MUSEUM OF NEW MEXICO

OFFICE OF ARCHAEOLOGICAL STUDIES

EXCAVATIONS AT TWO PREHISTORIC LITHIC SCATTERS ALONG U.S. 380 IN SOCORRO COUNTY, NEW MEXICO

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ADMINISTRATIVE SUMMARY

Two prehistoric lithic scatters (LA 45877 and LA 45878) were excavated by the Office of Archaeological Studies (OAS), Museum of New Mexico, during February and March of 1987 at the request of the New Mexico State Highway and Transportation Department (NMSHTD). The sites are situated along U.S. 380 near Carthage, Socorro County, New Mexico. They are on Bureau of Land Management (BLM) lands located within the highway right-of-way.

The sites were originally reported by Clifton (1983) and subsequent testing was conducted by OAS on these and nine other historic sites. The historic sites, part of the community of Carthage, are described by Zamora (1997). For the testing, Yvonne R. Oakes served as project director and James A. Lancaster acted as field supervisor on the two prehistoric lithic sites. Testing of LA 45877 and LA 45878 revealed extensive lithic deposits with potential for intact subsurface features (Oakes 1984). A data recovery program was completed in 1987 with field excavations directed by Steven R. Hoagland of the OAS (formerly the Research Section). A geomorphological study found both sites to be the result of downslope movement of soils and gravels. The lithic artifacts are probably Archaic in age but have been displaced from their points of origin.

Unfortunately, Mr. Hoagland and several succeeding assigned authors left the OAS without completing the report on the two sites. Field notes, site records, and photographs were put into storage. The artifacts were, however, analyzed, but write-up was not finished. This report undertakes a reconstruction of the work attempted by these earlier authors. Data are not as complete as we would have liked; however, the findings are presented to the best of our ability, given the inherent problems in completing another archaeologist's material.

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NMSHTD Project: SPF-019-1(202)
Antiquities Permit: No.81-NMC056

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INTRODUCTION

At the request of Mr. William Taylor of the NMSHTD in 1983, the OAS conducted a testing program at eleven sites along U.S. 380 from its intersection with I-25 at San Antonio east to its junction with NM 525 (7.9 miles) in Socorro County, New Mexico. The NMSHTD planned to reconstruct and improve the highway corridor in this area (NMSHTD Project SPF-019-1(202). Two of the sites were prehistoric lithic artifact scatters with potential for subsurface features and, therefore, a data recovery program was prepared (Oakes 1984). Other sites were part of the historic mining community of Carthage and data recovery is described in Zamora (1997). The two lithic artifact scatters (LA 45877 and LA 45878) are located on Bureau of Lan Management lands within the highway right-of-way (Fig. 1). Legal descriptions are provided in Appendix 1. The data recovery program, implemented in February and March of 1987, revealed that both of the sites were the result of redeposition of soils, gravels, and artifacts around 2,000 years ago, as confirmed by a geomorphologist (see McFadden, this report).

Testing was conducted by James A. Lancaster and excavations by Steven R. Hoagland, field supervisors of the OAS. John Ware served as principal investigator. Both supervisors left the employment of the OAS soon after fieldwork was finished and the report was not completed. Now, 14 years later, this report describes the excavations at the two sites as conducted by these earlier researchers and presents the results of their findings, as best as possible.

This undertaking complies with the provisions of the National Historic Preservation Act of 1966 and applicable regulations. The report is consistent with applicable federal and state standards for cultural resource management.

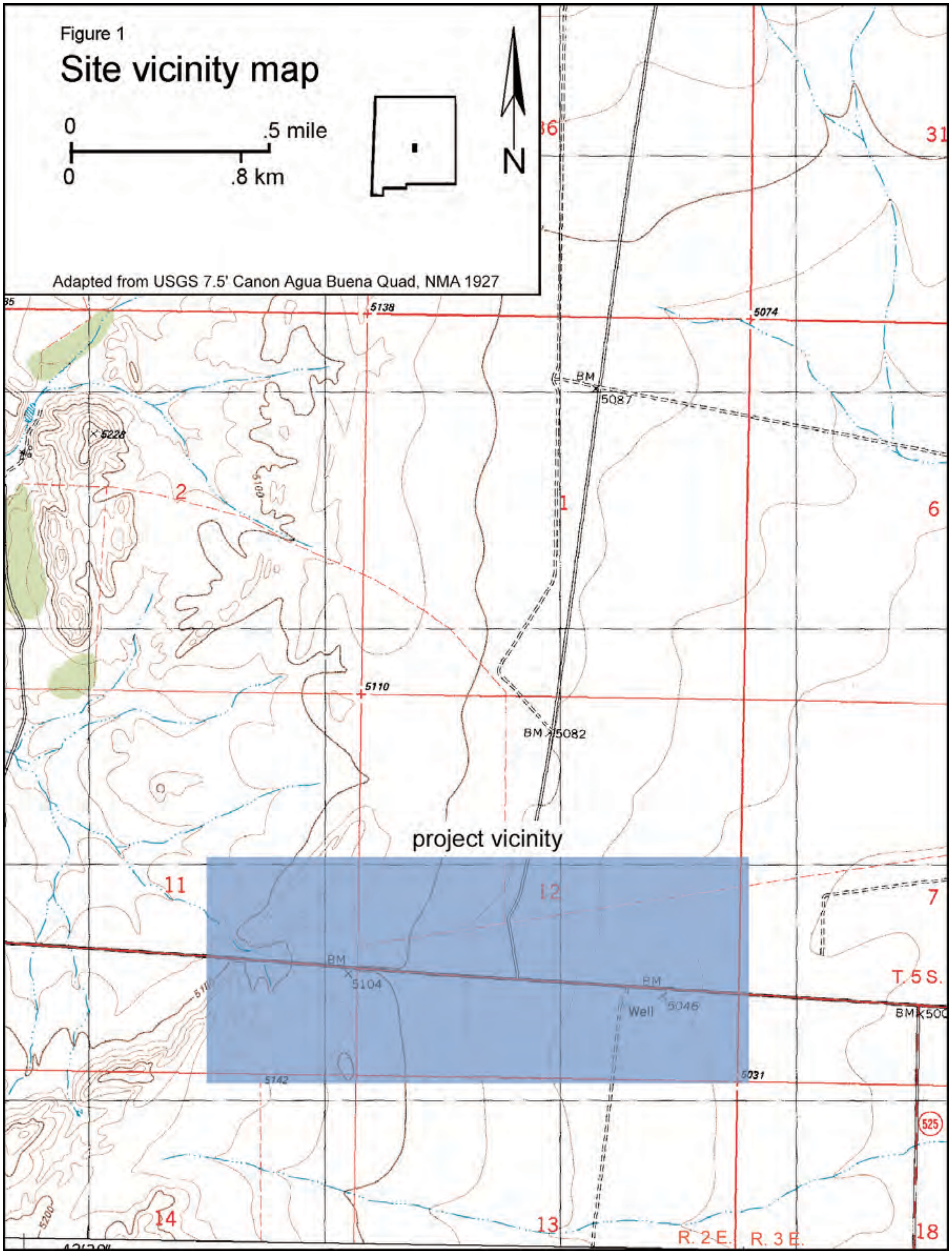
Figure 1
Site vicinity map
0
.5 mile
0
.8 km
N
Adapted from USGS 7.5' Canon Agua Buena Quad, NMA 1927
project vicinity
5138
5074
BM
5087
5228
2
1
6
36
31
5110
BM 5082
11
12
7
BM
5104
BM
Well
5046
T. 5 S.
5142
5031
525
14
13
R. 2 E.
R. 3 E.
18

ENVIRONMENTAL SETTING

At an elevation of 1,555 m (5,100 ft), the two sites lie within a relatively open area within the Loma de las Camas hills of Socorro County. The terrain in the immediate area is characterized by gently rolling dunes at LA 45877 and by a gradual east-sloping decline at LA 45878. The sites are surrounded by dissected arroyos that are 6 to 8 m deep and the closest water is the intermittent San Pedro Arroyo at a distance of 0.2 km and 0.6 km. The following sections are derived mainly from earlier reports on the project area and the nearby Carthage mining community (Oakes 1984; Zamora 1997).

Physiography

The project area lies within the Basin-and-Range Province of the Mexican Highland section on the eastern edge of the rocky hills and ridges of the Loma de las Camas before they give way to the vast, flat expanse of the northern Jornada del Muerto. The geological formations around the area also include the Joyita Hills, Cerro Colorado, and the Little San Pasqual Mountains ranging in age from the Mississippian to the Cretaceous ages. The formations are mostly limestone but also contain sandstones, dolomites, interbedded shales and conglomerates, mudstones, siltstones, and gypsum. Rhyolitic and andesitic rocks also are present in the area (Anderholm 1983:303). Fossils, gastropods, and ammonite chambers can often be found in the Fite Ranch sandstone (Smith et al. 1983:23). Several peaks in the area were formerly centers of volcanic activity and some are laccoliths. Faulting sometimes outlines the structural features of the region (Fenneman 1931:379-390). One fault runs north-south along the crest of the Lomas de las Camas.

Today, water drains eastward from the Loma de las Camas and surrounding hills in intermittent flows after heavy rains. However, most of the year the area is dry. Prehistorically, the water availability must have been much greater in order to support the various pueblos and campsites in the area.

Soils

The soil in the area is sandy loam containing gravels and has low water-retention capacity. Some has been utilized for grazing but much is unusuable. Soil in the site areas belong to the Haplargids-Torripsamments association (Maker et al. 1979:36-37). These soils are found in the eastern portion of the region and are comprised mostly of sandy soils on gently rolling lands. Heavy wind erosion in the area frequently has created coppice dunes stabilized by mesquite and other shrubs. These often actively erode during windy periods. However, there are small areas of gently sloping soils in swales and infrequent depressed areas. Soils are moderately deep and are developing in eolian and valley-filling sediments derived from surrounding outcropped rocks. Surface soils are noncalcareous, fine sandy loam over thick, sandy clay loam subsoils. Thick gypsum beds develop at 25 to 50 cm below the surface. Representative soils for the project area are Berino, Bluepoint, and Onite.

A geomorphological study conducted by McFadden (this report) found that soils on the sites could be stratified into three general layers. The first 5 to 15 cm of surface soils consisted of thin, somewhat gravelly, fluvial deposits. The second soil horizon was moderately nongravelly ranging in depth from 5 cm to about 65 cm. The soil appeared to be a weakly developed, fluvially reworked eolian deposit formed as a result of dune erosion. At about 65 to 160 cm below the surface was a moderately to strongly developed soil showing a well-developed calcic horizon. At this depth, the parent material appeared to be fluvially deposited gravelly sand with a slightly higher clay content than in the upper soil horizons.

Climate

The climate of the area is classified as semiarid, averaging 355.6 mm (14 inches) of precipitation annually with less in the nearby Rio Grande Valley and more in the mountains, a reflection of elevational changes in the topography of the region. The majority of precipitation is in the form of rainfall during the months of July through September, with over 45 percent of the annual total occurring at this time. This summer-dominant rainfall pattern is caused by an extension of the Bermuda subtropical high pressure cell moving north out of the Gulf of Mexico into the area. The system pushes moist, unstable air into the region, while at the same time solar activity causes the ground to heat up, producing a strong rising air mass that often develops into thunderstorms. Spring is the driest period, as it falls between the summer air currents from the Gulf of Mexico and the weaker winter storm systems from the Pacific Ocean, which are characterized by high pressure, dry, stable, continental air patterns (Bennett 1986a). Winter snowfall averages 152 mm (6 inches) annually (Bennett 1986b).

The average annual number of days with temperatures of 32.2 degrees C (90 degrees F) or greater ranges from 111 in the Rio Grande Valley to 21 in the mountains. The mean maximum temperature was 24.4 degrees C (76 degrees F) in 1960 and the mean minimum temperature was 4.9 degrees C (41 degrees F). The frost-free period is 180 to 192 days, generally from mid-April to late October (Maker et al. 1972:7-9).

Flora and Fauna

The project area soils support a fair cover of vegetation. The dominant understory of grasses includes black grama, mesa dropseed, sand dropseed, giant dropseed, and fluffgrass. Less common are the shrub species of mesquite, yucca, broom snakeweed, and sand sagebrush. The deeper sands support a sparse to fair vegetational cover of creosotebush, mesquite, chamisa, and small amounts of smakeweed, mesa drospeed, spike dropseed, black grama, bush muhly, and various annuals. Some tobosa is found in swales and small depressions (Maker et al. 1979:36). Occasionally, cacti, three awn, saltbush, and juniper are also present (Martin 1986).

A variety of faunal species are found within the project area and include jack rabbit, cottontail, coyote, antelope, and deer (in the eastern section), bobcat, ground squirrel, redtail hawk, golden eagle, roadrunner, scaled quail, rattlesnake, kingsnake, various lizards, millipedes, and scorpions (MacMahon 1985).

CULTURAL OVERVIEW

(adapted from Oakes 1986)

A recent review of the current literature on the Rio Abajo area reveals that very little work has been done in this region since the flurry of activity in the mid-1980s. This is, in fact, one of the most understudied regions in New Mexico despite the presence of some very large Late Pueblo sites. Information for this section was derived mainly from Oakes (1986) because little has been written about the cultural history since that time. The few updates found are added to this section where appropriate.

The two sites described in this report are within what has been generally identified as the Rio Abajo area. The term has been used to define the southern sector of the vast Rio Grande region. The Rio Abajo has been the domain of prehistoric and modern peoples throughout history. However, the area suffers from a lack of substantially large surveys, systematic excavations, and rigorous examination, in contrast to the Northern Rio Grande area. Dating of Rio Abajo sites has been based almost entirely on ceramic cross-dating. There is no comprehensive database from which to generate valid explanations for the variety of cultural processes that occurred in the region.

