahua types (Moore 1991, and others). However these points are typically more similar to the Sudden Side-notched and San Rafael Side-notched types (Acklen et al. 1997:306) than to

the Chiricahua type as it was identified at Bat Cave (Dick 1965:27). Associated dates for Northern Side-notched points in New Mexico are infrequent, but evidence suggests a wide span between 5450 and 1750 BP (Acklen et al. 1997:306). None of these distinctive side-notched projectiles were recovered from the NM 44 excavations, but the type has been found at the nearby Nageezi Divide site (Marshall 1985:45).

It is curious that the projectile point sample from LA 50460 exhibits such a mixed collection of attributes which makes placement into existing typologies somewhat difficult. Certainly the assemblage is not a typical Oshara Tradition sample, but it is also far from being a typical collection of Great Basin or Northern Plateau points. In the San Juan Basin, most of the Archaic period sites have been assigned to the Oshara Tradition. However, Cochise, Great Basin, and Northern Plateau materials have also been recognized. In terms of the Oshara Tradition, the best typological fit for the LA 50460 sample is the San Jose and Armijo phases, which date primarily within the third and fourth millennia BC, two thousand years after the radiocarbon dates obtained from LA 50460. In terms of the Great Basin–Northern Plateau cultures, there is some similarity to Pinto and Elko materials, which are more consistent with the site's sixth millennium BC dates.

The radiocarbon dates obtained from LA 50460 were all from carbonized wood taken from the sediments in direct association with the projectile points. There is no evidence to suggest that the carbon material predates the occupational horizon or that any other type of sample error occurred. All three dates establish the occupation in the sixth millennium BC during what is normally considered in the San Juan Basin to be the Jay and early Bajada phase horizon. However, it is clear that the projectile point assemblage, with its mixed traits of concave and convex bases, stemmed and corner notched forms, and serrated or unserrated blades, in no way resembles the Jay or Bajada projectile point types. It is also of interest that none of the points exhibit the basal grinding that is typical of early Oshara phase assemblages. For the present, no definite conclusions can be made regarding this assemblage, but the possibility that stemmed-serrated and corner-notched points occur in the San Juan Basin at a much earlier date than previously recognized should be entertained (see Chapter 13).

LA 45961

Four projectile point fragments were recovered from LA 45961, all from surface contexts (Figure 25). Two points observed during the 1997 survey were small corner-notched points. Both of the points that were recovered during the excavations were also from surface contexts and represent blade fragments of larger types. The small corner-notched specimens appear to be arrow points, suggesting an association with the late component and indicating an occupation during the late Archaic–early Formative period. No radiocarbon dates were obtained from the late component at LA 45961, but the two arrow points from this aceramic site indicate that it was occupied after the introduction of the bow and arrow but presumably before the local manufacture of ceramics (ca. 100 BC to 400 AD).

LA 50460 Faunal Assemblage

Excavations at LA 50460 yielded a relatively large sample of faunal remains considering the antiquity and the open and exposed nature of the site. A sample of 486 specimens (95% of the site sample) was obtained from the West Provenience and 28 (5% of the site sample) were found in the East Provenience. Bones from the excavation area in the West Provenience outnumber the

chipped stone artifacts! This is most unusual for an open Archaic period site in the San Juan Basin and indicates rather intensive hunting-butchering activity. The high incidence of bone at the site cannot be attributed to especially good preservation since many of the bone elements from this shallow eolian deposit are splintered and heavily eroded. Therefore, the West Provenience deposits probably reflect a hunting encampment where numerous animals were butchered.

In the West Provenience, the majority of the faunal remains (81%) were found in Level 2b. Since the site had experienced considerable bioturbation, all of the material is believed to be associated with a single site occupation and preservation seems to have been better in the lower deposits.

The great majority of faunal remains from LA 50460 are deer or deer-size mammals (82.1%), whereas mouse-size (1.2%), rabbit-size (16.3%), and coyote/dog-size (0.4%) mammals are uncommon. Many of the smaller mammal bones are in good condition and appear to be of intrusive, postoccupational, origin. However, a few small mammal bones are eroded and may be associated with the occupation. None of the smaller mammal bones is charred, although 22 large mammal bones (5.2%) are burned.

The predominant taxa in the collection are mule deer and deer-size mammals. Nonetheless, a few smaller mammals, including prairie dog, dog/coyote, cottontail rabbit, and jackrabbit, also appear to be associated with the site occupations.

Many of the large mammal bones from LA 50460 are in splintered condition, suggesting that the long bones were broken for marrow extraction. Since only 15 bones are charred and 3 calcined, it is evident that few of the bones were discarded into fires. Meat-yielding elements from large mammals include scapula, ischium, and femur. The high incidence of non-meat-yielding elements, including lower limb bones, suggests that butchering took place on or near the site. Primary butchering refuse would have been discarded rather than been transported to LA 50460 if the kill sites were at a considerable distance. This assemblage reflects a bulk large mammal transport situation rather than a selected or "gourmet" transportation type (Binford 1978), suggesting that the animals were hunted in the site's vicinity.

It is clear that the occupants of the West Provenience and to a lesser degree those of the East Provenience concentrated on hunting mule deer and deer-size mammals. This contrasts with most Archaic sites in the San Juan Basin that contain a predominance of smaller mammals, principally rabbits (Elyea 1999), even in the earliest Archaic horizons in the area such as the Jay sites on Gallegos Mesa (Wiens 1994:67). The high incidence of rabbit bones in the San Juan Basin Archaic faunal assemblages is considered by some to be evidence that rabbit drives were common (Vogler et al. 1993:134).

In most San Juan Basin Archaic sites, smaller species constituted the bulk of the meat in the diet. In contrast, the high incidence of mule deer and deer-size mammals at LA 50460 suggests a specialized deer-hunting encampment. Such sites are usually found at higher elevations (Holloway et al. 1997:127) and may have been part of a seasonal round of fall-winter hunting in the mountains and plant gathering during the spring and summer in the lowlands (Matson 1991).

The occurrence of a large-mammal-dominated assemblage in a relatively low elevation site (6725 feet) such as LA 50460 is unusual. Mule deer (*Odocoileus hemionus*) are indigenous to the area today, as are antelope, and they may have been more abundant in the area during the site

occupation. Mule deer tend to congregate in the Lower Montane habitat (ponderosa forest) in the summers and move down into the pinyon-juniper zone in the winter months (Osborn 1993). If the high incidence of deer remains at LA 50460 reflects this pattern, the site would be considered a winter hunting encampment.

Maize Agriculture

Excavations at LA 45961 encountered a storage or roasting pit at a depth of 1.0 m below the present ground surface. This isolated pit is the only evidence found of the early component at LA 45961. The pit (Figure 17) was 90 cm in depth and the fill contained fragments of carbonized wood, maize, and Cheno-Am seeds. Radiocarbon analysis of charcoal in the pit fill yielded a date of 2030 BP ± 120 (80 BC), while fragments of carbonized maize dated to 2570 BP ± 120 (620 BC). The rather significant difference in the wood and maize dates suggests some type of sample error. However, it is clear that maize was stored or roasted in the pit during the late Archaic period.

Evidence of maize cultivation first appears in Southwestern Archaic sites by about 4500 to 3500 BP (Huckell 1996:343). Radiocarbon dates for maize at Bat Cave of 4300 BP were reported by Herbert Dick in 1965. However, subsequent work at Bat Cave suggests a more recent 3200 BP (1250 BC) affinity (Berry 1985; Wills 1988). Agriculture as a part of the Archaic subsistence base appears to have been well established within the San Pedro phase (ca. 3500–2000 BP) over a large area of northern Mexico, southern Arizona, and south-central New Mexico. Associated with San Pedro sites are numerous bell-shaped storage pits and occasional habitation structures that indicate an incipient sedentary-village organization.

A summary of early maize radiocarbon dates in Archaic sites in the southeast San Juan Basin and Rio Puerco Valley by Elyea (1999) revealed a span of maize dates from 3755 BP (1805 BC) to 1523 BP (AD 427). However, the presence of maize in most late Archaic sites in the area remained infrequent until approximately 200 BC (Elyea 1999). The majority of the sites where early maize has been identified are San Pedro phase affiliated. This suggests that intrusive San Pedro phase populations from the south introduced maize agriculture into the region.

Evidence of early maize cultivation was recently identified at the San Luis de Cabezon site (LA 110946) in the Rio Puerco Valley near San Luis (Bargman et al. 1999). This site yielded abundant evidence of maize in association with six radiocarbon dates ranging from 1265 to 1805 BC. This San Pedro phase site demonstrates that maize agriculture was practiced by populations in the vicinity of the San Juan Basin as early as 3755 BP (1805 BC). The site is also of interest in that it contains numerous shallow habitation structures, various storage and roasting pits, and hearths. The presence of these habitation and storage pits in association with maize suggests that the occupants of the San Luiz de Cabezon site were early farmers and foragers rather than mobile hunters and gatherers.

Maize cultivation in the San Juan Basin, based on the presence of maize pollen in Archaic sites in the Cañada Alemita–Chaco Canyon area, appears to have been practiced as early as 2000 to 1700 BC (Simmons 1986). However, maize agriculture does not appear to have been a common practice until the En Medio phase at about 500 BC (Hogan 1985; Vogler et al. 1993:229).