Existing Database

The first account of archaeological investigations in the Rio Abajo is found in the journals of Adolph F. Bandelier, who in 1881 visited and described numerous sites along the Rio Grande near Socorro (Lange and Riley 1966:320). Not until the 1930s were further archaeological explorations conducted in the region. H. W. Yeo examined the area from Valverde to San Marcial and left copious notes on file at the Laboratory of Anthropology, Museum of New Mexico. In the late 1930s, H. P. Mera located and documented 24 Piro pueblos in the Rio Abajo. His research focused on ceramic distributions and temporal affinities of glaze period sites (Mera 1940), and conditioned archaeological inquiry in the Rio Abajo for many future archaeologists. From 1940 to 1970, Mera was one of the few researchers interested in the region, publishing articles mostly on ceramic data (Mera 1943).

Until recently, most research focused on the late Piro settlements along the Rio Grande. Not until the 1970s, when Weber and Agogino (no report published) uncovered numerous Paleoindian finds at Mockingbird Gap, 16 km (10 miles) west of the project sites, was attention diverted to earlier cultural manifestations in the region. The 1970s saw further reconnaissance of the Rio Grande area when six major Piro settlements were located and documented. At this time, Weber (1973) also partially excavated a pithouse community southeast of Socorro from the previously unstudied Pueblo II period (ca. A.D. 950-1100).

A complex of pithouses and surface rooms east of the Rio Abajo region in the southern foothills of Chupadero Mesa was excavated by Peckham (1976) at Taylor Draw. The work is significant for the Rio Abajo because the architectural and ceramic material is closely related to the area and to the Mogollon country further west. Peckham (1976) places the Taylor Draw site within a late Pueblo I/Pueblo II (late Tajo) time frame. Another pithouse site (LA 71276), just west of Taylor Draw was excavated by Levine (1997). It was radiocarbon-dated to a calibrated A.D. 930-1010 within the Tajo phase. It also had similar architecture and ceramics to sites in the Rio Abajo.

Marshall (1976) published results of a survey conducted from Socorro south to Bosque del Apache. He recorded a high density of sites along the Rio Grande and surrounding benches, including an extension of sites to the east along major arroyos and drainages. The concept of regional cultural diversity finally became established with the confirmation of pithouses, field camps, lithic artifact scatters, and changing ceramic components in the same geographic locales as the well-known Piro pueblos.

Overviews by Berman (1979), Cordell (1979), and Stuart and Gauthier (1981) are important syntheses of work done in areas mostly just outside of the Rio Abajo. However, they all agree that there is a lack of understanding of the area east of the Rio Grande in terms of Mogollon/Anasazi adaptations, architectural diversity, and changing social organization.

Wimberly and Eidenbach (1980) surveyed a 10-mile area along the lower Puerco and Salado rivers and recorded 54 sites dating to the Pueblo period. Winter (1980) conducted an excavation of Sevilleta Shelter, just north of Socorro, with the major occupation dating to the Pueblo II period, based on ceramics and one of the first radiocarbon dates for the area at A.D. 1065±80. In 1981, the University of New Mexico field school focused attention on the Rio Abajo with the first excavation of a Piro pueblo, LA 282 (Earls 1983). Testing of six sites in the Sevilleta National Wildlife Refuge by Hogan and Winter (1981) continued to expand the database for the Rio Abajo, as did a survey by Gossett and Gossett (1982) for an area immediately southeast of the project region. Eight lithic and/or ceramic scatters were located, three of which were subjects of further study (Gossett and Gossett 1983).

Lekson and Wandsnider (1983) developed a predictive land-use model for site location in and around the project area, based upon an environmental planning statement for the East Socorro District by the BLM (1979). Soil associations and vegetal zones were linked to site locations to produce wild plant resource and agricultural models.

An extensive survey of much of the Rio Abajo region from Fra Cristobal to Abeytas was conducted by Marshall and Walt (1984). The survey identified considerable architectural and ceramic variability, which Marshall ordered into a systematic scheme. The study is a valuable synthesis of sites in the area.

Cultural Sequences

Various systems have attempted to classify sites culturally and temporally within the Rio Abajo. The standard used throughout the state, the Pecos Classification (Table 1), has been extensively used in the Rio Abajo. However, Marshall and Walt (1984) established a sequence specifically for sites in this region and it is also presented in Table 1. This report follows the Marshall and Walt (1984) scheme.

TABLE 1. CLASSIFICATION SCHEMES FOR THE RIO ABAJO

CULTURES	DATES	RIO ABAJO	PECOS
PALEOINDIAN	10,000-5000 B.C.		
ARCHAIC	5000 B.C.-A.D. 200		
PUEBLO	A.D. 200-700	SAN MARCIAL	BM II/III
	A.D. 700-1000	TAJO	PUEBLO I
	A.D. 1000-1100	EARLY ELMENDORF	PUEBLO II
	A.D. 1100-1300	LATE ELMENDORF	PUEBLO III
	A.D. 1300-1540	ANCESTRAL PIRO	PUEBLO IV
	A.D. 1540-1680	COLONIAL PIRO	PUEBLO V
MODERN	1700-PRESENT		

Paleoindian Period (10,000-5000 B.C.)

Paleoindian occupation of the Rio Abajo may have been extensive, with many remains found in immediately adjacent areas such as the northern Jornada del Muerto and the Plains of San Agustin to the west. In the northern Jornada at nearby Mockingbird Gap, Weber located extensive Paleoindian campsites with hearths and light artifact scatters (Cordell 1979:12). The sites are often multicomponent, with diagnostic projectile points ranging from Clovis (N=150), Folsom, and Midland, to Plano (Marshall 1976). The significance of these sites cannot be overstated. The area, now a dry basin with intermittent stream flow, was once the location of numerous lakes and playas in the early Pleistocene. The sites, which were probably situated around these sources of water, are now mostly covered with sand dunes. Where dunal deflation has occurred, sites have been exposed, suggesting there may be many more campsites present in the area (Weber 1963). Indeed, numerous isolated Paleoindian projectile points and scrapers have been recovered from the region (Kayser and Carroll 1988).

The Plains of San Agustin have also yielded Paleoindian sites occurring in deflated dunes, generally near playas (Bussey and Beckett (1974). Weber (1963) has documented isolated Clovis spear points throughout Socorro County in association with diatom-bearing pond or stream deposits, and Folsom points on open plains and in mountain foothills.

The climate during the Paleoindian period was quite a bit wetter and cooler than today. In the now desert environment of the Rio Abajo, lakes and playas once were not uncommon in the basins and lower lying areas. These conditions would have attracted big-game such as mammoth and bison and drawn Paleoindian hunters to the region.

Archaic Period (5000 B.C.-A.D. 200)

This period is not well documented for the region, primarily because necessary chronometric data have not been collected. Like Paleoindian sites, Archaic manifestations are found in dunal situations around former lakes and playas and near springs (Berman 1979:18). Use of caves and rockshelters has also been recorded. Earls (1983) notes that there are numerous aceramic sites along the Rio Grande, which may be Archaic, associated with hearths, ground stone, and fire-cracked rock. Weber (1963) states that Archaic sites extend from river terraces, open plains, foothills, and canyons to high ridges and saddles.

There seems to be a wide range of adaptive strategies employed by Archaic populations in the region, focusing on a broader-based hunting and gathering economy. Evidence, mostly from caves and rockshelters, indicates economic use of mesquite, yucca, hackberry, prickly pear, acorns, and pinyon nuts. Other Archaic sites have yielded seeds of amaranth, grasses, sagebrush, and saltbush (Whalen 1971:99-100). This diverse exploitation of the surrounding resources is also reflected in the variety of manos, metates, mortars, and pestles found on Archaic sites. Cultigens may also have been incorporated into the subsistence strategy towards the end of the period. There are diverse opinions, however, based on the vegetal data, as to the length of occupation of these sites (Beckett 1973).

Because of the lack of a chronometric template for the Archaic in the Rio Abajo, most classification has been based solely on projectile point style and lack of ceramics, tenuous indicators at best. Excavation of stratified Archaic sites is necessary to resolve the chronological and economic ambiguities of the period (Marshall and Walt 1984).

Pueblo Period

San Marcial Phase (BM II/III; A.D. 200-700). This phase may present the earliest evidence of sedentary adaptations in the Rio Abajo. However, Winter (1980:25) believes the San Marcial phase was actually a semimobile adaptation, citing evidence of both farming and foraging activities on sites. The sites are generally small, with one to eight structures, and are characterized by irregular, shallow pithouses and jacal units in association with storage pits (Marshall and Walt 1984:35). Ceramics appear for the first time on these sites and exhibit both Mogollon and Anasazi traits. Most sites cluster in the southern Rio Abajo near Black Mesa and somewhat in the north along the Rio Salado (Wimberly and Eidenbach 1980). The predominant ceramic ware is locally produced San Marcial Black-on-white in association with plain brown Mogollon wares and minor amounts of plain gray pottery.

All sites of the San Marcial phase have been dated by ceramic association. No excavations of this phase have been undertaken and so the accuracy of the ceramic dates has never been tested.

Tajo Phase (Pueblo I; A.D. 700-1000). The phase is characterized by a change from pithouses to above-ground, rectangular rooms, often in a linear arrangement and formed of cobble-based jacal construction (Cordell 1979:135). Sites remain small, consisting of one to ten rooms, with occasional pithouses present (Marshall and Walt 1984:47). No ceremonial structures have been documented for this phase. Ceramics are primarily brown wares, both plain and banded, with some Red Mesa Black-on-white. San Marcial Black-on-white is no longer in use. Cibola White Wares show up later in the phase.

Sites frequently occur on the edges of gravel benches and range from San Pedro Wash (adjacent to project sites) north to the Rio Puerco. Several Tajo phase sites have been located near the study area (Marshall and Walt 1984; Oakes 1986); only LA 45884 has been excavated (Oakes 1986). North of Socorro, Hogan and Winter (1981) conducted a testing program on several late Pueblo I (Tajo phase) sites and to the east near Taylor Draw, Levine (1997) excavated a single pithouse also of the Tajo phase. A survey on the northern edge of nearby White Sands Missile Range produced over 20 sites dating ceramically to the Tajo phase (Sale 1988).

Early Elmendorf Phase (Pueblo II; A.D. 1000-1100). Population growth, agricultural intensification, and evidence of increased social interaction are characteristic of this phase (Winter 1980:28). Pithouses are occasionally found along with surface structures, although masonry tends to replace jacal as the primary construction material (Cordell 1979:36). The average site is still fairly small, from three to ten rooms, although sites with one hundred or more rooms are known. Sites tend to aggregate into small villages spread over diverse geographic areas, from the Bosque del Apache to the lower Rio Puerco, to elevated benches along the east bank of the Rio Grande (Marshall and Walt 1984:75). They believe this represents a change in social organization but not necessarily a sign of population growth as suggested by Winter (1980). Ceramics are primarily brown wares with an increase in texturing. During this time, local white wares also appear, such as Elmendorf Black-on-white, often considered an unscored Chupadero Black-on-white (Levine 1997:9).

This phase is represented by two excavated sites, the Tajo 2 pithouse site (Weber 1973) and Sevilleta Shelter with a radiocarbon date of A.D. 1065±80 (Winter 1980).

Late Elmendorf Phase (Pueblo III; A.D. 1100-1300). Woodbury (1979:28) defines the Pueblo III development as one of large communities, intensive local specialization, and a greater concern with the esoteric. Populations increased slightly. While small villages still exist, sites are frequently aggregated into large fortified complexes arranged around plazas; many are situated in high, defensive locations. Pueblos are usually of masonry construction with some cobble-based jacal. Pithouses are rare. Corrugated wares dominate plain wares, and there is a trend toward the use of carbon rather than mineral paints. At small sites, the presence of White Mountain Redware is said to be the only characteristic distinguishing early and late Elmendorf phase sites (Marshall and Walt 1984:75, 95). The division into cultural phases based on the presence or absence of White Mountain Redware points to the need for a more accurate basis of distinction.

Most sites are on the east side of the Rio Grande between San Acacia and San Pedro. Winter (1980:29) notes that these sites are located further from the river and at higher elevations than earlier sites. One such site, Bell Mountain (LA 1080), is on Campana Peak, approximately 11.2 km southeast of the project area. It consists of 300 or more rock-walled rooms near the summit of this prominent peak.

No Pueblo III sites have been excavated within the Rio Abajo.

Ancestral Piro (Pueblo IV; A.D. 1300-1540). This phase includes those sites inhabited up to the time of Spanish contact and is marked by the appearance of Rio Grande glaze wares, with a dominance of Glaze A and some C and D. During this time, there appears to have been a large population increase; people lived in large villages, often multistoried, of 200 to 600 rooms with plazas. Construction material is mostly puddled, coursed adobe. Jacal structures occur as isolated rooms (Marshall and Walt 1984:135). Earls (1983) believes that the general lack of small sites during this period may be the result of changing subsistence strategies, low visibility of small sites, or the lack of systematic survey.

Ancestral Piro sites spread into previously unoccupied zones along low terraces and into the southern desert river areas. Most are located between the Bosque del Apache, directly west of the project area, and the northern limits of the Rio Abajo. Sites are often paired, one on each side of the Rio Grande at regularly spaced intervals at a mean distance apart of 12.8 km (Marshall and Walt 1984:135). LA 282 (Earls 1983) is the only Piro settlement excavated in the Rio Abajo of this period and it spans both Pueblo IV and Pueblo V times.

Colonial Piro (Pueblo V; A.D. 1540-1680). Events occurring during the Colonial Piro period include Spanish contacts, the Pueblo Revolt, and subsequent abandonment of the Rio Abajo by the Piro. Village plans remain similar to those of the preceding period, with a reliance on masonry or masonry-based adobe construction materials. Rio Grande glazes degenerate into Glaze E and F types and exhibit some Spanish influence. A small number of Mexican earthenwares are also present. Site locations tend toward smaller, isolated units away from previously occupied centers. A small fieldhouse of this time with ceramics displaying Spanish forms has been excavated within the project area by Oakes (1986). A large pueblo of the period, Qualacu, located along the Rio Grande near San Antonio, was excavated by Marshall (1987).

Some of the notable events of the period begin with the first Spanish contact in 1540 between Coronado's recconaissance party and four Piro pueblos in the Rio Abajo. Accounts of entradas between 1581 and 1583 describe mud-walled houses in settlements on both sides of the river. Espejo stated that the Piro occupation consisted of 20 pueblos with a population of over 12,000 (Hammond and Rey 1966:219). In 1598, the Piro settlement of Teypama was renamed Socorro by Oñate (Betancourt 1980:33). By 1600, Spanish *obedencias* listed 44 settlements. From this point on, however, population figures began to drop, whether from decimation by disease or warfare, Piro abandonment or resettlement into outlying areas (such as Magdalena to the west), or rising Apache depredation. By 1630 there were only fourteen pueblos, and this number was further reduced to four by the time of the northern-based Pueblo Revolt in 1680 (Bandelier 1892:249). During the 1680s, the Rio Abajo was abandoned, probably as much because of Apache incursions as because of consequences of the Pueblo Revolt, which precipitated widespread abandonment of the entire Rio Grande area by Indian groups. The Piro moved south to El Paso del Norte, where their descendants live today.

Modern Period

From approximately 1700 to 1800 the Rio Abajo area remained basically unsettled because of Apache depredation. There were several Spanish land grants allotted in the region during this time, beginning in 1739, when some small Spanish communities and estancias were established. The area did not see major reoccupation until the early 1800s, following the resettlement of Socorro in 1815. By 1820, the former Camino Real, which followed the Rio Grande between Mexico and Santa Fe, became reestablished as the Chihuahua Trail (Betancourt 1980:37). Because of continued Apache presence, troops were stationed along the route at Socorro between 1849 and 1851, as well as Fort Conrad and Fort Craig, built during this period. The Apache problem was not resolved until 1864 when Anglo occupation increased in response to the Homestead Act of 1862, which opened the territory to cattle ranching and settlement. Mining also became an impetus to development of the Rio Abajo beginning in the 1870s, when mines opened near Socorro and Carthage (Oakes 1984). Today, small Spanish and Anglo agricultural and cattle ranches dominate the landscape near the Rio Grande. Outlying areas, such as in the project vicinity, remain undeveloped except for mining and government installations at nearby White Sands Missile Range. Socorro remains the economic and political center of the region.

RESEARCH GOALS

(adapted from Lancaster 1984)

The testing program at LA 45877 and LA 45878 (Oakes 1984) indicated that significant cultural deposits consisting of lithic artifacts were likely present below the surfaces of the sites. The context of the deposits at both sites suggested that they may be of reasonable antiquity. The materials at LA 45877 were found primarily at the stratigraphic juncture of what appeared to be an old dune surface, while those at LA 45878 were within a gravel layer that was partially cemented by deposits of caliche. Although there are a great number of variables governing the length of time necessary for the deposition of caliche, the maximum depth of the deposits (65 cm below surface), as well as the presence of caliche, presented the possibility of a respectable age for the two sites.

Given both the uncertainty of the temporal placement of the two sites with the possibility that they may be of significant antiquity, one of the goals of the data recovery program was to recover artifact, economic, and stratigraphic data that could be used to date the occupations. Techniques suggested for retrieving these data were radiocarbon dating, archaeomagnetic sampling, and associational dating along with temporally diagnostic artifacts.

If the two sites had proved to be of some antiquity, their proximity to the Mockingbird Gap Paleoindian site could have provided an opportunity for potentially significant comparative analyses. The data recovery plan called for implementation of the type of lithic artifact analyses conducted at the time by Chapman (1977, 1982), Laumbach (1980), and Schutt (1980). The thrust of these investigations was to isolate attributes of lithic debitage that could be used to date archaeological sites. The perfection of such a technique is particularly relevant to the problem of classifying ubiquitous lithic artifact scatters of unknown affiliation. Data generated from the analysis of lithic materials from the two sites, as well as from Mockingbird Gap, could be used to establish a baseline or debitage signature for Paleoindian or Archaic sites. The research potential for studies such as these goes beyond their use simply to date sites: if differences in debitage attributes could have been demonstrated, researchers could have addressed broader questions relative to factors that may have conditioned these differences.

The excavation of the two lithic artifact deposits could have allowed for studies of site structure, albeit at a rather basic level. It may have been possible, from an analysis of the spatial relationship of artifact and/or feature clusters, to determine whether the sites represented single, intense occupations or a series of more sporadic ones. Data such as this would have provided valuable settlement pattern information for the area and a comparative basis from which to further examine such sites as Mockingbird Gap and the AKE site.

Data generated from studies such as these are helpful in beginning to correct what appears to be a bias in the sampling of early, aceramic sites. If the data recovered would have allowed for the dating of the sites to either the Paleoindian or Archaic periods, the above comparisons could have been made. However, as a result of geomorphic studies conducted on-site, both sites proved to be redeposited materials, probably from an early time period, but no diagnostic artifacts or reliable dates were retrieved. Analysis methodology slightly shifted to what was believed at the time to be more appropriate for the assemblage, given its depositional history—the utilization of a lithic analysis model proposed by Sullivan and Rozen (1985).

SITE DESCRIPTIONS

Testing of the sites by OAS revealed the presence of numerous subsurface lithic artifacts to a maximum depth of 65 cm within the highway right-of-way along U.S. 380. A data recovery plan was prepared (Lancaster 1984) and excavations proceeded. Although more artifacts were recovered, no cultural features or utilized surfaces were found. A geomorphological study (McFadden, this report) revealed that both sites were the result of redeposition of soils and artifacts at some earlier point in time. This chapter describes the methods used and the findings of the excavations at the two sites.

Field Methods

Oakes (1984) outlined a four-stage excavation strategy for the recovery of data at LA 45877 and LA 45878. This involved:

1. Pre-Excavation Recording and Preparation: including photographic documentation of the sites and their surroundings, mappping of the site area with a transit and stadia rod, and the establishment of vertical and horizontal controls.
2. Surface Collection and Exploratory Excavations: retrieval of surface artifacts and placement of test trenches in areas of high artifact density and in potential features. The results of these tests will be evaluated and areas warranting more intensive investigations will be identified and examined. (Some surface collections were completed in 5 m diameter dog-leash units during the testing program.)
3. Intensive Excavation: to take place in those areas, such as cultural features and artifact clusters, identified as having high research potential. Excavation will include the collection of appropriate pollen, ethbotanical samples, archaeomagnetic samples, radiocarbon data, soil, and tree-ring samples, if available.
4. Post-Excavation: includes the final site photographic documentation and mapping of any exposed features. All areas will be backfilled upon completion of the excavations.

To implement the data recovery plan, using the methodological guidelines stated above, a primary datum was established on both sites from which north-south and east-west baselines were laid out. Then, a portable 4-by-4-m sq, adjustable grid system was utilized for surface collections at LA 45878. After these collection units were inventoried, a traditional 1-by-1-m grid system (as used at LA 45877) was established for control purposes during subsurface explorations.

Hand tools, including trowels, shovels, picks, and brushes, were used to excavate the site. Grids were dug in natural, stratified levels until sterile soil was encountered. All soil was screened through ¼- inch mesh cloth. Profiles were drawn when more than one stratum occurred in an excavation unit. Artifacts were collected and bagged by grid provenience and level.

At LA 45877, a trench 8-by-1 m in length by 0.60 to 0.80 m deep was hand-dug to expose the stratified soil deposition for geomorphological study. Another trench 14-by-1-m long by 0.70 to 1.20 m deep was excavated at LA 45788. The trenching also confirmed that no intact cultural features were present on the sites. Auger tests, ranging from 0.54 to 1.40 m in depth verified that sterile soil had been reached in the excavation units.

At LA 45877, 114 1-by-1-m grids were excavated (including the trench and seven previous test pits) for a total of 26.00 cu m plus 139 grids that were surface stripped (to a mean depth of 5 cm) for another 6.95 cu m of soil removal with a combined excavation total of 32.95 cu m. Excavations reached 80 cm depth in some units.

And at LA 45878, a total of 32.0 cu m of soil was excavated on the site, which included 96 1-by-1-m grids with a mean depth of 29.7 cm and six test pits with a mean depth of 53.5 cm. The trench is included with the 96 excavated grids. Approximately 20 percent of the units were surface stripped only, accounting for a lower overall mean depth.

LA 45877

Excavations at LA 45877 were conducted primarily along the south side of the highway right-of-way. The site is a 6,240 sq m (120-by-52 m) redeposited lithic artifact scatter originally recorded by Clifton in 1983 (Fig. 2). It is situated on a low, sandy dune ridge, overlooking a broad, open plain.

The site was initially recorded as an 84-by-66-m artifact scatter located on both sides of U.S. 380. Thousands of quartzite, chert, jasper, chalcedony, siltstone, and obsidian flakes showing all stages of material reduction were located in the deep eolian dune. Three possible hearths with fire-cracked rock, a dense concentration of flakes, and a one-hand mano were noted on the south side of the highway (Clifton 1983). The site was subsequently tested for subsurface cultural remains by the OAS (Oakes 1984) in advance of planned road-widening activities. As a result of testing, the site area was reduced to 700 sq m with a sparse artifact scatter and two possible hearths within the highway right-of-way; however, later excavations found the site to be much larger but with only one definable hearth.

In the testing program, directed by J. Lancaster, artifact concentrations were identified and all surface artifacts within these concentrations were collected (N=170 lithic artifacts). In addition, six 1-by-2-m test pits and a 1-by-1-m pit were excavated on both sides of the highway (Fig. 3). Pit depths ranged from 25 to 50 cm. Artifacts were primarily within the upper 12 cm of soil, extending sometimes to 30 cm. An exception was found in two pits in the approximate center of the site, where artifacts were encountered at depths of 45 cm. Testing located one completely deflated hearth as well as the concentrated artifacts in the center of the site. The hearth was found in Test Pit 7 on the northwest edge of the site and only fire-cracked rock remained. Any charcoal had apparently blown away. Although no diagnostic artifacts were recovered, it was believed that the lithic deposits might be representative of considerable antiquity and a data recovery plan was prepared (Oakes 1984).

Excavation units were 1-m square, placed throughout the site within areas of dense artifact concentrations (Fig. 4). Soil was removed in 10-cm arbitrary increments until natural levels were apparent. Work began under the direction of S. Hoagland, with the excavation of a 1-m-wide by 8-m-long trench in the approximate center of the site. It was dug to a depth of 80 cm. All of the excavation units contained 5 to 10 cm of loose, eolian sand (ranging up to 20 cm in rare cases). The majority of artifacts located at LA 45877 were within the first 0 to 30 cm of soil below the surface.

Soil strata were only slightly different in appearance so that distinctions were not readily apparent. The soil varied only slightly in reddish hues by level, with a few dispersed, small rocks scattered between 30 and 50 cm below the surface in a few grids and some small flecks of caliche at 50 to 70 cm depth with a slightly increased clay content appearing by 60 cm depth (Fig. 5).

A consistently high distribution of artifacts was present within the trench. However, no clear breaks or occupation surfaces were denoted by these subsurface concentrations. This may be a direct result of the active eolian nature of the site as well as the ongoing repositioning of cultural material.

The initial trench was used to provide a means for examing the soil formation processes by Dr. Leslie McFadden, Department of Geology, University of New Mexico. Soil samples were extracted and sent to Quaternary Studies Laboratory at the university for textural and chemical

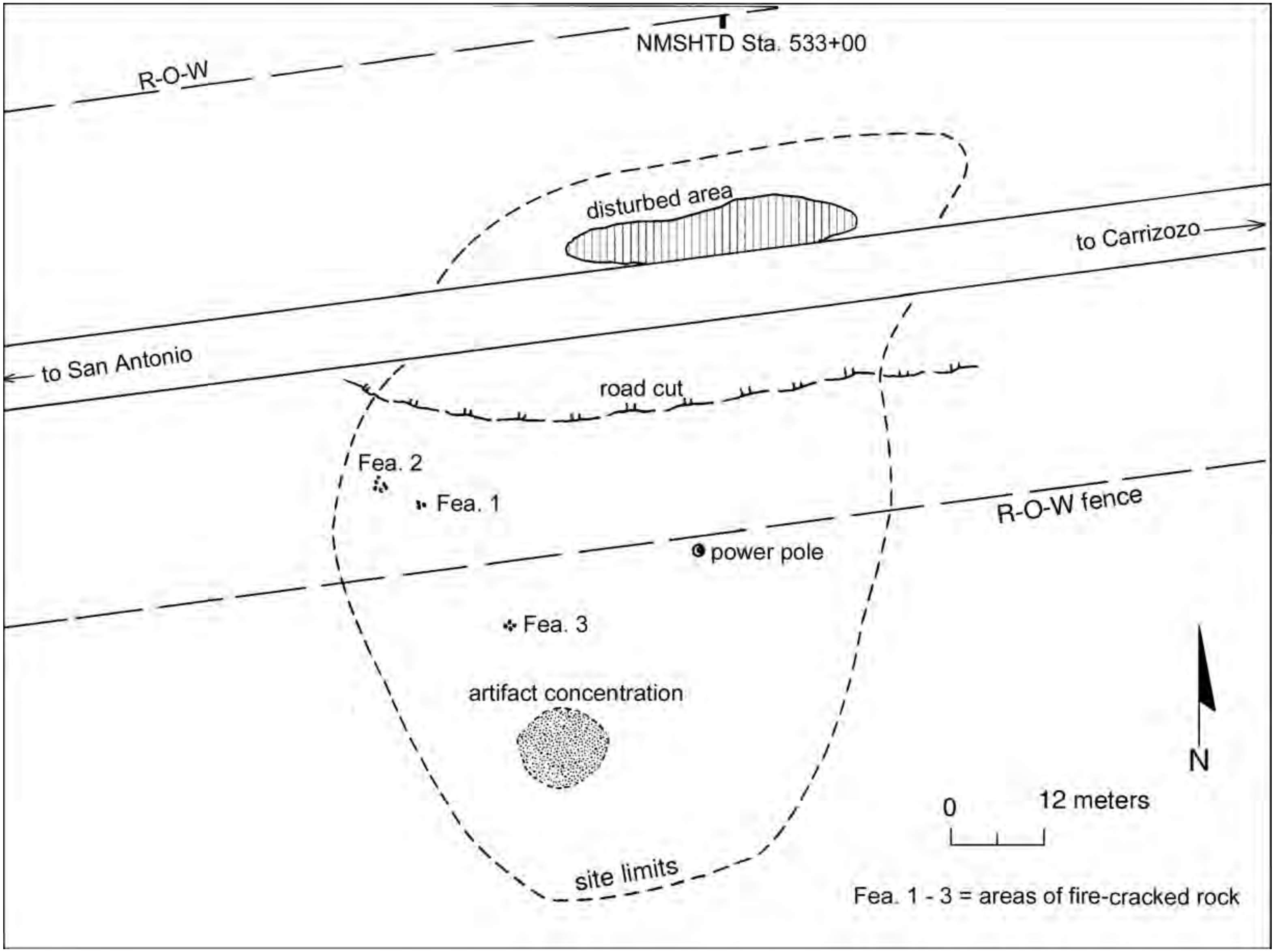

Figure 2. Survey map of LA 45877.