The corn recovered from the pit at LA 45961 yielded a radiocarbon date of ca. 620 BC, providing further evidence that maize agriculture

was becoming an important part of the late Archaic subsistence adaptation in the San Juan Basin. Unfortunately, this pit appears to have been an isolated storage structure, probably located adjacent to a nearby field, and no diagnostic artifacts were found in association.

Maize agriculture appears to have been an important part of the early Formative period economy in the northern San Juan drainage during the first to fourth centuries AD, as is evident in the aceramic early Los Pinos phase and the Durango Basket Maker II sites (Dittert et al. 1961:213; Morris and Burgh 1954:48–49). Maize from aceramic storage pits in the lower Largo Canyon drainage yielded a date of AD 110 ± 85 (Marshall 1985:139).

Archaic Habitations

Habitation structures consisting of shallow basin pits have been identified at various Archaic sites in the Southwest and are usually interpreted to be winter encampments or shelters associated with early agriculture. Habitations consisting of shallow pits with central hearths and dating to the early Archaic period have been identified in Utah and Colorado. Three structures found in Cowboy Cave in Utah have been dated to 6300–7200 BP (Schroedl and Coulam 1994). Archaic habitations in the San Juan Basin and surrounding area are first recognized in the San Jose phase (Irwin-Williams 1973).

Archaic structures that have been identified as winter habitations have been found in the Jemez, Rio Puerco, and Ceja Mesa areas on the southeast edge of the San Juan Basin. They have yielded radiocarbon dates ranging from 4740 BP (2790 BC) to AD 427. Many of these structures have been identified as San Pedro phase sites. However, one San Jose phase structure at LA 109137 on the MAPCO pipeline and one structure of San Rafael phase affinity (LA 65522) in the Macbeth Land Exchange have also been identified. These structures range from 2.5 to 5.0 m in diameter and are shallow basins 8 to 12 cm in depth. Many exhibit post holes marginal to the basins and a few have hearths and outside door middens (Bargman et al. 1999: Table 2).

A number of middle and late Archaic period pitstructures, 2.0 to 4.5 m in diameter, have been recently excavated in the Rio Grande Valley near Bernalillo and have yielded dates as early as 4500–3500 BP (Schmader 1996).

Seven middle Archaic habitation structures were recently identified at a San Pedro phase site (LA 110946) in the Rio Puerco Valley near San Luis (Bargman et al. 1999). These structures ranged from 2.0 to 3.5 m in diameter and from 12 to 40 cm in depth. Radiocarbon dates obtained from the structures, many of which also contained evidence of maize, ranged from 2990 ± 70 BP to 3540 ± 80 BP (1050 to 1590 BC). These structures probably represent multicomponent use of the site area, but their presence in conjunction with maize suggests the beginnings of seasonal sedentism in the area. Actual villages consisting of multiple pit rooms and apparent permanent habitations came much later. However, there is some evidence to suggest that permanent pithouse villages with large community pitrooms were inhabited along major drainages in northern New Mexico by about 100 BC. A preceramic pithouse village partially excavated at the Montano Bridge site in the Rio Grande Valley near Albuquerque (Gossett and Gossett 1988; O'Leary and Biella 1986) yielded radiocarbon dates of ca. 100 BC in association with arrow points.

One possible habitation was identified at LA 50460 in the NM 44-North project area. This apparent structure (Feature 1) is a shallow basin that measures 2.0 by 3.0 m and 50 cm in depth.

The basin is filled with charcoal-stained soil. Radiocarbon dates from carbonized wood in the area of the structure suggest a sixth millennium BC affinity. The charcoal stain is most concentrated in the lower section of the basin. There is no evidence of a defined floor, hearth, or walls. However, this feature is located in sandy soil and it is unlikely that the structural details of a brush shelter would be preserved. It is not possible to state with any confidence that the feature is a habitation. However, it is clear that brush shelters and small pithouses were constructed in the early Archaic period and were probably used at most winter encampments.

Ground Stone

The presence of ground stone is a hallmark of the Archaic period and cultural adaptation in the Southwest and contrasts with the apparent absence of such material in Paleoindian sites. One-hand manos and slab metates have been identified in sites of the Ventana complex of southern Arizona by 8500 BP and may occur as early as 9500–8700 BP (Huckell and Haynes 1995). The presence of ground stone in Archaic sites reflects a foraging subsistence economy which is reliant, to various degrees, on grass seeds and other grains. Ground stone materials may be absent or infrequent in certain Archaic site types where emphasis was placed on hunting or other specialized activities. There is often a lower incidence of ground stone on Archaic sites at higher elevations that may have functioned as hunting camps and stations (Hudspeth 1997b: 131–132).

The preliminary definition of the Oshara Tradition in northwest New Mexico (Irwin-Williams 1973) noted that ground stone was absent from Jay and Bajada phase assemblages. However, excavations of Jay phase components on Gallegos Mesa revealed a consistent association of ground stone: 75% of the sites have ground stone in quantities of 2.3% to 15.8% of the lithic assemblage (Vogler et al. 1993:133; Wiens 1994:67).

Most of the ground stone artifacts found in Southwestern Archaic period sites consist of slab and slab-basin metates and one-hand cobble manos. There is no evidence to suggest any major morphological shift in ground stone tools in the Southwest concurrent with the introduction of agriculture. However, the flatter slab types appear to outnumber slab-basin forms during the earlier Archaic horizons (Dick 1965:108).

Ground stone artifacts recovered from the NM 44-North excavations included slab metates, slab-basin metates, one-hand cobble manos, and shaped triangular or sub-triangular slabs of unknown function. The East Provenience of LA 50460 yielded 12 specimens with a density of 0.85 specimens per cubic meter of fill and representing 9.0% of the lithic assemblage. The West Provenience contained 21 specimens, with a density of 0.50 specimens per cubic meter and representing 0.5% of the lithic assemblage. The sample from LA 45961 consisted of 3 specimens or 0.63 per cubic meter of fill, which represents 1.1% of the lithic sample. The highest incidence of ground stone in the East Provenience of LA 50460 was in association with a high density of fire-heated stone.

Archaic Site Types and Settlement System

A series of models has been proposed which outline possible patterns of Archaic hunter-gatherer land use and mobility in the San Juan Basin area. Most of these models employ or refer to ethnographic information and research regarding the regional use of space by modern or ethnohistorically documented hunter-gatherer populations. Hunter-gatherer land use and

mobility patterns were defined by Binford (1982) and applied to the San Juan Basin Archaic settlement system by Vierra (1994). The area utilized by a hunting-gathering band as it shifts locations on a seasonal or available resource basis is known as the *annual range*. The annual range in ethnographic terms can extend from 450 to 13,000 square miles depending on the nature of the subsistence base or available resources. Annual ranges may shift if local resources are depleted or groups are forced to relocate because of environmental change or group competition. These shifts in annual range may be cyclical or serial and are referred to as the *extended* or *overall territory*.

Binford (1982) summarized the basic demographic and land-use patterns of hunting-gathering bands, noting that the *residential base* is where the group resides and is the focus for subsistence activities during the seasonal use of a specific area. The immediate area surrounding this residential base is the *foraging zone,* which is the area that is covered on a daily basis from the base camp. Outside the foraging radius is the *logistical zone,* in which task-specific groups travel and camp for short or long periods depending on the nature of the resources being exploited. Beyond the logistical zone is the *extended* or *visiting zone* to which longer-term expeditions are made for the purpose of gathering nonlocal materials, trade, or monitoring resource availability in case a change in annual range is anticipated.

Archaic land use patterns in the San Juan Basin are generally believed to have involved a seasonal shift from the basin lowlands in the spring-summer to uplands on the margins of the basin during the late fall and winter (Elyea and Hogan 1983; Huckell 1996). The spring and summer occupations were oriented toward the collection of various small-seed annuals, grasses, and cacti (Toll and Cully 1983) and the hunting of small mammals, mostly rabbits, on the basin floor. The late fall–winter occupations in the pinyon-juniper zone were situated to utilize pinyon nut, juniper seed, and acorn crops and for hunting large mammals and collecting firewood for winter heating. Seeds cached in subsurface storage pits were probably retrieved from summer gathering sites and carried to winter encampments for use. Winter occupations may have included habitations and rockshelters and may have been of longer-term use than lowland summer occupations. Winter occupations could also have involved encampments along major river systems and riparian habitats within the desert basin (Moore 1980; Whalen 1994; Wills 1988). In the San Juan Basin, travel from summer to winter ranges may have only involved 10 to 20 km, but the spatial discontinuities in resource distribution and abundance may have required much greater distances into areas that were on the margins of or outside the basin. The frequent presence of obsidian on San Juan Basin sites has been suggested to be an indicator of Archaic group range (Vierra 1994). However, such material could have been obtained by expeditions outside the normal foraging and logistical zones into extended or visiting zones. Obsidian could also have been traded by Jemez Mountain bands to more distant groups in the San Juan Basin.

In an attempt to explain Archaic hunter-gatherer land use and mobility, two models have been proposed. One is described as *central-based collecting* (Vogler et al. 1993:328) and the other is *serial foraging* (Vierra 1980; Hogan 1985). Land use in the central-based collecting model would have involved the occupation of large seasonal base camps established by bands near water sources and in areas of high vegetative diversity. Support for these base camps was provided by logistical or satellite sites over a wider area of the landscape and included such site types as hunting camps and stations, gathering locations, and short-term

encampments. Base camps would have been moved from time to time to allow for the exploitation of another catchment area.