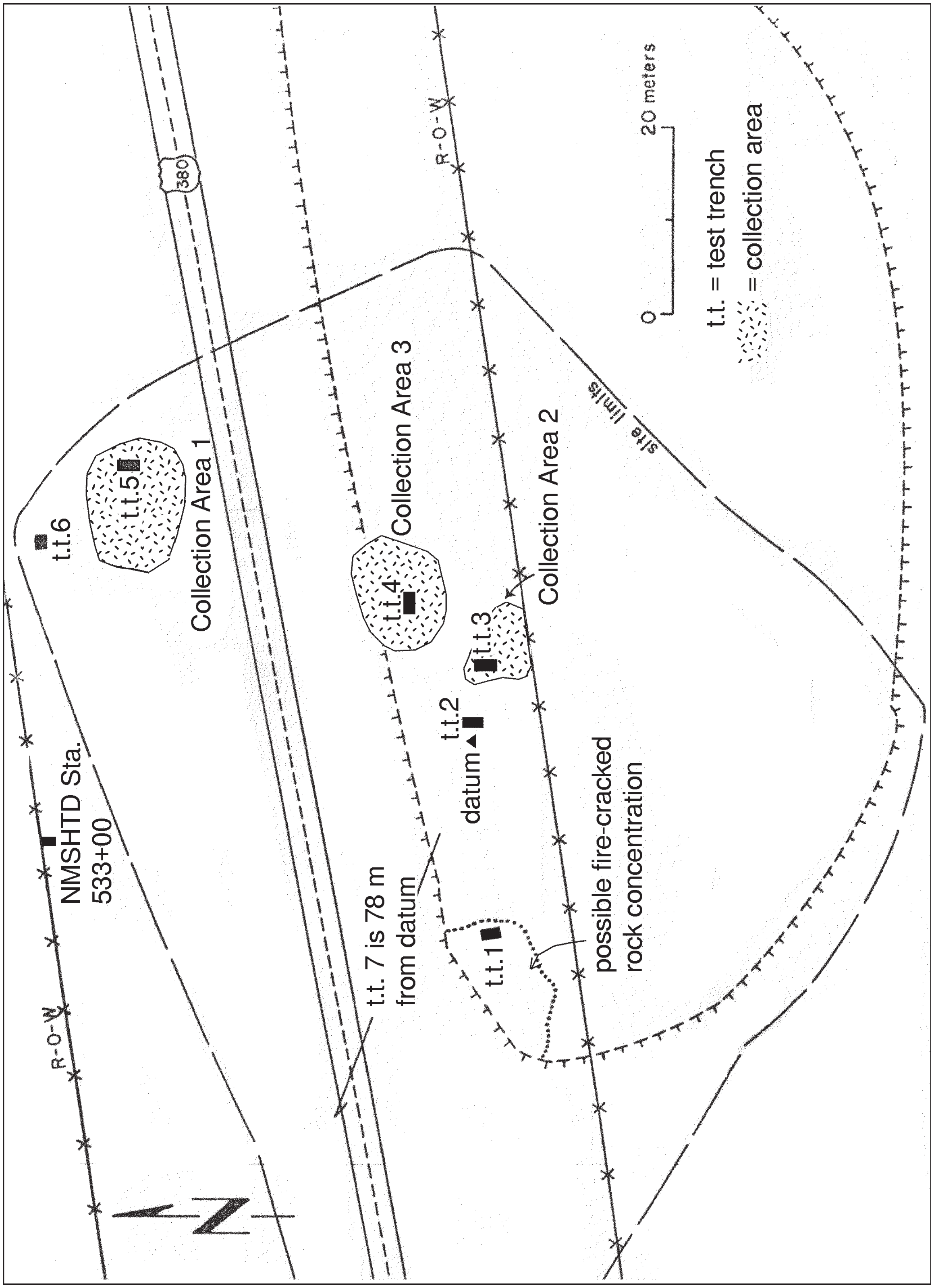

Figure 3. LA 45877 testing map.

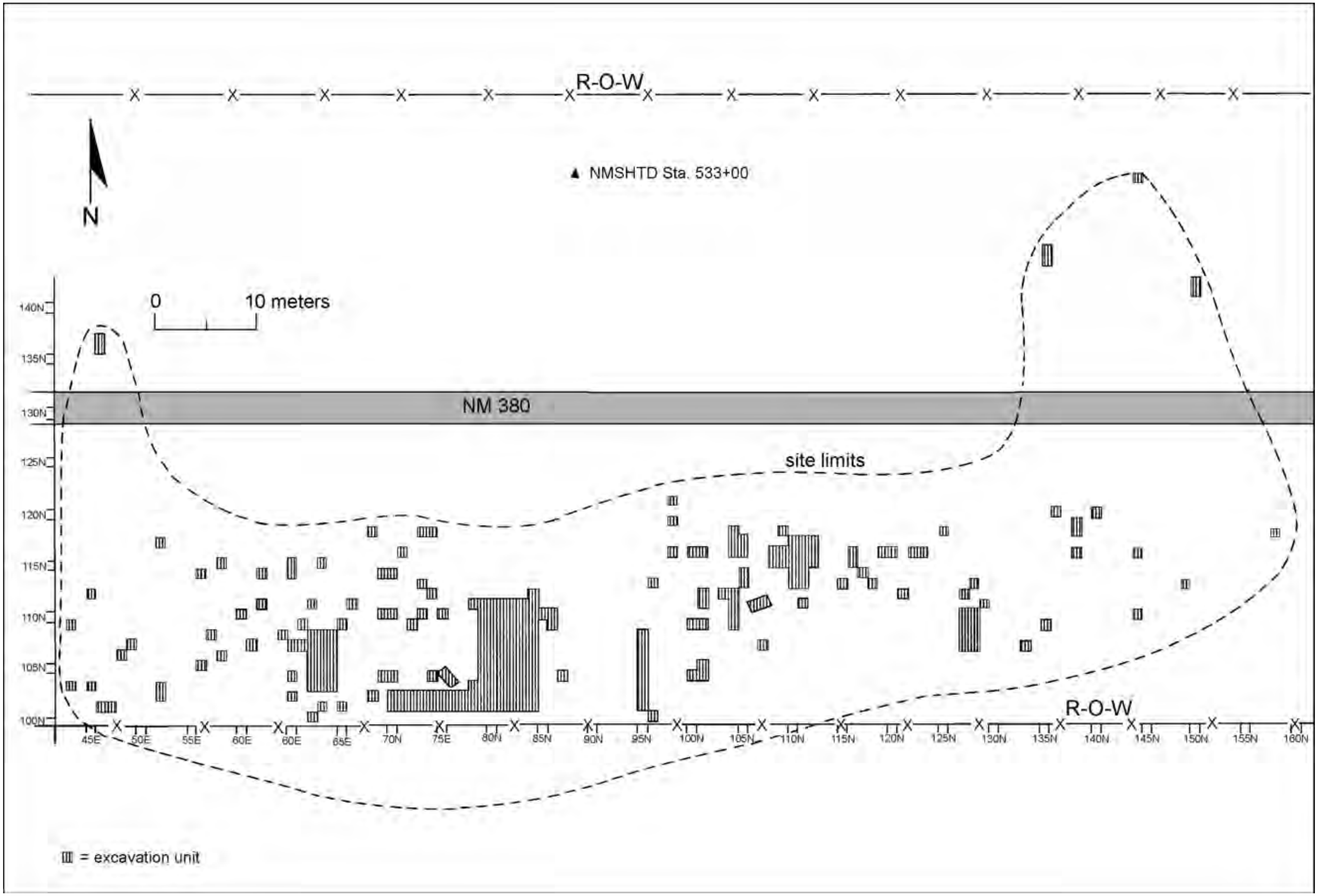

Figure 4. Excavation units at LA 45877.

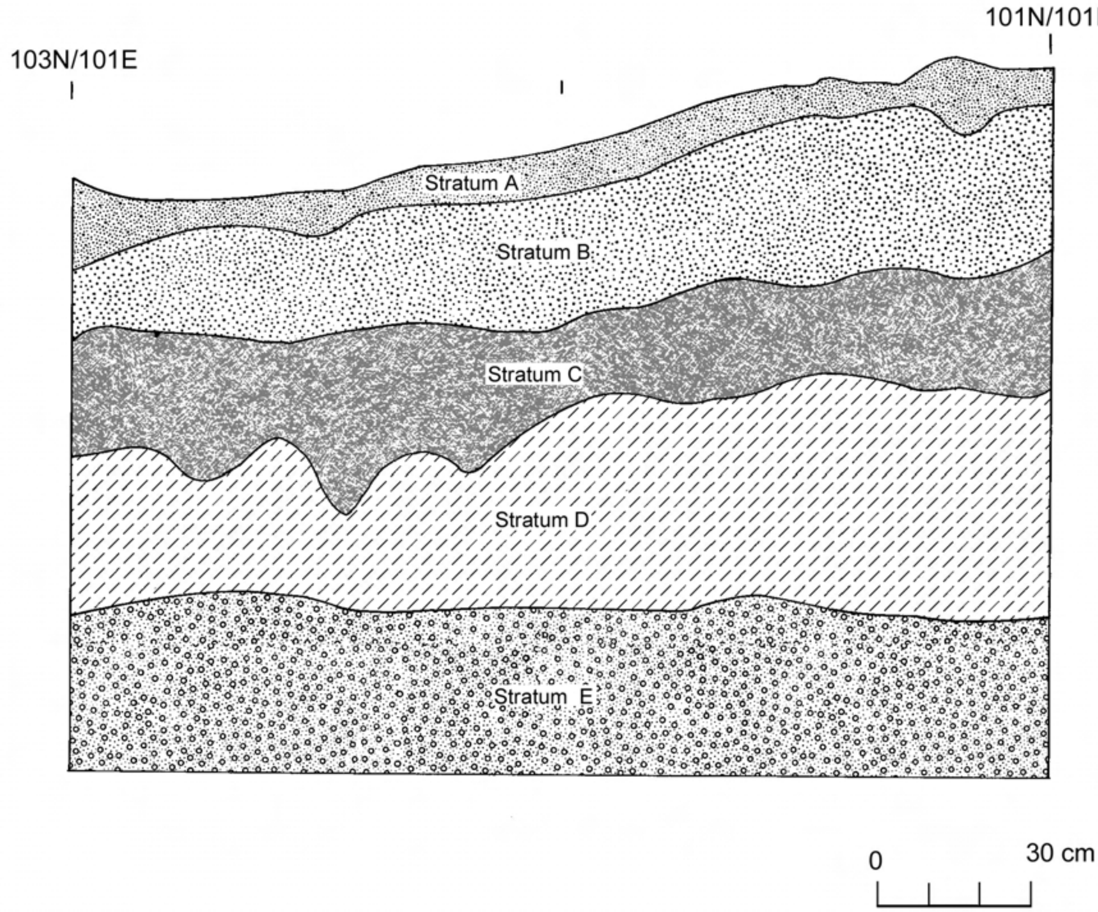

Figure 5. Profile of east wall of trench, LA 45877; (a) loose eolian sand; (b) yellowish compacted sand; (c) reddish compacted sand; (d) fine-grained reddish sand with some caliche; (e) reddish compacted sand with much caliche.

analysis. Three separate eolian deposits were exposed in the trench. McFadden (this report) found that the surficial deposit was approximately only 15 cm deep and was characterized by practically no soil development other than a weak ochric upper horizon. A small amount of leaching occurred between the upper and lower levels of this horizon indicated by the pH values.

The second soil unit was located at a depth of 15 to 64 cm below the surface. Soil development was stronger in this horizon but still characterized by an overall weakness. The upper level of this soil structure was about 16 cm thick and represents a period of dune stability that occurred prior to the eolian activity that resulted in the deposition of the surface horizon.

The third soil level was located at a depth of 64 to 80 cm below the surface. This horizon had a slightly higher clay and silt content than the previous levels, which resulted in enhanced permeability and an increased likelihood of water retention. Soils in this level are deeply buried, moderately developed, and are recognized by an argillic horizon with a weakly increased clay content.

In summary, McFadden found that the younger surface horizon, Qe3, was less than 2,000 years old and was comprised of weakly developed, but active dunal soils. The second horizon may equate with the Archaic period in time, but a definitive classification could not be made. The deepest horizon identified at LA 45877 contained a more thoroughly developed soil that appears to compare with the eolian unit, Qel, a late Pleistocene to middle Holocene association. As this corresponds with the Paleoindian period, it is possible that a few of the site artifacts might be from this time period; however, most were found in the upper horizon dating to less than 2,000 years old.

An interesting observation was made by Hoagland (field notes) who noted that a comparison of the artifact concentration areas recorded in 1983 with those documented in 1987 yielded seeming evidence of the recent movement of these artifacts by strong eolian activity. He suggests an eastward movement of material was indicated by the changed physical placement of the artifact concentration areas. It appeared to him that the dunal activity had moved the site over 10 m to the east between excavation phases, based on artifact density maps. This, however, remains invalidated because no comparative maps were relocated and none of the initially noted artifacts were identified or tagged for movement observations in 1983. Similar tests by Beckett (1980) and Shelley and Nials (1981) show that winds can move artifacts considerably within a short time frame.

Based on the soil profile of the trench, as well as the character of the physiographic area, the geomorphologist concluded that the site was within a region of extensive eolian activity. It appears that the site has undergone extensive restructuring and redistribution as a result of the strong wind and active dunal activity, resulting in the relocation of the artifacts from their original depositional positions. In other words, LA 45877 is not in its original context.

LA 45878

LA 45878 is also a redeposited lithic artifact scatter situated on flat, gently sloping land surrounded by active dunes. The site was originally recorded as a 180-by-90-sq-m scatter located on both sides of U.S. 380 (Fig. 6). Hundreds of primary flakes of quartzite and chert were noted in the exposed gravels (Clifton 1983). The site was tested, under the direction of J. Lancaster, for subsurface cultural remains by the OAS in 1983. At that time, the site limits were expanded to 10,000 sq m. Eleven areas of spatially discrete artifact clusters were identified. Within these cluster areas, 5-m-diameter circles of artifacts were collected, resulting in the curation of 1,007 chipped stone artifacts. In addition, five 1-by-2-m test pits and a 1-by-1-m pit were excavated in various areas of the site (Fig. 7). Pit depths ranged from 0.50 to 1.20 m, with a distinct lithic artifact stratum between 40 and 60 cm below the surface. Testing procedures indicated that subsurface cultural remains were present on both sides of the highway. Many of the lithic artifacts were

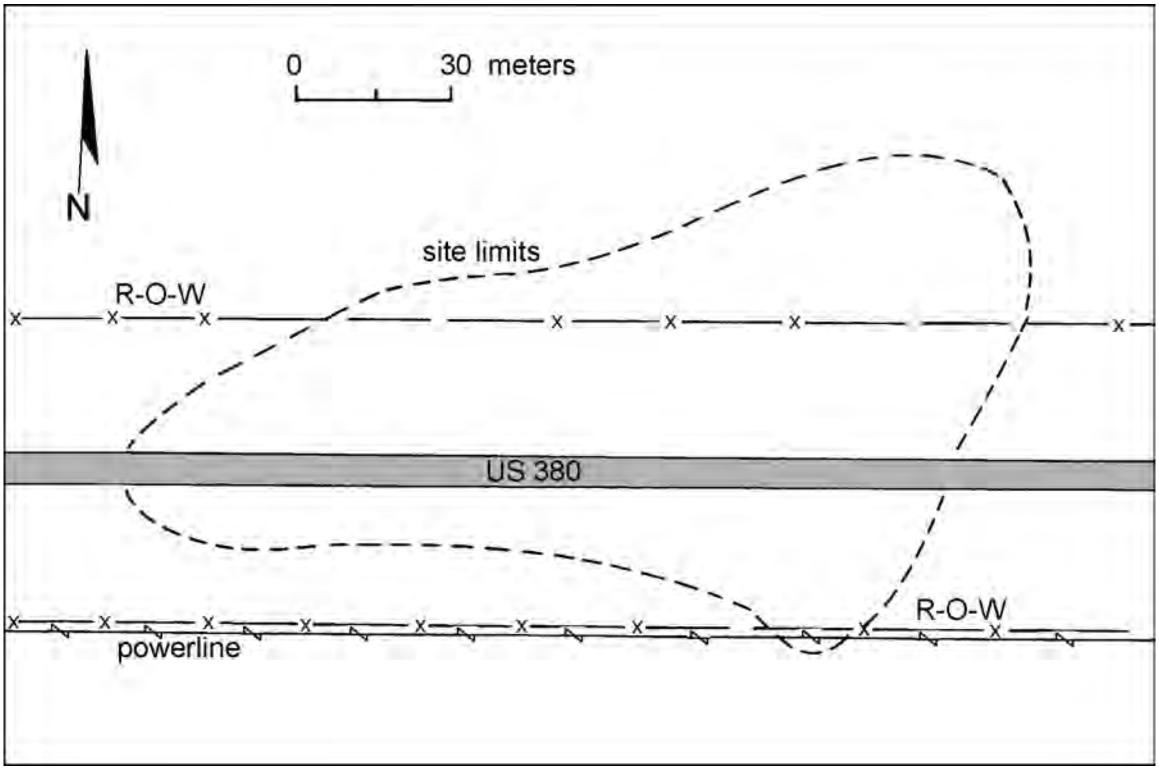

Figure 6. Survey map of LA 45878 (after Clifton 1983).

deposited in a gravel/cobble stratum characterized by their being partially cemented in caliche. The artifact material appears to be local in origin, derived from gravels and cobbles common to the site area.

Excavation grids were 1-m square, placed throughout the site in areas of dense artifact concentrations (Fig. 8). Soil was removed in 10-cm arbitrary levels, unless natural stratigraphy was present. Hand excavation began with a 1-m-wide by 16-m-long trench on the north side of the highway where artifact concentrations were heaviest. As with all of the excavation units, the initial 5 to 20 cm consisted of loose, eolian sand. The majority of the artifacts at LA 45878 were found at 50 to 60 cm below the surface.

The trench revealed numerous, fairly similar soil horizons, causing them to not be easily recognized during excavation. The soil varied slightly in hue from reddish to gray, and became more compact in density through the deeper levels. A sparse scattering of caliche appeared at about 35 cm in depth, but a dense stratum of caliche was never located. At 1.2 m depth, no artifacts were found and further excavation was halted.

A few scattered charcoal specks and several thin, gray soil lenses were located within the first few centimeters of loose sand in several areas of the site. These areas were excavated, but none had any depth, recoverable charcoal, nor definable lenses. In all cases, these were found to be either the remains of small, sagebrush fires, modern temporary hearths, or natural soil lenses from decomposing rocks located throughout the area.

The majority of the artifacts from LA 45878 were concentrated in the center of the north half of the site area. A clear occupation surface was not located. It is probable that the artifact remains have been consistently repositioned by the continual effects of eolian action. The original site may well have been an unknown distance to the west, with the artifact levels found during this excavation representing material that has no real cultural patterning.

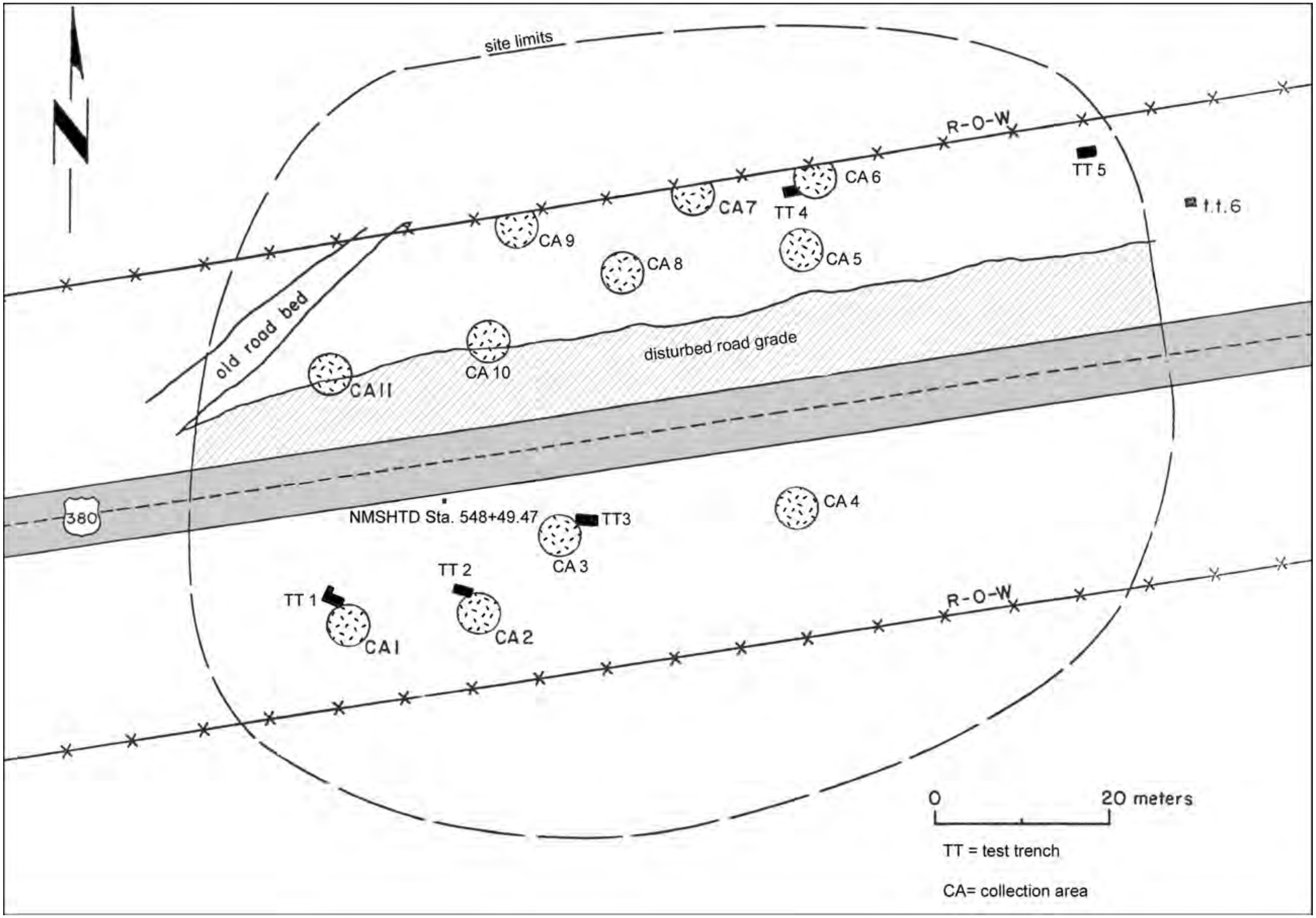

Figure 7. LA 45878 testing map.

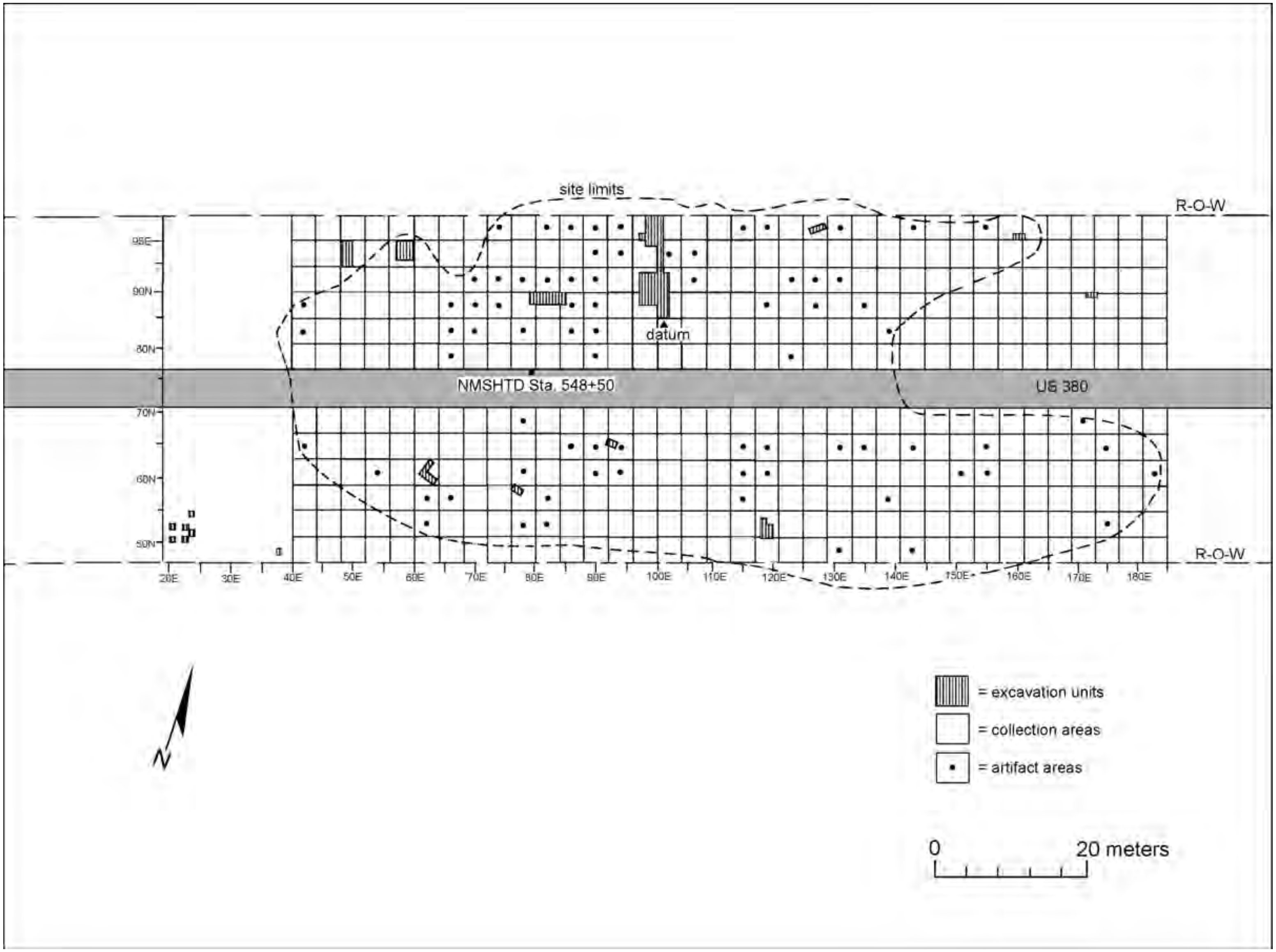

Figure 8. Excavation units at LA 45878.