In the serial foraging model, Archaic bands would have established short-term camps near water until the immediate foraging zone was exhausted or no longer in season. These camps, occupied for a few days or weeks, were then moved to a new area. A cyclic seasonal utilization of the landscape in both the central-based collecting and serial-foraging systems would have resulted in the reoccupation of campsites in subsequent years and a palimpsest of cultural debris.

Classification of sites in the San Juan Basin has been attempted by various researchers in an effort to identify the subsistence-settlement systems of the Archaic occupations. Archaic site types are usually identified on the basis of size, content, artifact assemblage, and landscape or environmental location (Huckell 1996:353). Multicomponent site use is often noted as a problem in the definition of specific site types as assemblages from different occupations and functions may be mixed. Therefore, efforts are made to identify spatially and chronologically distinct manifestations at a given site locale. This is an important consideration given the fact many multicomponent occupations are not identified in archaeological surveys but are only recognized after excavation (Marshall 1985:194). Many of the larger Archaic sites, usually referred to as base camps or extended habitation sites, are clearly the result of repeated use. Indeed, "in the absence of stratigraphic separation of components, efforts to understand the details of site function and occupation are liable to be not only fruitless, but also misleading" (Huckell 1996: 334).

A number of Archaic site typologies for the San Juan Basin area have been proposed (Dykman and Simmons 1982; Kemrer 1982; Vierra 1980, and others). Most emphasize the differentiation of habitation and special use sites, such as the base camp–satellite (Vogler et al. 1993) and base camp–task specific (Vierra 1980) dichotomies. Dykman and Simmons (1982) recognized six functional site types in Chaco Canyon on the basis of tool kit indices: maintenance sites, hunting camps, plant processing locations, manufacturing locations, and limited task-specific gathering/ hunting loci. In the Bisti–Star Lake area, Kemrer (1982), identified Archaic site types on the basis of numbers, location, and types of features present; site size; and tool types. His typology recognized large base camps; limited base camps; plant processing sites; plant-procurement areas; hunting camps and stations; and lithic procurement areas (quarry sites).

In a recent study of the Jemez Mountain OLE transmission line, Hudspeth (1997b: Table 23.9) proposed an Archaic site classification based on a series of site attributes and characteristics: location; ecotone-habitat-microenvironment; elevation; artifact richness and diversity; artifact type clusters; assemblage size; site size; feature and structure types; and presence-absence and incidence of faunal remains, botanical materials, projectile points, and ground stone.

The site types identified in the OLE study area consisted of base camps, habitation sites, logistical sites, hunting stations, and storage sites. Artifact assemblage diversity and richness was measured on the basis of 22 tool type categories. A similar definition of site characteristics for the NM 44-North site components is provided in Volume 2. These lists attempt to summarize the important information obtained from the NM 44-North excavations that are useful to the identification of the site function and type.

Base camps, the largest of the Archaic period sites, are rare in the OLE (Jemez Mountain) study

area. They exhibit numerous tool types (12 or more), including projectile points and ground stone, and contain hearths, structures, and midden deposits. Base camps are located at lower elevations (Hudspeth 1997b) and are often along major drainages or in proximity to water (Vogler et al. 1993:317).

In the OLE classification habitation sites are much more numerous than base camps and are also located at lower elevations in the pinyon-juniper zone. They are relatively large and have a high artifact diversity (10–17 tool types). Hearths are usually present, and many sites have remains of habitations. The presence of projectile points and ground stone indicates hunting and gathering activities. Faunal assemblages are usually diverse.

Logistical sites or camps are usually smaller than habitation or base camps. These sites are considered to be short-term hunting-foraging camps, probably utilized from a nearby habitation site, in which a limited number of resources were exploited. Logistical sites exhibit low artifact diversity (5–8 classes) and may or may not have hearths, ground stone, and projectile points. They are located in a variety of ecozones and may occur in higher elevations than habitation sites or base camps. They may or may not be associated with water.

Hunting stations are common in the Jemez Mountain study area. They are usually small sites that contain projectile points and biface manufacturing debris, but no ground stone. They exhibit low artifact diversity but contain hunting-butchering tools such as projectiles, bifaces, scrapers, and knives. Hearths may or may not be present. Hunting stations are frequently situated on the edge of the tree line and may occur at higher elevations where large mammals were hunted. There seems to be a direct association with water sources.

Storage or cache sites are also recognized in the OLE study, but none were found during the investigation. Isolated storage pits may have been used to store nuts or seed products. Other storage sites may have included cached weapons and raw materials.

Archaic sites that have been identified elsewhere include kill and butchering sites, plant gathering stations, lithic quarry sites, game observation loci, and rock art sites (Schaafsma 1980:33–79).

Site Characteristics

Important attributes which are often overlooked in Archaic site studies include the densities of cultural material per cubic meter of excavated fill (Table 35) and the nature and density of fire-heated stones (Chapter 8). The number and density of cultural materials are useful for the statistical comparison of site attributes and should be calculated for all excavated Archaic sites and site areas.

Summary information on the density of cultural materials is provided in Table 35 and detailed information on the type, size, location, and density of fire-heated stone is provided in Chapter 8.

In terms of the NM 44 components in the context of previous Archaic site typologies, none of the site components can be considered to represent a base camp or major habitation site.

LA 50460, West Provenience

The West Provenience at LA 50460 appears to be a logistical encampment, probably of rather short-term use in which occupants specialized in the hunting of mule deer. There is a relatively high incidence of bone in the West Provenience

Table 35. Densities of Cultural Material within the NM 44-North Archaeological Sites

	Fill Volume (m^3)	Chipped Stone (per m^3)	Ground Stone (per m^3)	Bone (per m^3)	Fire-Heated Stone (per m^3)
LA 50460					
East Provenience	14.4	7.98	0.85	1.9	1566
West Provenience*	52.0	8.13	0.50	9.3	50
LA 45961	9.6	17.3	0.63	0	134
LA 119580†	25.1	0.59	0	0	Trace

* The 52.0 cubic meters of fill sifted for cultural material yielded most of the recovered artifacts. However, a few specimens were found in the additional 33.2 cubic meters of overburden, most of which was discarded without sifting. Density estimates may be slightly less than indicated.

† Surface material is included only at LA 119580. Just two artifacts were found in the excavated fill, or 0.002 specimens per cubic meter.

sediments (9.3 specimens per cubic meter). The bone outnumbers chipped stone artifacts! Most of the identified bone is mule deer or large (deer-size) mammals. The presence of various non-meat-yielding bones indicates that butchering occurred in the encampment and that hunting was conducted in the vicinity.

One possible structure (Feature 1) was found at the site. It consists of a shallow basin (2.0 by 3.0 m) and may have been a temporary brush shelter, perhaps utilized during the winter. Brush shelters may have been constructed at short-term encampments during inclement weather and do not necessarily indicate permanent or long-term occupations. However, the presence of formalized habitations is one indicator of a habitation site or base camp.

Tool type diversity in the West Provenience sediments is low, as is overall artifact density, suggesting a specialized and short-term occupation. However, the presence of numerous manos and informal metates suggests that plant products were also gathered and processed at the location. The fact that most of the metates were small, thin slabs of apparent expedient nature also suggest a short-term occupation. Larger, more formal metates would have probably been used on longer-term habitation sites. However, the manos are extremely well used and were probably carried from encampment to encampment. Some of the manos may have also been used in the processing of the mule deer hides (Adams 1988).

Fire-heated stone occurs much less frequently in the West Provenience deposits than in the East Provenience, indicating a very fundamental difference in site function.

LA 50460, East Provenience

The East Provenience of LA 50460 also appears to be a short-term logistical encampment. Radiocarbon dating indicates that this component was utilized nearly four centuries after the West Provenience. The East Provenience has a very high density of fire-heated stone clustered around

two hearths. It has 31 times the density of heated stone noted in the nearby West Provenience. The stones are concentrated in two areas (Features 2 and 3) that appear to have been surface or shallow basin ovens or hearths. There is no evidence of pit features. The heated stones consist almost entirely of soft sandstone blocks that were probably used for baking rather than stone boiling.

Considerably less bone was found in the East Provenience than in the West Provenience, and the emphasis at the former camp was probably on gathering plant foods rather than hunting. However, most of the identified bone from the East Provenience was also mule deer. Only one projectile point was recovered from the East Provenience in contrast to the nine points from the West Provenience. Tool type diversity is very low, which suggests that a very limited set of activities was conducted at the location. Because preservation of botanical material from both the East and West proveniences was poor, it is not known what plant resources were exploited during the occupations.

LA 45961, Early Component

The early component at LA 45961 appears to have been an isolated storage feature that was probably associated with an early agricultural plot. Carbonized maize and Cheno-Am seeds were found in the pit. Radiocarbon dates indicate a late Archaic affinity. No evidence of an occupation surface or associated cultural materials was found adjacent to the pit or in the nearby test trenches which were excavated to the level of the pit. This suggests that the pit was an isolated feature or that it was built at some distance from a nearby encampment. The pit walls exhibit some oxidation, which could indicate a roasting pit rather than a storage structure. However, storage pit walls were often fired to dry out the adjacent soil and to harden them.