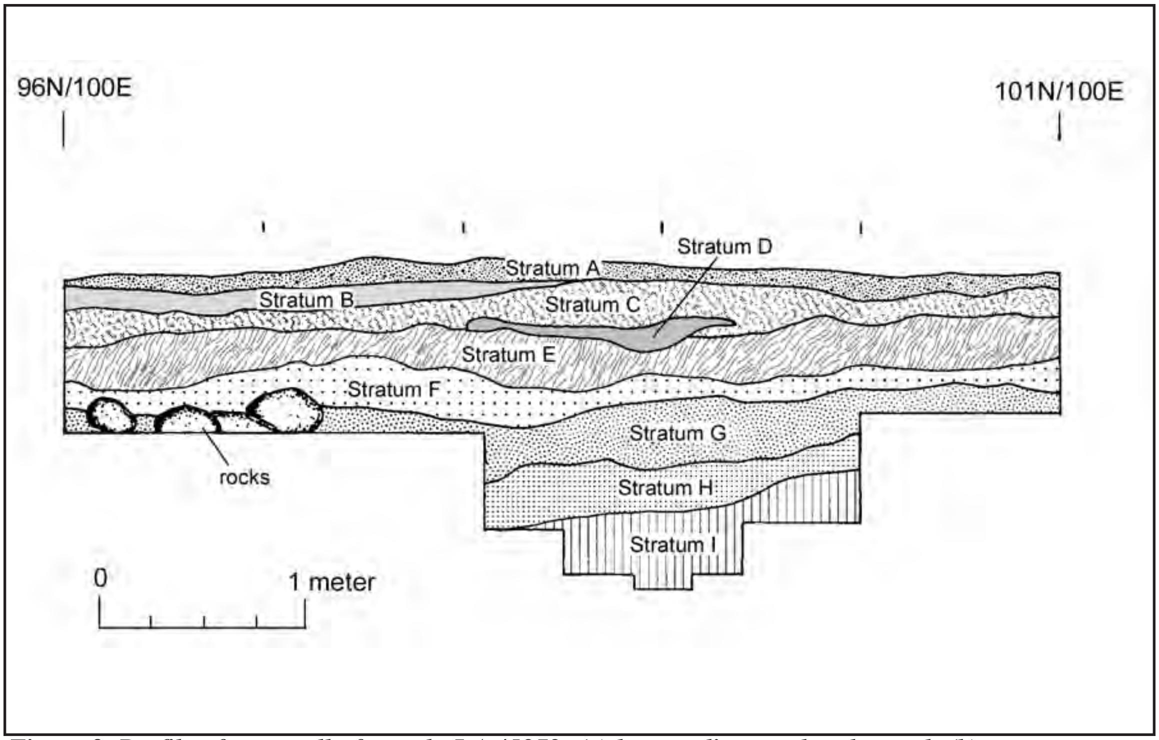

Figure 9. Profile of west wall of trench, LA 45878; (a) loose eolian sand and gravel; (b) more compacted sand with more calcium carbonate; (c) fine-grained reddish sand; (d) tannish clay loam; (e) tannish soil with angular gravel and caliche nodules; (f) whitish soil with small gravel and caliche nodules; (g) whitish gray soil with large rocks; (h) grayish soil with dark brown organic stains; (i) grayish white soil with tinges of pink.

To determine the character of the stratigraphy at LA 45878, the 16-m-long trench provided an opportunity to examine the soil formation processes as well as a profile of the various levels (Fig. 9). The profile was examined by Dr. Leslie McFadden, Department of Geology, University of New Mexico. Samples were sent to the university for analysis.

Three soil horizons were identified by Dr. McFadden. The surface stratum was only about 5 cm thick and represents a fluvial gravel. Below this was a weakly developed soil stratum composed of about 30 cm of nongravelly sand, followed by approximately 25 cm of pedogenic carbonate. The sand was interpreted as fluvially reworked eolian material from the erosion of the dunes mantling the pediment above the trench. Unfortunately, the pedogenic carbonate is not diagnostic, as the proportions of this material derived from external sources are unknown. This second soil stratum failed to meet the requirements of an argillic horizon, as significant clay films were not located. The third, and oldest, stratum exhibited a strongly developed soil with a well-developed calcic horizon. This was identified as an impregnated argillic horizon, parented by fluvial, gravelly sand and some limestone. The limestone is partially responsible for the advanced carbonate morphology of the soil. The gradual heightening of the red hue in the soil stratum as indicated in the trench profile (Fig. 9) is partially due to the reduced levels of pedogenic carbonate.

In summary, McFadden found that the surface soil had been deposited over the last hundred years, and that the second horizon may be tentatively associated with the middle Holocene or the Pleistocene. The deepest soil horizon suggests a pre-Holocene to late Pleistocene age. Thus, the artifacts at 40 to 60 cm depth and the soil associations point toward the vague possibility of a Paleoindian occupation at LA 45878, although no diagnostic Paleoindian material was found. It is more likely that this is a redeposited Archaic site.

DESCRIPTION AND CHARACTERIZATION OF THE SOIL STRATIGRAPHY IN THE LOMA DE LAS CAMAS HILLS

Dr. Leslie D. McFadden

Approximately 10 km east of San Antonio, where LA 45877 and LA 45878 are located, two trenches were hand excavated in order to expose underlying geologic units and permit further studies of the sites. The purpose of this report is to describe and characterize the soil stratigraphy of the trenches. The soils were described and sampled according to the procedure and terminology of the Soil Survey Staff (1975). Soil samples were taken to the Quaternary Studies Laboratory of the Department of Geology, University of New Mexico, for textural and chemical analysis. Soils were initially air dried, and split into a <2 mm and >2 mm fraction. From splits of the <2 mm fraction, particle size distribution (PSD), pH, and $CaCO_3$ content were determined. PSD was determined by clay dispersal in 10 percent sodium pyrophosphate, wet-sieve separation of the sand and silt and clay fractions, and pipette extraction for clay content (Soil Conservation Service 1972). For samples that contained more than 10 percent $CaC0_3$, $CaCO_3$ was removed prior to PSD determination using a digestion procedure (Jackson 1969; Rabenhorst and Wilding 1984). Soil pH was measured in 1:10 soil-to-water ratio in 0.01 m $CaCO_3$ (Peech 1965). CaCO3 content was measured using a Chittack apparatus according to the procedure of Machette (1985) after crushing the sample to 100 mesh. Soil data are given in Tables 2 and 3. Gary Weadock performed the analysis of the soil.

Geomorphic Setting

Formations exposed in the Loma de las Camas Hills include limestone and detrital rocks of Pennsylvanian to Triassic age and volcanic clastic rocks of Tertiary age (Baca and Spears formations) and the source of Quaternary alluvium that occurs in the study area. Reconnaissance in the study area indicated that the oldest Quaternary alluvial deposits are relatively thin and overlie a pediment cut on tilted and deformed deposits of the Baca or Spears Formations. LA 45878 is located on an eroded remnant of this pediment terrace. Younger Quaternary deposits are inset into these older deposits. Eolian landforms and deposits also occur in the study area. The shape and orientation of the dunes indicates that they are either eroded parabolic dunes or longitudinal dunes, with arms or crests oriented approximately east-west. Direction of sand transport is from west to east; sources of sand may be quite local (poorly vegetated floodplains and young terraces) or extra-local (weathered hillslopes on Panerozoic sandstones, unconsolidated sediments of the Santa Fe Group or Rio Grande floodplain and terraces). LA 45877 is located on a dune landform.

Soil Morphology, Texture, and Chemistry

LA 45877

Soil stratigraphic features show that three eolian deposits are visible in this trench. The youngest, surfacial deposit is sandy, 2 cm thick, and has practically no soil development (Tables 2 and 3). Soil pH values do indicate that a small amount of leaching from the A and C horizon has occurred, as suggested by a noticeable increase in pH and possibly the observed increase in $CaCO_3$ content. No visible segregated carbonate is observed in the C horizon, however, no other evidence of pedogenesis is evident.

TABLE 2. SUMMARY OF MORPHOLOGICAL DATA FOR LA 45877 AND LA 45878

LA 45877

HORIZON	THICKNESS (CM)	COLOR		CONSISTENCY		TEXTURE	STRUCTURE	BOUNDARY	$CaCO_3$ MORPHOLOGY	MISCELLANEOUS
		Wet	Dry	Wet	Dry					
A	0-2	7.5YR 5/4	7.5YR 5/4	Soft	no, po	Sand	Weak, sub-angular, blocky		None present	Fine roots
Cu	2-15	7.5YR 4/6	7.5YR 5/6	Soft	no, po	Sand	Massive	Abrupt to wavy	Slightly effervescent	Fine roots
2Ab	15-31	7.5YR 4/4	7.5YR 4/6	Soft	no, po	Loamy sand	Massive	Clear and smooth	Effervescent present	Few coarse grains
2Cb	31-59	7.5YR 4/4	7.5YR 5/6	Soft	no, po	Loamy sand	Massive	Wavy and clear	non-effervescent	
2Ckb	59-64	7.5YR 4/4	7.5YR 5/6	Slightly hard	no, po	Loamy sand	Massive	Abrupt wavy	Slightly effervescent: few very fine filaments	
3A/Bkb	64-80	7.5YR 5/4	6.25YR 5/6	Soft	no, po	Sandy loam	Massive	Abrupt wavy	Slightly effervescent; few very fine filaments	Few fine roots
3Bkb	80-90	7.5YR 5/6	6.25YR 6/6	Slightly hard	no, po	Sandy loamy sand	Massive	Gradual	Slightly effervescent; few very fine filaments	
3Btklb	92-122	5YR 5/6	6.25YR 6/6	Slightly hard	ss, po	Sandy loam	Weak, subangular blocky	Gradual	Slightly effervescent; few very fine filaments	
3Bwk2b	122-130+	5YR 5/8	5YR 6/6	Hard	no, po	Loamy sand	Weak, sugangular blocky	Gradual	Slightly effervescent; few very fine filaments	Very weathered volcanic fragments

HORIZON	THICKNESS (CM)	COLOR		CONSISTENCY		TEXTURE	STRUCTURE	BOUNDARY	$CaCO_3$ MORPHOLOGY	MISCELLANEOUS
		Wet	Dry	Wet	Dry					
						LA 45878				
C	0-5	7.5YR 4/6	7.5YR 6/6	Soft	no, po	Gravelly loamy sand	Loose		Effervescent dissemination	Reworked deposit? on bar and swale
2Bw	5-20	5YR 4/6	5YR 5/6	Soft	no, po	Loamy sand	Massive	Clear	Effervescent disseminated and nodular	Bioturbated, few roots
2Bwk	20-35	5YR 3/4	5YR 5/6	Soft	ss, po	Loamy sand	Weak, subangular, blocky	Abrupt wavy	Violently effervescent disseminated and nodular Stage I	Volcanic clasts
2Bkl	35-44	7.5YR 4/4	7.5YR 5/6	Slightly hard	ss, po	Loamy sand	Massive	Clear wavy	Violently effervescent disseminated and nodular	
2Bk2	44-60	6.25YR 5/4	6.25YR 6/4	Slightly hard	ss, po	Pebbly, sandy loam	Weak, subangular, blocky	Smooth wavy	Violently effervescent disseminated	
3Bk1b	60-74	5YR 6/2	7.5YR 7/2	Slightly hard	s, p	Cobbly sandy loam	Massive	Clear wavy	Violently effervescent disseminated and coating on clasts	Clasts > 40 cm
3Bk2b	74-120	7.5YR 8/2	7.5YR 6/4	Soft	s, p	Gravelly, sandy loam	Massive	Gradual	Violently effervescent thick coatings on bottom of clasts	Volcanic clasts very weathered
3Bk3b	120-142	7.5YR 7/2	7.5YR 6/4	Soft	s, p	Gravelly sand	Massive	Gradual	Violently effervescent disseminated and nodular	
3B/Cb	142-160	5YR 6/2	5YR 6/4	Soft	ss, po	Loamy sand	Massive	Gradual	Strongly effervescent coating clasts	

TABLE 3. SUMMARY OF TEXTURAL AND CHEMICAL DATA

PROFILE	HORIZON	< 2 MM PERCENT WHOLE SOIL	< 2 MM PERCENT SAND	< 2 MM PERCENT SILT	< 2 MM PERCENT CLAY	pH ($CaCl_2$)	WEIGHT PERCENT $CaCO_3$
LA 45877	A	100.0	91.42	7.39	1.19	7.10	1.81
	Cu	100.0	89.82	6.69	3.49	7.80	2.32
	2Ab	100.0	87.66	6.13	3.21	7.90	0.73
	2cb	98.8	82.45	10.48	7.07	7.94	0.39
	2Ckb	99.9	80.82	12.25	6.93	7.49	2.28
	3A/Bkb	99.9	75.09	11.48	10.08	8.10	4.10
	3Bkb	99.7	77.16	14.29	8.55	8.08	3.45
	3Btk1b	99.9	76.46	12.05	11.49	7.49	2.35
	3Bwk2b	99.7	78.83	12.71	8.46	7.94	0.85
LA 45878	C	97.5	82.81	12.76	4.43	7.73	2.25
	2Bw	98.8	84.09	10.39	5.52	7.90	1.53
	2Bwk	98.8	81.57	6.02	12.41	7.90	5.28
	2Bk1	93.2	80.38	14.34	5.28	8.09	9.44
	2Bk2	80.4	72.03	19.19	8.78	8.13	24.06
	3Bk1b	52.6	58.49	23.02	18.49	8.08	9.44
	3Bk2b	64.0	53.62	29.43	16.95	8.20	59.94
	3Bk3b	67.5	69.17	26.21	4.62	8.22	15.44
	3B/Cb	75.8	73.25	23.40	3.35	8.22	31.92

A second eolian unit is present from a depth of 15 cm to 64 cm. The degree of soil development in this unit is stronger than that observed in the surface unit, but the overall soil development is still weak, because no strong B horizon development is present. The ochric A horizon is 16 cm thick, indicating some period of dune stability prior to renewed eolian activity and deposition of the surficial unit. The particle size data indicate little net accumulation of clay, but do suggest some increases in silt content. Net leaching of CaCO3 out of the A and C horizons into the Ck and subjacent horizons is suggested by presence of carbonate filaments (Stage I; after Gile et al. 1966) and increases in measured carbonate content. Part of the increase in carbonates, however, may be attributable to the presence of a third soil present in the lowest unit exposed in the trench. The soil, present from 64 cm to the base of the trench, has slightly higher clay and silt content than overlying units. The permeability of the soil boundary, with dissolved carbonates precipitating near the top of and in the buried 3A/Bk horizon (Tables 2 and 3). The soil is deeply buried, moderately developed, possessing a weak argillic horizon, as shown by the presence of clay films, increase in clay content, and somewhat redder colors (inferred to be in part the result of oxidation). Pedogenic carbonate has accumulated in the soil (Stage I), but some of the carbonate may have been derived by leaching of carbonate through younger, overlying units. A fragment of weathered volcanic rock located at the base of the exposure suggests that this unit overlies a buried fluvial unit. A more strongly developed soil occurs in buried eolian deposit exposed near the trench. The soil, however, was not exposed in the trench, but was observed in roadcut exposures. Medium nodules of carbonate, exceeding in size any segregated carbonate observed in soils exposed in the trench, indicate that this soil is older than the trench soils.

Soil stratigraphic data indicate that at least three stratigraphic units are exposed in the trench. The surficial unit is only 5 cm thick and is gravelly, showing that the deposit is fluvial. No soil is present in this unit. The unit present from 5 to 60 cm has a weakly developed soil. The parent material of the upper 30 cm of the soil consists of nongravelly sand and is interpreted to be a fluvially reworked eolian material derived by erosion of dunes that mantle a pediment above the trench site. Data from Table 2 suggest a significant increase in clay content, but clay films were not evident. Thus, the B horizon does not meet the requirements of the argillic horizon. A significant amount of pedogenic carbonate has accumulated in the lower B horizon (Stage II). Unfortunately, lime clastics derived from Paleozoic formations exposed in drainage basins are also sources of pedogenic carbonate, and the proportion of pedogenic carbonate derived from dissolution of limestone relative to carbonate derived from external sources (such as calcareous dust) is not known.

The oldest unit exposed in the trench (60 cm to 65 cm) has strongly developed soil with a well-developed calcic horizon and what is inferred to be an impregnated argillic horizon. The parent material is fluvial gravelly sand and, as the overlying unit, limestone. The presence of limestone is at least partly responsible for the advanced carbonate morphology (Stage III). Removal of pedogenic carbonate prior to PSD shows that a significant amount of clay has accumulated in the argillic horizon. Red soil color, however, is probably masked by the carbonate that has impregnated the argillic B horizon. In the lower part of the soil there is less pedogenic carbonate and redder colors are present (Tables 2 and 3).

Discussion and Conclusions

The overall degree of soil development can be used (with an appropriate degree of caution) to estimate preliminarily the age of the Quaternary units in which soils have formed. The basis for this soil-dating strategy is provided in the work of Jenny (1941, 1980) and is called the state-factor approach. Several soil-forming factors affect soil development, such as parent materials, time, and climate. In suites of soils that have similar parent materials, topographic position, and have experienced a similar climate, one may initially assume that differences in the duration of soil development explain observed differences in degree of soil development. Thus, soils can be used to correlate deposits as well as estimate age, especially when circumstances are such that soils forming in a similar environment have been absolutely dated and described and therefore can be used for comparison and calibration.

The soils in the study area have formed in parent materials and in a climate that is not significantly different from those in the Chaco region (San Juan Basin) or in parts of southern New Mexico (semiarid, seasonally warm), where extensive soil-geographic studies have been conducted (Gile et al. 1979, 1981; McFadden et al. 1983; Wells et al. 1985). Therefore, the age of soils in the study area can be estimated by comparing the basic pedological characteristic of these soils with those of the dated and more well studied soils. Soils in the LA 45877 area, formed in eolian deposits, are comparable to soils formed in similar eolian deposits in the San Juan Basin. In the San Juan Basin, three major eolian units are recognized on the basis of soil stratigraphic relation and radiocarbon dating. The youngest eolian unit, Qe3, is less than 2,000 years old and possesses a very weakly developed soil. Locally, Qe3 dunes are active. These soils are usually classified as Pssaments (weakly developed sandy soil). The soils developed in the uppermost two units at LA 45877 are also Pssaments, and are tentatively correlated with Qe3. An older eolian unit that occurs in the San Juan Basin, Qe2, ranges from ca. 6,500 years to ca. 2,500 years in age and possesses weakly developed soils that have cambic B horizons and Stage I calcic horizon morphology. This soil is probably an Ochrept (weakly developed soil with at least a B horizon in a semiarid or more humid climate). The soil developed in the oldest unit exposed in the trench at LA 45877 may be an Ochrept, although it might also be a weakly developed Haplargid, if the A horizon has less than 8.5 percent clay prior to burial. However, clay may have been eluviated into the A horizon from overlying soils; therefore, it is not possible to classify this soil in a definitive manner. It is clear, however, that this soil is not as well developed as the soil found in an older eolian unit observed in the study area. This older, more developed soil appears to compare favorably with eolian unit Qe1, a late Pleistocene(?) to early Holocene(?) unit that has a Stage II calcic horizon and an argillic horizon. Therefore, the oldest buried unit observed in the trench at LA 45877 is preliminarily estimated to be of middle Holocene age.

At LA 45878, the very thin surficial deposit is very recent (10^2 years), a conclusion based on the observed lack of soil development. The second soil, possessing a cambic B and a calcic horizon, is probably a Calciorthid. This soil may be as young as middle Holocene, but may be slightly older. The presence of the Stage II calcic horizon does not necessarily indicate an older, Pleistocene age because the presence of limestone in the parent material presumably has accelerated the rate of calcic horizon developed (Gile et al. 1981). I base this tentative age, therefore, on the lack of an argillic horizon. The more well developed soil developed in the oldest unit exposed in the trench has an argillic horizon which has been impregnated with carbonate. The presence of a thick argillic horizon as well as the thick carbonate coatings suggests at least a pre-Holocene, late Pleistocene age. This age estimate is made on the basis of comparisons of soil morphology in the study area with morphology of soils formed in fluvial deposits in southern New Mexico.

Further soil-stratigraphic research in the study are will be required in order to constrain more definitively the ages of deposits and soils of this area. The presence of carbonate in the fluvial parent materials, the superposition of soils formed in permeable soils, and the availability of only two trenches present difficulties in interpretation of soil data. The availability of at least a few radiocarbon dates and cultural materials found in situ would greatly increase the confidence in estimated age ranges. However, the age-range estimates presented in this paper are fairly conservative and are at least consistent with age-ranges provided by more extensive soil-stratigraphic studies conducted elsewhere in New Mexico.

LITHIC ARTIFACT ASSEMBLAGE

Anthony Martinez

LA 45877 and LA 45878 yielded a total of 4,596 lithic artifacts. There is a limited amount of information available on lithic artifact scatters in the Socorro area. LA 45877 also had two ceramics (Rio Abajo Plain) dating between A.D. 850 and A.D. 950 and obsidian hydration dates of 2622±353 B.P. (672 B.C.), 3351±397 B.P. (1401 B.C.),and 1173±73 B.P. (A.D. 777). LA 45878 produced no dates. No features were found during data recovery at either site.

Methodology

The lithic artifacts recovered from LA 45877 and 45878 were analyzed by Steven R. Hoagland and Anthony Martinez with the aid of a binocular microscope. The attributes applied during the analysis were patterned after Chapman and Schutt (1977) in order to provide data for comparative studies of sites around the area (Appendix B). After the analyses were completed, all data were entered into an SPSS Statistical package where comparisons were produced.

As Condie and Smith (1989:58:59) point out, "Lithic analysis of the typical aceramic site in the Southwest is complicated by several factors. The sites are usually open-air, have little or no depth, contain relatively low quantities of materials, and most of the material present falls in the category of debitage (i.e., few formal tools are found). Even so, most archaeologists accept that a relationship exists between the formal artifacts and debris of tool manufacture, arguing that the study of the waste material has the potential of providing information relevant to technology and behavior."

It was therefore decided that the Carthage lithic analysis data would be interpreted in a manner suggested by Sullivan and Rozen (1985:758-759). They state:

> We argue that the categories employed in debitage analysis should not be linked a priori to specific conclusions about lithic technology. Rather, debitage analyses should be conducted with interpretation-free categories to enhance objectivity and replicability. One useful way to derive interpretation-free categories is by means of a hierarchical key (Dunnell 1971:76-84). Our key has three dimensions of variability, each with two naturally dichotomous attributes.
>
> The first dimension of variability is Single Interior Surface (Stiles et al. 1974:293; Ackerly 1979:320). A single interior surface is indicated by positive percussion features such as ripple marks, force lines, or a bulb of percussion (Speth 1972:35). If these features cannot be reliably determined, or if there are multiple occurrences of them, a single interior surface cannot be discerned.
>
> The second dimension of variability is Point of Applied Force. On debitage with intact striking platforms, a point of applied force occurs where the bulb of percussion intersects the striking platform. In those instances where only a fragmentary striking platform remains, a point of applied force is indicated by the origin of force line radiation. A missing striking platform means a point of applied force is absent. This dimension does not apply to debitage where a single interior surface is not discernible.

> The third dimension of variability is Margins. Debitage margins are intact if the distal end exhibits a hinge or a feather termination (Crabtree 1972:63) and if lateral breaks or snaps (if present) do not interfere with accurate width measurements (Fish 1979:29). If these conditions are not met, debitage margins are not intact. This dimension does not apply to artifacts where a single interior surface is not discernible and the point of applied force is absent.
>
> Four mutually exclusive debitage categories have been defined: complete flakes, broken flakes, flake fragments, and debris. The categories are interpretation-free because they are not linked to a particular method of technological production nor do they imply a particular reduction sequence .

Criticisms of this method (Amick et al.1989; Ensor and Roemer 1989) were somewhat unsatisfying in that they solely addressed terminological and theoretical issues without addressing the content of the method itself. As Sullivan and Rozen (1989:173) point out, the critiques provided ". . . nor data, experimental or otherwise, to challenge our interpretations or suggest that factors other than technology could influence assemblage composition." Rozen further points out that, ". . . debitage is observed to group into these categories irregardless of whether the knowledge of the categories into which the debitage falls is a priori or a postiori . . ." (Rozen, pers. comm. 1990) in response to the critique of the categories not being "interpretation-free" due to a knowledge of the existence of the debitage groups that was not a priori. Given the success of Sullivan and Rozen in using this method, as well as Condie and Smith's (1989) and Boyer's (1986) satisfaction with this method after applying it to projects in which they were involved, we saw no valid reasons for not applying this method to the Carthage sites.

Since artifact analysis had already been completed prior to this application of the Sullivan and Rozen method, it was initially thought that previous work would be incompatible with that on the Carthage project. In praise of the earlier method, however, the Carthage debitage analysis for each site was easily categorized as:

> Complete Flakes had platforms of any kind (so long as they were present) and feathered, hinged, or cortical terminations.
>
> Broken Flakes had platforms (again, of any kind) and terminations that were not feathered, hinged, or cortical.
>
> Flake Fragments were simply flakes that had no platforms.

The category for debris proposed by Hoagland in keeping with Chapman and Schutt (1977) was believed to be commensurate with the Sullivan and Rozen definition of debris in that in both the absence of the ventral (interior) and presence of positive percussion features surface were the criteria for inclusion in this category.

Raw Material Selection

Materials encountered in the excavation of LA 45877 and LA 45878 consisted of various cherts, quartzite, limestone, rhyolite, welded tuff, and obsidian. All of these materials are available from either local formations, or in the form of water-deposited cobbles (Weber pers. comm. 1990).

A significant problem was encountered during the process of material type identification, which involved inconsistencies between archaeologists of different organizations in the assessment of the raw materials from which the lithic artifacts were manufactured. While this is not a new problem (Oakes 1986:102), it does raise questions regarding the standardization of lithic material typologies. As an example, a particular material type, quartzite, has alternately been identified as being quartzite (Gossett and Gossett 1982:10; Gossett and Gossett 1983:17; Seaman et al. 1989; Weber, pers. comm. 1990), siltstone (Oakes 1986:102), mudstone (Zamora, pers. comm. 1990), quartzitic sandstone (Weber, pers. comm. 1990), basalt (Marshall, pers. comm. 1990) and in its finer states, even chert (Oakes, pers. comm. 1990).

It is suggested that part of the problem regarding different assessments of this material type involves the material itself. To clarify, this material, which is available in large quantities throughout a wide geographic region (Weber, pers. comm. 1990), can be found to grade in quality from a very fine, uniform chert-like material, to a coarse, banded, metamorphosed sandstone. Portions of the Baca formation contain a red, medium-grained, chert-like material that can be found in the same geological formation as well as a red, banded, coarse-grained quartzitic sandstone material. This of course should be no surprise to the geologist, but it can be problematic for the archaeologist.

Again, the problem of different archaeologists calling the same material different things is common enough, but given the paucity of data east of the Rio Grande in the Socorro area (Stuart and Gauthier 1981:147), it seems that this lack of comparability in the existing data is relevant enough to have merited the comments given to it.

It is because of this lack of uniformity that various material types have been grouped together in the hopes of "smoothing over" biases in observation and classification of materials by separate individuals (after Oakes 1986:102). The problems with this sort of approach are, of course, numerous but without the time or money to access individual collections of artifacts from this region, it seems that such an approach must be taken in order to make any sort of intersite comparisons between archaeological work done by different institutions in the Socorro area.

Artifact size played a big role in the distinction between chert, jasper, chalcedony, and silicified wood. It was often observed that smaller pieces of debitage were most difficult to classify and more often than not were termed chert, even though they might well have been classified as silicified wood or even occasionally chalcedony, had the artifact size been greater. Given the local, widespread availability of all of these individual types of materials in cobble form (Weber, pers. comm. 1990) as well as mechanical fracture properties that are more similar to one another than to any of the other material types encountered (such as limestone or quartzite), chert, jasper, chalcedony, and silicified wood were grouped together as chertic-materials even though on a very basic geological level, distinctions between them can easily be made.