LA 45961, Late Component

Definition of the late component at LA 45961 was based on a small excavation area in an originally larger, but disturbed, site location. It is difficult to identify the specific nature of the occupation based on this small sample. Furthermore, the cultural deposits were shallow and poorly preserved. However, artifact density and diversity in the excavated area is low, suggesting a short-term and rather specialized site use. Fire-heated stone is infrequent. Chipped stone materials occur with moderate density (17.3 specimens per cubic meter) and ground stone is present. Poor preservation precludes analysis of the floral and faunal assemblage. The relatively high incidence of obsidian (36.1%) suggests considerable familiarity with the Jemez Mountain source or perhaps an obsidian reduction event. The late component at LA 45961 is also probably a short-term logistical encampment.

LA 119580

Excavations at LA 119580 revealed only a few chipped stone artifacts with traces of fire-heated stone. It is clear that the site was a limited activity or task specific area of very short-term use and probably the result of a single event. The cultural-temporal affinity of the site remains undetermined.

Chapter 13

The Cultural-Temporal Affinity of the Tancosa Site (LA 50460)

by Patrick Hogan

The excavations at the Tancosa Site (LA 50460) raise questions about the adequacy of the cultural-temporal framework currently used for the Archaic period in northwestern New Mexico. The site yielded three radiocarbon dates ranging from 7670 to 7090 BP and a mixed assemblage of stemmed and notched projectile points. The stemmed points were not the Jay or Bajada styles expected at sites of this age but forms resembling San Josė and Armijo. If accepted at face value, this evidence would require significant revisions to the Oshara projectile point chronology (Irwin-Williams 1973). Alternative explanations for the apparent association between early Archaic dates and middle to late Archaic projectile point forms must be considered, however, before any such revisions are proposed. The radiocarbon dates may be spurious; the apparent association of the dated materials and the projectile points might result from the cultural debris of multiple occupations; or the projectile points may be misclassified as Oshara points and actually relate to another Archaic tradition.

There seems little basis for questioning the accuracy of the radiocarbon assays. The three dates were obtained from wood charcoal collected from subsurface contexts, and all indicate an early Archaic age for the site. No obvious sources of gross contamination were noted during the excavation and, although wood dates from long-lived species often overestimate the actual age of an occupation owing to a combination of the "old wood" problem and cross-sectional effect, these overestimates are typically on the order of several centuries and not millennia.

The difference in the 7670 ± 130 BP and 7460 ± 180 BP dates from the West Provenience is not statistically significant ($t = 0.95$) at the 0.05 level, which is consistent with Marshall's hypothesis that the occupation zone in this area may have originally been narrower before it was blurred by pedoturbation. Nevertheless, the midranges for the two dates are stratigraphically consistent, and they bracket the stratum which yielded seven of the nine projectile points from the site. The 7090 ± 190 BP date from the East Provenience is significantly more recent than the 7670 BP date ($t = 2.52$) and the 7598 ± 100 BP weighted average (Berry 1982:10) of the two dates from the West Provenience ($t = 2.37$), supporting Marshall's contention that the East Provenience represents a later but still early Archaic occupation.

There also seems little likelihood that the cultural debris at LA 50460 is part of a secondary alluvial deposit. The site is situated on a slight prominence adjacent to Tancosa Wash but outside the floodplain, and the artifact-bearing strata appear to be eolian rather than alluvial

sediments. Marshall describes the cultural deposits in the West Provenience (Level 2) as a 50-cm-thick stratum of loose to compact, charcoal-stained eolian sand with no visible laminations or other depositional features. These sediments overlay a culturally sterile basal stratum of coarse yellow sand (Level 3) and were buried by a 30-cm-thick stratum of fine-grained eolian sediments (Level 1). Marshall interprets the stratigraphic sequence as indicating that the West Provenience occupation was on a low dune on the margins of the Tancosa drainage.

A 7670 BP radiocarbon date was obtained from charcoal collected from the lower Level 2b horizon, and a 7460 BP date, from charcoal in the upper fill of Level 2a. The dates therefore bracket the cultural deposits in this part of the site. If the site is actually a mixed cultural deposit, then it is the more recent radiocarbon date that is questionable as it provides a minimum age for the occupation. In considering alternative interpretations of the stratigraphic sequence, it is possible that the cultural materials at LA 50460 are a lag deposit of early, middle, and late Archaic artifacts that were reburied by relatively recent eolian deposits. It is also possible that the sediments in Level 2 represent several thousand rather than several hundred years of deposition, incorporating several ephemeral occupations spanning most of the Archaic period. In either case, an anomalously early date might result from upward displacement of charcoal from an early Archaic occupation in the lower part of the stratum by rodent and insect burrowing.

The problem with this explanation is that charcoal from the later occupations would also have been subject to the same pedoturbation processes. Consequently, it must be assumed that (1) the later occupations were so ephemeral as to produce no residual charcoal; (2) erosion selectively removed charcoal from all but the early Archaic component; or (3) the radiocarbon sample collected from Level 2a somehow contained a disproportionately large quantity of charcoal from the earliest occupation of the site. None of these assumptions seems likely. As Marshall concluded, the most probable and parsimonious interpretation of the stratigraphic and chronometric evidence presented in this report is that the Tancosa site represents two or more occupational episodes dating roughly to 7500–7000 BP.

Since the only evidence suggesting that the site was occupied during the middle and/or late Archaic periods is the projectile points, the next concern is whether or not that evidence is conclusive. This problem has two aspects: (1) Can the Tancosa site points be legitimately classified as San Jose and Armijo? (2) Are the accepted date ranges for those types adequately supported by chronometric and stratigraphic data from other sites in the region? Neither of those questions can be answered unequivocally.

The Oshara projectile point sequence is derived from Irwin-Williams's preliminary synthesis of the Oshara Tradition (1973), which provided proposed date ranges and brief descriptions of the diagnostic projectile point styles for five Archaic phases. The synthesis was based on six years of fieldwork, including the excavation of 12 sites and testing at 60 others (Irwin-Williams 1973:2), but except for a preliminary report on the excavation of En Medio Shelter (Irwin-Williams and Tompkins 1968), none of this work has been published.

The Oshara sequence has nevertheless been widely accepted by archaeologists working in the region, partly because it provided a single cohesive framework for ordering the Archaic occupation of northwestern New Mexico and partly because of Irwin-Williams's reputation of careful fieldwork. In the absence of more detailed data, the brief descriptions included in the Oshara

report together with the few illustrated specimens have been employed as informal type descriptions for the projectile point forms diagnostic of each phase.

Irwin-Williams asserts that San Jose phase projectile points are evidence of continuity with the large indented-base stemmed and shouldered forms of the preceding Bajada phase, "with the principal shifts being in the increasing use of serration along the blade and relatively shorter stem to blade ratio. Through time a trend develops toward decreased overall length, increasingly expanded stems and increasingly marked serration" (Irwin-Williams 1973:8). Moore (1991) has expanded on this initial description based on an analysis of 173 San Jose points from the Four Corners region. His data indicate that San Jose points are a morphologically heterogeneous group of medium-size stemmed points with concave or indented bases, typically formed by one or more large percussion flake scars. Lateral stem margins are straight to slightly expanding and are usually ground. On average, stem length is about one-third of the overall length of the point. Blades are triangular, elongate triangular, or lanceolate, and the margins are usually serrated. The blade is usually set off from the stem by well-defined shoulders, but on heavily serrated blades, the shoulders may be reduced to a sharp prominence.

Several projectile point forms are associated with the Armijo phase. As described by Irwin-Williams (1973:11), "evolved late forms of the old serrated San Jose style with short widely expanding stems and concave or (later) straight bases were commonest early in the period. Subsequently this class began to show increased internal variety, and a number of variations on a shallow corner notched or narrow stemmed node made their appearance." Among archaeologists working in northwestern New Mexico, the term "Armijo point" is most commonly applied to the "late form of old San Jose style" described by Irwin-Williams—a medium-size, elongate triangular point with a serrated blade; a short, widely expanding stem; and a concave or indented base. This type has also been termed "Armijo Corner-notched" (Turnbow 1997) and "Armijo Eared" (Thoms 1977).

Two other Armijo varieties are also illustrated by Irwin-Williams (1973:Figure 5). The first—presumably one of the "narrow stemmed" variations—has a short stem with slightly expanding lateral margins and a convex base, and a serrated triangular blade with the lowermost serration forming a slight, sloping shoulder (Irwin-Williams 1973:Figure 5e). This style has been termed "Armijo Stemmed B" in the OLE project projectile point typology (Turnbow 1997). The second variety (Irwin-Williams 1973:Figure 5c,d) has shallow side-notches and an indented or rounded base, and has been termed "Armijo Side-notched" (Turnbow 1997).

Four radiocarbon dates associated with San Jose points are reported from two excavated sites in the northern San Juan Basin (Del Bene and Ford 1982). Dates of 5660 ± 270 BP (I-11, 721), 4460 ± 220 BP (I-11, 658), and 4195 ± 240 BP (I-11, 701) were obtained from H-27-34, and a date of 5680 ± 80 BP (I-11, 721) was obtained from H-27-35. In addition, a date of 4850 ± 100 BP (Beta 12257) is reported in association with a late San Jose/Armijo point at LA 25322 in the Abiquiu Reservoir area (Lord and Cella 1986). During the OLE data recovery program (Turnbow 1997:173), a San Jose point was also recovered from the surface of LA 66891 approximately 40 m from a feature dated to 4320 ± 65 BP (AA-9315). These dates are generally consistent with the 5200 to 3800 BP date range proposed by Irwin-Williams for the San Jose phase, but they do not preclude an earlier date for the initial appearance of this point style, a possibility suggested by data from at least three other sites.

Agogino and Hester (1958) obtained a radiocarbon date of 6880 ± 400 BP (M-346) from a hearth in the red old dune level at Grants 1, one of the type sites for the San Jose Complex. This date was originally attributed to the San Jose projectile points eroding from the upper portion of the old dune deposits (Bryan and McCann 1943). In reexamining the artifact collection from the Grants 1 site, however, Laumbach and Brockman (1983:9) found that it included at least three Bajada points. They therefore argued that the date should be attributed to the Bajada phase. In actuality, the relationship between the dated feature and the various projectile points recovered from the site is uncertain; it might be associated with the San Jose points, the Bajada points, or both.

Similarly, radiocarbon dates of 8260 ± 100 BP (A-1694) and 8000 ± 120 BP (A-1756) were obtained from two hearths at the Hastqin site near Ganado, Arizona (Huckell 1977). One complete and five fragmentary projectile points were recovered from the site, four of which were classifiable—a Jay point stem fragment, a Bajada point, a San Jose point broken at the base, and a shallowly side-notched, split-stemmed point of uncertain affinity. None of the points was closely associated with the dated features. Finally, at AZ:DL11:3063 on Black Mesa, radiocarbon dates of 8080 ± 160 BP (Beta 5635) and 7810 ± 500 BP (Beta 5634) are associated with two projectile points (Parry and Christenson 1987:168–170). One of these points is a small, straight-sided, indented-base stem fragment, tentatively identified as San Jose or Pinto. The other point has a slightly contracting stem with an indented base, and what appears to be slight, sloping shoulders. The blade has been extensively reworked by steep beveling of the blade margins. This point was tentatively identified as a small Bajada point, but from the illustration, its size and basal morphology appear closer to San Jose than Bajada.

Although the evidence from these three sites is hardly conclusive, it does suggest the possibility that San Jose points may have appeared on the southern Colorado Plateau as early as 8000 BP. In all cases, however, there has been a tendency to accept the interpretation of these sites that is most consistent with the Oshara phase sequence as outlined by Irwin-Williams (1973), and to ignore potentially conflicting data.

Irwin-Williams (1973:9) suggests a date range of about 3800–2800 BP for the Armijo phase, which is also accepted as the date range for the Armijo projectile points. There seems little independent chronometric evidence to support this assumption. To my knowledge, there are no reported radiocarbon dates in clear association with the expanded-stem form. At En Medio Shelter, two type AEM 14 projectile points—medium-size points with triangular, unserrated blades; well-defined shoulders; and short, wide, parallel-sided stems with straight bases—were recovered from Zone B2, which is bracketed by radiocarbon dates of 3035 ± 95 BP and 1960 ± 85 BP (Irwin-Williams and Tompkins 1968). A third AEM 14 point was recovered from the overlying Zone B1. This type is equated with Armijo Stemmed B points as defined in the OLE project point typology (Turnbow 1997). Two of the sites investigated during the OLE project also yielded associated radiocarbon dates. An Armijo Stemmed B point was located near Feature 1 at LA 82600, which yielded extended-count radiocarbon dates of 3720 ± 100 BP (Beta 52383) and 3320 ± 120 BP (Beta 52382). Another Armijo Stemmed B point was associated with an AMS date of 6355 ± 70 BP (AA 9313) from Feature 4 at LA 66874 (Turnbow 1997:178). This last date was considered questionable in light of the dates from stratified deposits at En Medio Shelter.

Six classifiable projectile points from the Tancosa site were recovered from the cultural deposits in the West Provenience bracketed by

the 7670–7460 BP radiocarbon dates. Vierra (Chapter 6) indicates that two of these points (L-52 and L-53) have concave bases and could be classified as San Jose, while the other four (L-49, L-51, L-54, and L-55) have straight to convex bases and could be classified as Armijo. I agree with his classification of the San Jose points: L-53 is a complete point and closely matches the definition of San Jose provided earlier, and although L-52 is only a fragment, its basal characteristics appear identical to those of L-53. I am less confident in identifying the other four points as Armijo. Two of those points, L-49 and L-51, resemble the Armijo stemmed point illustrated by Irwin-Williams, but there are only general similarities to the AEM 14 points. Conversely, the other two points, L-54 and L-55, more closely resemble the AEM 14 points but are only vaguely similar to the Armijo stemmed point illustrated in the Oshara report. Moreover, the base of L-55 is broken, so its precise form is uncertain.

These concerns are secondary to a more fundamental issue, however. As currently defined, the Armijo projectile point types are at best morphological types of uncertain age. The expanded stemmed form is the most completely described and best illustrated of the Armijo variants discussed in the Oshara synthesis, but there are no published chronometric data supporting the date range proposed by Irwin-Williams for this type. The other Armijo point forms are described in a single phrase—"a number of variations on a shallow corner notched or narrow stemmed node" (Irwin-Williams 1973:11)—supplemented by two or three illustrated points. The OLE project projectile point classification is a credible attempt to formalize the variability alluded to by Irwin-Williams, but the four Armijo point types defined in that classification scheme appear to be based on morphological descriptions of points from undated contexts, with references to similar points illustrated in the Oshara and En Medio Shelter reports. At present, there is no way to tell how well these types correspond to the variability observed by Irwin-Williams in the Arroyo Cuervo.

If we limit ourselves to consideration of the available chronometric data, then it appears that the dates associated with Armijo Stemmed B are more or less evenly split between the early Archaic (i.e., the dates from the Tancosa site and LA 66874, an OLE project site) and late Archaic (i.e., the dates from En Medio Shelter and LA 82600, an OLE project site). These data could be interpreted as indicating that Armijo Stemmed B is a long-lived point type or that the type, as now defined, encompasses two temporally distinct but morphologically similar forms. In the latter case, the designation Armijo Stemmed B should be reserved for the later form and a new type designation proposed for the earlier form. If the form is long-lived, then the type name should probably be changed, as "Armijo" is irreversibly associated with the later Archaic.

Vierra considered only the Oshara sequence in classifying the projectile points from the Tancosa site, although he acknowledges that there are also some similarities between the Tancosa assemblage and the Pinto and Elko points which are characteristic of early Archaic occupations on the northern Colorado Plateau and eastern Great Basin between about 8300 and 6200 BP (Geib 1996; Holmer 1978, 1986; Schroedl 1976). This alternative interpretation is tempting, since the classification of the Tancosa points as Pinto and Elko would be fully consistent with the radiocarbon dates from the site and would avoid the problem of dealing with apparent inconsistencies in the Oshara sequence.

A comparison of illustrated points suggests that San Jose points from the southern Colorado Plateau and Pinto points from the northern

Colorado Plateau are distinct types, however, and the two specimens from the Tancosa site are, in my opinion, more properly classified as San Jose. Stem length on San Jose points averages about one-third of the overall length, whereas on eastern Pinto points, it tends to be one-quarter or less. The stems on Pinto points also tend to expand toward the base, and basal indentations are relatively deep, resulting in pronounced, rounded ears. Stem margins on San Jose points tend to be nearly parallel, and the basal concavities are broad and fairly shallow. Consequently, while Pinto points are aptly characterized as bifurcated-stemmed points, San Jose points are more appropriately described as stemmed, indented-base points. In addition, the blades of San Jose points are usually serrated, whereas Pinto points on the northern Colorado Plateau are usually unserrated.

Similarly, the classification of two points from the Tancosa site (L-54 and L-55) as Elko is also possible but not probable. Elko Corner-notched points typically have deep, narrow notches producing both a widely expanding stem and pronounced shoulder barbs. The notches on L-54 and L-55 are relatively shallow, the stem margins are only slightly expanded, and there are no pronounced shoulder barbs. The other two classifiable points recovered from the West Provenience deposits, L-49 and L-51, have no close analogs at early Archaic sites on the northern Colorado Plateau.

To conclude, I find little reason to challenge Marshall's interpretation of the Tancosa site as an early Archaic occupation, nor to doubt that the projectile points recovered from the cultural deposits in the West Provenience were associated with occupational episodes dating to sometime between 7700 and 7100 BP. At least two of those points can be classified as San Jose, which suggests that the initial date for this type may be two millennia earlier than proposed by Irwin-Williams, overlapping the occurrence of Jay and Bajada. The other four points from this area suggest that the straight-stemmed and/or notched form variations typically classified as Armijo are also of similar age. Whether those forms persist into the late Archaic or are morphologically similar but distinct types is unclear at present.

Clearly this research has profound implications for the use of projectile points to date sites. We can no longer assume that early Archaic occupations will be marked by Jay and Bajada points, that the presence of San Jose points necessarily indicates a middle Archaic occupation, or that straight stemmed or notched points necessarily indicate a late Archaic occupation. There is no question that this uncertainty will be frustrating to most researchers, but it is preferable to building an understanding of Archaic period adaptations that is grounded in an erroneous chronological framework. Periodically, we need a little "data-in-your-face" reality check. Many of us have become so complacent in our acceptance of the Oshara sequence that we have tended to discount any conflicting data generated by our research. That tendency smacks more of blind faith than scientific method, and I doubt that Irwin-Williams would approve.

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Radiocarbon Data Sheets

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No.	**GX-25531-LS**	Date Received:	03/30/99
Your Reference:	letter dated 03/29/99	Date Reported:	06/09/99

Submitted by: Dr. Michael P. Marshall
Cibola Research Consultants
Post Office Box 743
Corrales, New Mexico 87048

Sample Name: **Cibola #1, LA 45961, Lower Pit, 40-60 cm**

AGE = **2,030 ± 100 ^{14}C years BP (^{13}C corrected).**

Description: Sample of charcoal.

Pretreatment: The charcoal fragments were separated from any sand, silt, rootlets, or other foreign matter. The sample was then treated with hot dilute HCl to remove any carbonates, and with hot dilute NaOH to remove humic acids and other organic contaminants. After washing and drying, the cleaned charcoal was converted to benzene and counted by liquid scintillation.

Comments:

$\delta^{13}C_{PDB}$ = **-21.5 ‰**

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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DIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

r Sample No.	**GX-25532-LS**	Date Received:	03/30/99
ur Reference:	letter dated 03/29/99	Date Reported:	06/09/99

bmitted by: Dr. Michael P. Marshall
Cibola Research Consultants
Post Office Box 743
Corrales, New Mexico 87048

---

mple Name: **Cibola #2, LA 50460, West Side**
Grios G-35 5E & F-35 West, Level 26, 50-70 cm

E = **7,670 ± 130 ^{14}C years BP (^{13}C corrected).**

---

scription: Sample of charcoal.

etreatment: The charcoal fragments were separated from any sand, silt, rootlets, or other foreign matter. The sample was then treated with hot dilute HCl to remove any carbonates, and with hot dilute NaOH to remove humic acids and other organic contaminants. After washing and drying, the cleaned charcoal was converted to benzene and counted by liquid scintillation.

mments:

$^{3}C_{PDB}$ = **-21.9 ‰**

---

tes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is ± 1σ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No.	**GX-25533-LS**	Date Received:	03/30/99
Your Reference:	letter dated 03/29/99	Date Reported:	06/09/99

Submitted by: Dr. Michael P. Marshall
Cibola Research Consultants
Post Office Box 743
Corrales, New Mexico 87048

Sample Name: **Cibola #3, LA 45961, Lower Pit, 40-90 cm**

AGE = **2,570 ± 120 ^{14}C years BP (^{13}C corrected).**

Description: Sample of maize kernels.

Pretreatment: The fragments were separated from any sand, silt, rootlets, or other foreign matter. The sample was then treated with hot dilute HCl to remove any carbonates, and with hot dilute NaOH to remove humic acids and other organic contaminants. After washing and drying, the cleaned sample was converted to benzene and counted by liquid scintillation.

Comments:

$\delta^{13}C_{PDB}$ = -11.1 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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ADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

ur Sample No.	**GX-25534-LS**	Date Received:	03/30/99
our Reference:	letter dated 03/29/99	Date Reported:	06/09/99

bmitted by: Dr. Michael P. Marshall
Cibola Research Consultants
Post Office Box 743
Corrales, New Mexico 87048

---

mple Name: **Cibola #4, LA 50460, East Complex Grios E9, E10, D8, D9, F11, & F12, 20-30 cm**

GE = **7,090 ± 190 ^{14}C years BP (^{13}C corrected).**

---

escription: Sample of charcoal.

etreatment: The charcoal fragments were separated from any sand, silt, rootlets, or other foreign matter. The sample was then treated with hot dilute HCl to remove any carbonates, and with hot dilute NaOH to remove humic acids and other organic contaminants. After washing and drying, the cleaned charcoal was converted to benzene and counted by liquid scintillation.

omments:

$^{3}C_{PDB}$ = **-22.3 ‰**

---

otes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No.	**GX-25535-LS**	Date Received:	03/30/99
Your Reference:	letter dated 03/29/99	Date Reported:	06/09/99

Submitted by: Dr. Michael P. Marshall
Cibola Research Consultants
Post Office Box 743
Corrales, New Mexico 87048

Sample Name: **Cibola #5, LA 50460, West Provenience Grio G-36, Level 2a, 40-50 cm**

AGE = **7,460 ± 180 ^{14}C years BP (^{13}C corrected).**

Description: Sample of charcoal.

Pretreatment: The charcoal fragments were separated from any sand, silt, rootlets, or other foreign matter. The sample was then treated with hot dilute HCl to remove any carbonates, and with hot dilute NaOH to remove humic acids and other organic contaminants. After washing and drying, the cleaned charcoal was converted to benzene and counted by liquid scintillation.

Comments:

$\delta^{13}C_{PDB}$ = **-23.4 ‰**

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

Appendix B

Obsidian Source Analysis

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO   SANTA BARBARA • SANTA CRUZ

ARCHAEOLOGICAL X-RAY FLUORESCENCE SPECTROMETRY LABORATORY
PHOEBE HEARST MUSEUM OF ANTHROPOLOGY
103 KROEBER HALL
BERKELEY, CALIFORNIA 94720-3712
USA

SOURCE PROVENANCE OF ARCHAEOLOGICAL OBSIDIAN FROM ARCHAEOLOGICAL SITES NEAR COUNSELOR, NEW MEXICO

AN ENERGY-DISPERSIVE X-RAY FLUORESCENCE (EDXRF) ANALYSIS

by

M. Steven Shackley, Ph.D., Director
Archaeological XRF Laboratory
Phoebe Hearst Museum of Anthropology
University of California, Berkeley

Report Prepared for

Cibola Research Consultants
Corrales, New Mexico

24 May 1998

INTRODUCTION

The following report documents a geochemical analysis of 15 obsidian artifacts from two sites (LA 45961 and 50460) located along New Mexico Highway 44, near Counselor, New Mexico. All of the artifacts were produced from obsidian originally procured from one of two chemical groups in the Jemez Mountains; Valle Grande member of the Tewa Group, and El Rechuelos Rhyolite of the Polvadera Group. A short summary of the silicic petrology in the Jemez Mountains is included relevant to archaeological obsidian.

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

All samples were analyzed whole with little or no formal preparation. The results presented here are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate x-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). Or more essentially, these data through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984).

The trace element analyses were performed in the Department of Geology and Geophysics, University of California, Berkeley, using a Spectrace™ 400 (United Scientific Corporation) energy dispersive x-ray fluorescence spectrometer. The spectrometer is equipped with a Rh x-ray tube, a 50 kV x-ray generator, with a Tracor X-ray (Spectrace™) TX 6100 x-ray analyzer using an IBM PC based microprocessor and Tracor reduction software. The x-ray tube was operated at 30 kV, 0.20 mA, using a 0.127 mm Rh primary beam filter in a vacuum path at 250 seconds livetime to generate x-ray intensity Kα-line data for elements titanium (Ti), manganese (Mn), iron (as Fe^T), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Weight percent iron ($Fe_2O_3{}^T$) can be derived by multiplying ppm estimates by 1.4297^{10-4}. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from the analysis of international rock

standards certified by the National Institute of Standards and Technology (NIST), the US. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1988, 1990, 1992, 1995; also Mahood and Stimac 1991; and Hughes and Smith 1993). Specific standards used for the best fit regression calibration for elements Ti through Nb include G-2 (basalt), AGV-1 (andesite), GSP-1 and SY-2 (syenite), BHVO-1 (hawaiite), STM-1 (syenite), QLM-1 (quartz latite), RGM-1 (obsidian), W-2 (diabase), BIR-1 (basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), all US Geological Survey standards, and BR-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). In addition to the reported values here Ni, Cu, Zn, Th, and Ga were measured, but these are not consistently useful in discriminating glass sources and are not generally reported. These data are available on disk by request.

The approximate practical detection limits of the elements of interest that include error imposed by inter-element interference are as follows: Ti 23 ppm; Mn 40 ppm; Fe 10 ppm; Pb 8 ppm; Rb 5 ppm; Sr 3.5 ppm; Y 7 ppm; Zr 7 ppm; Nb 8 ppm; Ba 20 ppm; La 20 ppm; Ce 20 ppm. These are the smallest amounts that can be quantitatively measured, defined as a signal which is six standard deviation units above background (6Σ).

The data from the Tracor software were translated directly into Excel™ for Windows software for manipulation and on into SPSS™ for Windows for statistical analyses. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. Table 1 shows a comparison between values recommended for three international obsidian and rhyolite rock standards, RGM-1, NBS(SRM)-278, and JR-2. One of these standards is analyzed during each sample run to check machine calibration. The results shown in Table 1 indicate that the machine accuracy is quite high, particularly for the mid-Z elements, and other instruments with comparable precision should yield comparable results. Further information on the laboratory instrumentation can be found on the World Wide

Web at: http://obsidian.pahma.berkeley.edu/. Trace element data exhibited in Tables 1 and 2 are reported in parts per million (ppm), a quantitative measure by weight. Source assignment was made by comparison to source standards here at Berkeley, and published and unpublished references in Baugh and Nelson (1987), Nelson (1984), and Glascock et al. (1998). The data reported in Glascock et al. (1998) are, in some cases, sample splits also analyzed at Berkeley. Statistical agreement between these labs is quite high and discussed in Shackley (1998a; see also Davis et al. 1998).

SILICIC VOLCANISM IN THE JEMEZ MOUNTAINS

Due to its proximity and relationship to the Rio Grande Rift System, potential uranium ore, geothermal possibilities, an active magma chamber, and a number of other geological issues, the Jemez Mountains and the Toledo and Valles Calderas particularly have been the subject of intensive structural and petrological study particularly since the 1970s (Bailey et al. 1969; Gardner et al. 1986; Goff et al. 1990; Heiken et al. 1986; Ross et al. 1961; Self et al. 1986; Smith et al. 1970; Figure 1 here). Half of the 1986 *Journal of Geophysical Research*, volume 91, was devoted to the then current research on the Jemez Mountains. More accessible for archaeologists, the geology of which is mainly derived from the above, is Baugh and Nelson's (1987) article on the relationship between northern New Mexico archaeological obsidian sources and procurement on the southern Plains.

Due to continuing tectonic stress along the Rio Grande, a lineament down into the mantle has produced a great amount of mafic volcanism during the last 13 million years (Self et al. 1986). Earlier eruptive events during the Tertiary more likely related to the complex interaction of the Basin and Range and Colorado Plateau provinces produced bimodal andesite-rhyolite fields, of which the Paliza Canyon (Keres Group) and probably the Polvadera Group is a part (Smith et al. 1970). While both these appear to have produced artifact quality obsidian, the nodule sizes are relatively small due to hydration and devitrification over time (see Hughes and Smith 1993; Shackley 1990, 1998b). Later, during rifting along the lineament and other processes not well understood, first the Toledo Caldera (ca. 1.45 Ma) and then the Valles Caldera

(1.12 Ma) collapsed causing the ring eruptive events that were dominated by crustally derived silicic volcanisim and dome formation (Self et al. 1986). The Cerro Toledo Rhyolite and Valles Grande Member obsidians are grouped within the Tewa Group due to their similar magmatic origins. The slight difference in trace element chemistry is probably due to evolution of the magma through time from the Cerro Toledo event to the Valle Grande events (see Hildreth 1981; Mahood and Stimac 1990; Shackley 1998c; see Figure 2 here). This evolutionary process has recently been documented in the Mount Taylor field (Shackley 1998c). Given the relatively recent events in the Tewa Group, nodule size is large and hydration and devitrification minimal, yielding the best natural glass media for tool production in the Jemez Mountains.

SOURCE ASSIGNMENT

Most of the artifacts were produced from Valles Grande obsidian, a generally better media for tool production than the El Rechuelos glass, the other source group in the assemblage. It is important to keep in mind that all of these sources are available as secondary deposits in the Rio Grande alluvium and many of the artifacts here could have been procured from these secondary deposits rather than the primary deposits in the Jemez Mountains (see Shackley 1998b). The location of these sites west of the Jemez Mountains, however, suggests that the raw material was likely procured from the source area. Regardless of the precise point of procurement, this assemblage can certainly be characterized as a regionally procured raw material assemblage.

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Table 1. X-ray fluorescence concentrations for selected trace elements of three international rock standards. ± values represent first standard deviation computations for the group of measurements. All values are in parts per million (ppm) as reported in Govindaraju (1994) and this study. RGM-1 is a U.S. Geological Survey rhyolite standard, NBS (SRM)-278 is a National Institute of Standards and Technology obsidian standard, and JR-2 is a Geological Survey of Japan rhyolite standard. Fe^T can be converted to $Fe_2O_3{}^T$ with a multiplier of 1.4297^{10-4} (see also Glascock 1991).

SAMPLE	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba
RGM-1 (Govindaraju 1994)	1600	279	12998	149	108	25	219	8.9	807
RGM-1 (Glascock and Anderson 1993)	1800±200	323±7	12400±300	145±3	120±10	n.r.[a]	150±7	n.r.	826±31
RGM-1 (this study)	1516±58	259±19	13991±143	152±3	108±2	24±1	226±4	10±1	806±12
SRM-278 (Govindaraju 1994)	1469	402	14256	127.5	63.5	39	290	18	1140[b]
SRM-278 (Glascock and Anderson 1993)	1460±270	428±8	14200±300	128±4	61±15	n.r.	208±20	n.r.	891±39
SRM-278 (this study)	1376±96	372±17	15229±399	129±2	68±2	42±2	290±3	17±2	1090±38
JR-2 (Govindaraju 1994)[b]	540	852	6015	297	8	51.3[b]	97.2[b]	19.2	39
JR-2 (this study)	343±51	680±17	7358±65	300±5	10±1	49±3	94±2	16±2	34±6

[a] n.r. = no report; n.m.=not measured

[b] values proposed not recommended

Table 2. Elemental concentrations for the archaeological specimens. All measurements in parts per million (ppm).

SAMPLE	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
LA 45961									
11	1157.8	396.7	12571.9	174.9	5.1	46.1	164.3	54.6	Valle Grande
12	878.5	385.2	10473.4	164.3	9.4	45.2	168.8	50.3	Valle Grande
13	888.5	452.5	10873.2	174.8	5.8	46.4	183.8	54.0	Valle Grande
14	916.0	375.5	10593.4	164.4	7.4	43.9	163.0	54.1	Valle Grande
15	868.4	366.2	10222.8	160.0	6.2	43.3	172.5	56.2	Valle Grande
LA 50460, EAST									
1	936.0	396.8	8023.8	167.0	5.4	25.3	76.8	48.2	El Rechuelos
2	875.1	376.9	7957.1	155.6	6.9	22.4	68.8	47.1	El Rechuelos
3	948.8	334.3	7244.1	150.9	7.9	21.8	71.6	47.5	El Rechuelos
4	874.4	343.3	9217.5	139.1	3.9	41.5	150.4	47.7	Valle Grande
LA 50460, WEST									
5	1125.1	399.1	7891.6	152.7	6.2	24.4	70.8	48.5	El Rechuelos
6	997.0	363.7	10471.6	165.3	6.2	43.1	172.9	52.1	Valle Grande
7	1258.6	409.3	9292.8	155.1	7.6	24.6	67.4	48.6	El Rechuelos
8	933.4	322.4	10093.1	155.7	5.9	42.5	163.5	56.5	Valle Grande
9	890.4	420.1	10771.9	181.7	3.7	47.5	174.9	55.1	Valle Grande?
10	1015.5	414.6	10988.1	174.2	6.6	45.7	170.6	53.2	Valle Grande?

Those samples marked with "?" deviate somewhat from source standard and published data, but are within 10% of accepted elemental concentrations for the source.

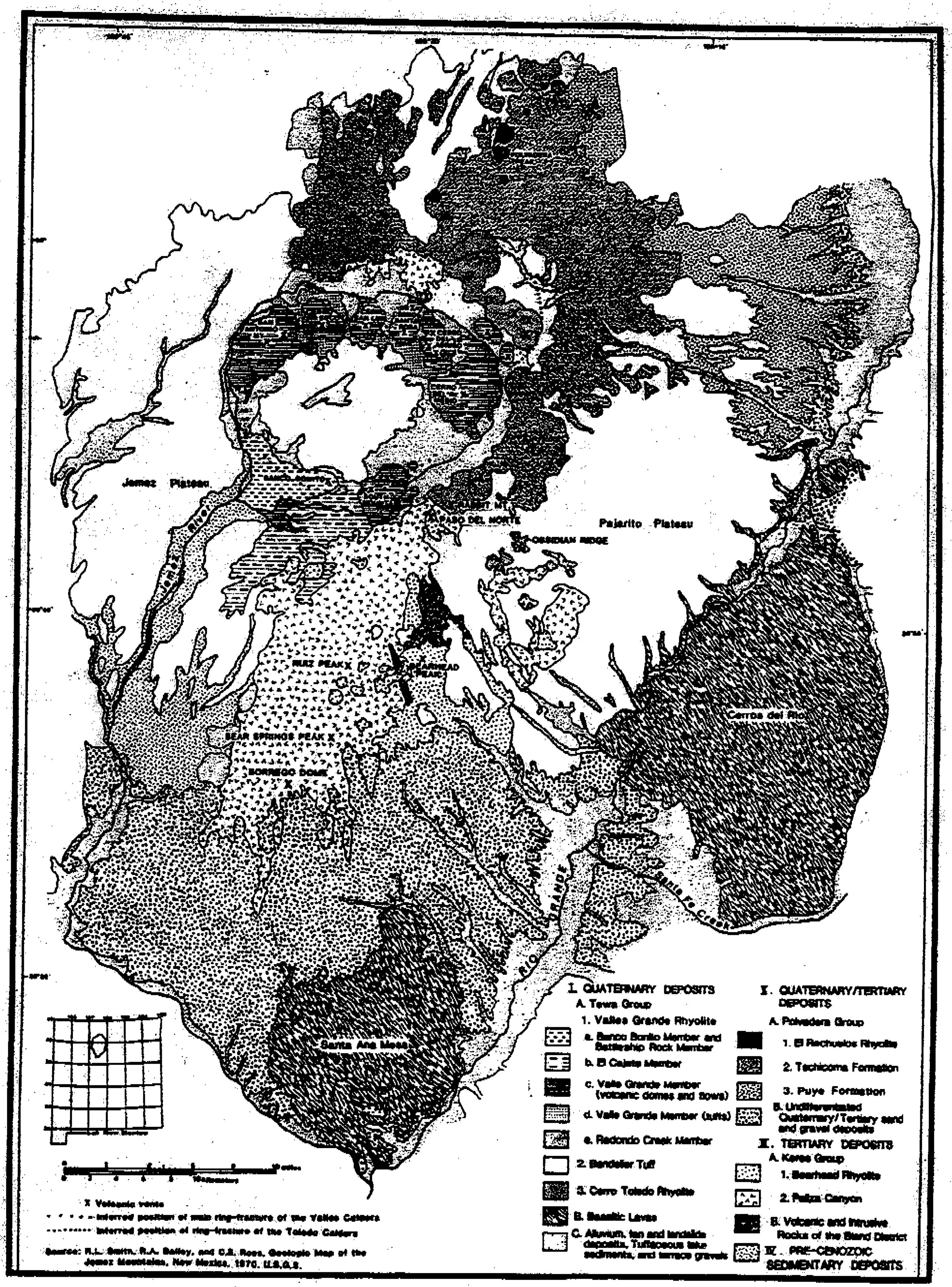

Figure 1. Geology of the Jemez Mountains, northern New Mexico (from Baugh and Nelson 1987; Smith et al. 1970).

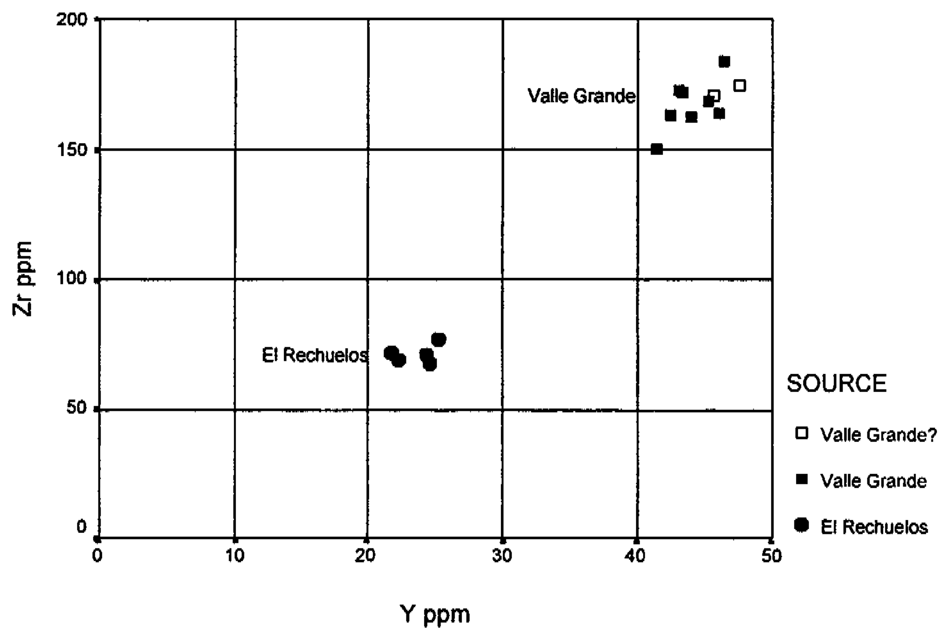

Figure 2. Y versus Zr biplot of archaeological samples from both sites. Those sample marked with "?"deviate somewhat from source standard and published data.

Appendix C

Obsidian Hydration Analysis

ANTHROPOLOGICAL STUDIES CENTER

Sonoma State University
Building 29
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Rohnert Park, CA 94928-3609

Michael Marshall
Director of Archaeological Projects
Cibola Research Consultants
P.O. Box 743
Corrales, New Mexico 87048

June 10, 1999

Dear Michael:

This letter reports hydration band analysis of 15 obsidian specimens from two Archaic period sites situated in northwestern, New Mexico. The sites include: LA 50460 (n=10) and LA 45961 (n=5). The specimens were sent to us by Steve Shackley, University of California, Berkeley, following his determination of the specimens' sources.

The analysis was completed at the Obsidian Laboratory, an adjunct of the Anthropological Studies Center, Sonoma State University. Procedures used by our hydration lab for preparation of thin sections and measurement of hydration bands are described below.

The specimens were examined to find two or more surfaces that would yield edges that would be perpendicular to the microslides when preparation of the thin sections was done. Two parallel cuts were made at an appropriate location along the edge of each specimen with a four-inch diameter circular saw blade mounted on a lapidary trimsaw. The cuts resulted in the isolation of small samples with a thickness of about one millimeter. The samples were removed from the specimens and mounted with Lakeside Cement onto etched glass micro-slides.

The thickness of each sample was reduced by manual grinding with a slurry of #500 silicon carbide abrasive on plate glass. Grinding was completed in two steps. The first grinding was stopped when a sample's thickness was reduced by approximate one-half. This eliminated any microchips created by the saw blade during the cutting process. Slides were then reheated, which liquefied the Lakeside Cement, and the samples inverted. Newly exposed surfaces were then ground until proper thicknesses were attained.

Correct thin section thickness was determined by the "touch" technique. A finger was rubbed across the slide, onto the sample, and the difference (sample thickness) was "felt." The second technique used to arrive at proper thin section thickness is the "transparency" test where each microslide was held up to a strong source of light and the translucency of the samples was observed. A sample was reduced enough when it readily allowed the passage of light. A coverslip was affixed over each sample when grinding was completed. The completed microslides are curated at our hydration lab under File No. 99-H1894.

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The hydration bands were measured with a strainfree 60 power objective and a Bausch and Lomb 12.5 power filar micrometer eyepiece on a Nikon petrographic microscope. Six measurements were taken at several locations along the edge of each thin section. The mean of each set of measurements was calculated and listed on the enclosed data pages with other pertinent information. The hydration measurements have a range of +/- 0.2 microns due to normal limitations of the equipment.

All specimens yielded hydration band measurements. Only one specimen (#14) yielded a hydration band measurement that was so small that it appears to date from a very late period. Also, one specimen was marked by hydration bands of different thicknesses on opposing faces. The thinner band is denoted as "Band 1" and the thicker as "Band 2" under the "Remarks" column on the data page. Overall, the hydration band measurements are relatively consistent for each site. Assuming that the two sources hydrate at roughly equal rates and that the sites have been subjected to similar environmental conditions, then hydration based seriation of the sites would be as follows:

LA 45961	- most recent
LA 50460 (east)	
LA 50460 (west)	- oldest.

Don't hesitate to contact me if you have questions.

Sincerely,

Thomas M. Origer, Director
Obsidian Laboratory

LA 50460/East Submitter: M. Marshall - Cibola Research Consultants June 11, 1999

Lab#	Specimen#	Description	Unit	Level	Remarks	Measurements	Mean	Source
1	1	Debitage	Grid D-11	20-30	none	3.6 3.7 3.7 3.8 3.8 3.8	3.7	ER(x)
2	2	Debitage	Grid D-10	20-30	none	3.8 3.8 3.8 3.9 3.9 3.9	3.9	ER(x)
3	3	Debitage	Grid E-11	20-30	none	3.8 3.8 3.8 3.8 3.8 3.9	3.8	ER(x)
4	4	Point	Grid E-11	20 cm	none	3.9 3.9 3.9 4.0 4.1 4.1	4.0	VG(x)

Lab Accession No.: H1894 Technician: Thomas M. Origer

LA 50460/West Submitter: M. Marshall - Cibola Research Consultants June 11, 1999

Lab#	Specimen#	Description	Unit	Level	Remarks	Measurements	Mean	Source
5	5	Point	Grid G-29	2a; 45 cm	none	4.3 4.3 4.4 4.4 4.5 4.5	4.4	ER(x)
6	6	Point	Grid G-30	2b; 53 cm	none	4.3 4.3 4.3 4.3 4.4 4.4	4.3	VG(x)
7	7	Point	Grid H-30	2a	none	4.2 4.2 4.2 4.3 4.3 4.3	4.3	ER(x)
8	8	Point	Grid F-35	2b; 70 cm	none	4.2 4.3 4.4 4.4 4.4 4.4	4.4	VG(x)
9	9	Debitage	Grid H-32	1-2a	none	4.1 4.1 4.1 4.2 4.2 4.4	4.2	VG(x)
10	10	Debitage	Grid H-34	2b	Band 1	4.2 4.2 4.2 4.3 4.4 4.4	4.3	VG(x)
10	10	Debitage	Grid H-34	2b	Band 2	7.1 7.1 7.1 7.2 7.2 7.2	7.2	VG(x)

Lab Accession No.: H1894 Technician: Thomas M. Origer

LA 45961 Submitter: M. Marshall - Cibola Research Consultants June 11, 1999

Lab#	Specimen#	Description	Unit	Level	Remarks	Measurements	Mean	Source
11	11	Debitage	Grid C-10	surface	none	3.3 3.3 3.4 3.4 3.4 3.4	3.4	VG(x)
12	12	Debitage	Grid D-9	1; 0-15cm	none	3.0 3.0 3.0 3.0 3.1 3.3	3.1	VG(x)
13	13	Debitage	Grid C-10	1; 0-15cm	none	3.0 3.0 3.1 3.1 3.1 3.1	3.1	VG(x)
14	14	Debitage	Grid F-11	1; 0-15cm	none	1.1 1.1 1.2 1.2 1.2 1.2	1.2	VG(x)
15	15	Debitage	Grid E-11	1; 0-15cm	none	3.0 3.0 3.0 3.1 3.2 3.3	3.1	VG(x)

Lab Accession No.: H1894 Technician: Thomas M. Origer