LA 45877

On an assemblage-wide basis, the cross-tabulation of artifact type versus material type revealed that 98.5 percent of all the artifacts recovered from this site were either quartzite or the combined chert/chalcedony/silicified wood material category (Table 4). Further, of these two types, the combined chertic-materials category was by far larger in terms of frequency of occurrence. The table also reveals that on an assemblage-wide basis, the lithic artifacts from LA 45877 consisted of moderate to high percentages of broken flakes and flake fragments and a low percentage of complete flakes, debris, cores, and retouched artifacts. The 254 quartzite artifacts from this site were found to have moderate to high percentages of broken flakes and flake fragments and a low percentage of complete flakes, debris, and tools. The 1,252 chertic-material artifacts were found to be made up of low to moderate percentages of tools, debris, and complete flakes and moderate to high percentages of broken flakes and flake fragments. Given the sparse incidence of the other four materials (limestone, obsidian, rhyolite, and welded tuff) present on the site, any sort of comparison between lithic artifacts produced from these materials would necessarily be skewed due to

TABLE 4. ARTIFACT TYPE BY MATERIAL FROM LA 45877

CELLS: Count Row Percent Column Percent	MATERIAL TYPE						
	Chert*	**Quartzite****	**Limestone**	**Obsidian**	**Rhyolite**	**Welded Tuff**	**ROW TOTAL**
Complete Flake	20 76.9% 1.6%	4 15.4% 1.6%		1 3.8% 25.0%		1 3.8% 25.0%	26 100.0% 1.7%
Broken Flake	633 78.3% 50.6%	164 20.3% 64.6%	4 .5% 36.4%	1 .1% 25.0%	3 .4% 100.0%	3 .4% 75.0%	808 100.0% 52.9%
Flake Fragment	523 90.0% 41.8%	56 9.6% 22.0%	1 .2% 9.1%	1 .2% 25.0%			581 100.0% 38.0%
Debris	56 70.9% 4.5%	22 27.8% 8.7%		1 1.3% 25.0%			79 100.0% 5.2%
Tools	4 57.1% .3%	1 14.3% .4%	2 28.6% 18.2%				7 100.0% .5%
Cores	16 59.3% 1.3%	7 25.9% 2.8%	4 14.8% 36.4%				27 100.0% 1.8%
COLUMN TOTAL	1252 81.9% 100.0%	254 16.6% 100.0%	11 .7% 100.0%	4 .3% 100.0%	3 .2% 100.0%	4 .3% 100.0%	1528 100.0% 100.0%

* This variable contains all the chertic-materials which includes chert, chalcedony (all types), and silicified wood.
** Includes quartzite and quartzitic sandstone.

insufficient sample size, and consequently were not considered appropriate for the investigation at LA 45877.

Based upon the frequencies of the debitage categories and their relation to one another, it seems as if the lithic artifacts on LA 45877 were produced as the result of core reduction and some tool manufacture. Reasoning for this comes from Rozen (1981) and Sullivan and Rozen's (1985:762) technological groups in which it was found that four clusters consistently described a series of 23 collections consisting of 27,000 lithic artifacts from 14 sites near St. Johns, Arizona. These groups are:

IA. Unintentive Core Reduction: Characterized by high percentages of cores and complete flakes, and low percentages of broken flakes, flake fragments, and debris.

IB1. Core Reduction and Tool Manufacture: Characterized by moderate percentages of cores and complete flakes and low to moderate percentages of broken flakes, flake fragments, and debris.

IB2. Intensive Core Reduction: Characterized by moderate percentages of cores and complete flakes, and moderate to high percentages of broken flakes, flake fragments, and debris.

II. Tool Manufacture: Characterized by high percentages of broken flakes, flake fragments, and debris, and low percentages of cores and complete flakes.

Examination of the lithic artifacts indicates that the majority of lithic activities at LA 45877 consisted of core reduction. Evidence for the artifacts from LA 45877 being a product of core reduction as opposed to any other sort of process can be obtained through an examination of the percentages of each of the artifact categories as well as a series of artifact attributes that have been observed to describe artifacts produced as a result of these activities (Neumann and Johnson 1979:83-84; Stafford 1979:103-104; Rozen 1981; Sullivan and Rozen 1985:764; Vierra 1985:17, 58). These attributes are percentage of cortical flakes, percentage of flakes with faceted platforms, percentage of flakes with lipped platforms, and mean values for artifact dimensions. Regarding the latter artifact attribute, Sullivan and Rozen's method (1985) was followed whereby the dimensional variable thickness (Table 5) on complete flakes (and only complete flakes) was tabulated through two separate methods: median flake thickness and mean relative flake thickness (Jelinek 1977:91-92).

TABLE 5. THICKNESS ON COMPLETE FLAKES, LA 45877

	Total Assemblage	Quartzite	Cherts
Median Flake Thickness (mm)	4.0	8.0	4.0
Mean Relative Flake Thickness	7.6	8.8	7.3
Cortical Flake Percentage	24.1	31.1	22.4
Faceted Platform Percentage	1.8	1.2	1.9
Lipped Platform Percentage	1.8	1.2	1.9

In reference to this table, 31.1 percent of all quartzite flakes on this site were cortical, and of these, the median flake thickness and mean relative flake thickness for complete flakes were found to be 8.0 mm and 8.8 mm, respectively. Further, the low incidence of faceted and lipped platforms in addition to the aforementioned thicknesses, provide additional support for them being characteristic of core reduction flakes. More specifically, when these attributes are compared to studies of this type performed by others (Rozen 1981; Sullivan and Rozen 1985; Boyer 1986; Condie and Smith 1989), it was found that the values of the artifact attributes examined are indicative of unintensive core reduction. The Sullivan and Rozen (1985) conclusions further support this interpretation:

* 91 percent of the time median flake thickness values greater than 3.9 mm indicated core reduction while values less than 3.9 mm indicated tool manufacture.

* 90 percent of the time mean relative flake thickness values greater than 12.0 mm suggested tool manufacture while values less than 12.0 mm indicated core reduction.

* 69 percent of the time assemblages with cortical debitage greater than 69 percent consisted of tool manufacture while assemblages with cortical debitage less than 69 percent indicated core reduction.

Looking at the values for quartzite flakes we find that for each of these three variables, Group I membership (core reduction) is suggested. When these attributes are compared to studies of this type performed by others (Sullivan and Rozen 1985; Boyer 1986; Condie and Smith 1989), it is found that the values of the artifact attributes examined are specifically suggestive of unintensive core reduction.

As for the "chertic-material" artifacts on LA 45877, it was determined through the same sort of examination as that performed for the quartzite artifacts, that the main lithic activity on the site involved core reduction. Examination of mean relative flake thickness, median flake thickness, and percentage of cortical flakes indicates this, as does the low to moderate percentages of all artifact types. The fairly high incidence of platform lipping and faceted platforms, however, indicates that some tool manufacture of chert artifacts on this site is not unreasonable to assume. What is not explained by an examination and comparison of these artifact attributes is the low frequency of cores made out of this material. In reference to Table 4, it is observed that in relation to other chert artifacts reasonably expected to be present, chert cores are relatively infrequent. This is problematic in that low percentages such as this are usually not found to be indicative of core reduction activities. It is postulated that given that the chert cobble forms on the site tend to be fairly small (Weber, pers. comm. 1990), such highly cryptocrystalline materials as these cherts would be utilized to the maximum extent possible, with the manifestation of such an activity being low frequencies of cores from these materials. It is also possible that the cores were transported away from the site for use at a later time.

LA 45878

The cross-tabulation of material type by artifact type on this site suggests that, like LA 45877, the majority of lithic activities consisted of core reduction (Table 6). Five general material types were found to characterize the assemblage, with three of these being principal types and two subordinate ones. Because the subordinate types (rhyolite and welded tuff) combined made up but 0.2 percent of the assemblage total, and because no diagnostic artifacts were produced from either of these types, they were dropped from further study after the initial cross-tabulation. As for the other material types, 14.7 percent were found to be quartzite, 79.2 percent cherts, and 5.9 percent limestone.

TABLE 6. LA 45878 CROSS-TABULATION OF LITHIC ARTIFACT TYPE BY MATERIAL TYPE

CELLS: Count Row Percent Column Percent	**Chert***	**Quartzite****	**Limestone**	**Rhyolite**	**Welded Tuff**	ROW TOTAL
Complete Flakes	64 72.7% 2.6%	11 12.5% 2.4%	13 14.8% 7.1%			88 100.0% 2.9%
Broken Flakes	1121 74.6% 46.2%	280 18.6% 61.9%	99 6.6% 54.4%	2 .1% 100.0%	1 .1% 33.3%	1503 100.0% 49.0%
Flake Fragments	655 83.2% 27.0%	92 11.7% 20.4%	40 5.1% 22.0%			787 100.0% 25.7%
Debris	509 85.4% 21.4%	58 9.7% 12.8%	27 4.5% 14.8%		2 .3% 66.7%	596 100.0% 19.4%
Tools	4 100.0% .2%					4 100.0% .1%
Cores	76 84.4% 3.1%	11 12.2% 2.4%	3 3.3% 1.6%			90 100.0% 2.9%
COLUMN TOTAL	2429 79.2% 100.0%	456 14.7% 100.0%	182 5.9% 100.0%	2 .1% 100.0%	3 .1% 100.0%	3068 100.0% 100.0%

* This variable contains all the chertic-materials which includes chert, chalcedony (all types), and silicified wood.
** Includes quartzite and quartzitic sandstone.

On an individual basis, chert as the predominant material was found to be characterized by moderate percentages of complete flakes and cores and moderate to high percentages of broken flakes, flake fragments, and debris. When the values for median flake thickness, mean relative flake thickness, frequency of cortical flakes, and lipped and faceted platforms are added, it seems as if the primary reduction strategy of this material type consisted of intensive, hard-hammer core reduction.

The same holds true of the quartzite artifacts because, again, intensive core reduction is denoted by the frequencies of artifact types and the distribution of values for median flake thickness, mean relative flake thickness, frequency of cortical flakes, and lipped and faceted platforms.

The limestone group, however, is problematic in that it possesses frequencies that are indicative of both intensive and nonintensive core reduction. This could be an indication that the reduction of this material included both reduction strategies or that the material type itself possesses physical characteristics which are significantly different from the Sullivan and Rozen (1985) comparative group and hence are unsuitable for the type of comparisons performed. Based upon the frequency of platform lipping and faceting, as well as the percentage of cortical flakes, it is probably not unreasonable to suppose that core reduction was the main activity that was performed with this material type. The generally poor knappable quality of limestone for specialized tools also supports this position.

Discussion

The assemblages at both sites can be characterized as primarily expedient in nature. Local gravels are the main source of raw materials at both sites but, a greater degree of selectivity for fine-grained chert is suggested at LA 45878. This observation comes not from the tool counts as much as from the relative higher proportions of tertiary flake debitage and microdebitage; few tools were recovered. The most likely explanation is that the resulting bifacial tools became part of the curated technology and were removed from the site. In other words, one aspect of the lithic reduction sequence involved an embedded procurement (Binford 1979) of preferred materials. Debitage produced during reduction of these materials was deposited at the site but the tools were curated.

LA 45877

The location of LA 45877 in a dune setting is of itself problematic in that, as others have shown (Villa 1982; Schiffer 1983; Gifford-Gonzalez et al. 1985), archaeological assemblages located in such contexts are highly prone to both vertical and horizontal dispersement. Therefore, initial prehistoric artifact depositional contexts cannot reasonably be expected to have remained intact. It is because of this that any sort of surface to subsurface comparisons regarding the distribution of the artifacts recovered from the excavation of LA 45877 should be considered to be highly suspect as it should be assumed that the artifacts themselves have "moved" from their original depositional locations. The dunal environment in which the site is located, as well as the fact that it can be considered geologically redeposited to some extent (McFadden, pers. comm. 1987; Weber, pers. comm. 1987) further emphasizes the difficulty in making such comparisons.

What of the impact of heavy machinery during the construction of the highway? Given the relatively fluid soil conditions at LA 45877, i.e., mostly unconsolidated sands, it is suggested that for the most part, artifacts on this site probably would have been depressed into the local sediments without a great deal of breakage. Reasoning for this comes from Sullivan and Rozen (1985:763) as well as Westfall (1981:6-12, 78) who point out in their description of the lithic debitage from a similar depositional environment that, ". . . debitage is unlikely to break as a result of striking unconsolidated sandy surfaces." The lessons learned by Gifford-Gonzalez et al.(1985:813-815)

TABLE 7. DAMAGE FOUND ON THE LITHIC ARTIFACTS FROM LA 45877 AND 45878

CELLS: Count Row Percent Column Percent	DAMAGE TYPE				ROW TOTAL
	Regular	Irregular	Regular and Irregular	Battered	
Angular debris	6 1.6% 8.2%	221 59.6% 7.1%	25 6.7% 7.4%	119 32.1% 52.4%	371 100.0% 9.8%
Core flake	59 1.8% 80.8%	2861 86.0% 91.3%	299 9.0% 87.9%	106 3.2% 46.7%	3325 100.0% 88.1%
Bipolar flake	4 14.3% 5.5%	20 71.4% .6%	4 14.3% 1.2%		28 100.0% .7%
Blade flake	3 12.5% 4.1%	17 70.8% .5%	3 12.5% .9%	1 4.2% .4%	24 100.0% .6%
Biface		1 33.3% .0%	1 33.3% .3%	1 33.3% .4%	3 100.0% .1%
Uniface			2 100.0% .6%		2 100.0% .1%
Uniface flake	1 33.3% 1.4%		2 66.7% .6%		3 100.0% .1%
Projectile point		1 100.0% .0%			1 100.0% .0%
Core		11 73.3% .4%	4 26.7% 1.2%		15 100.0% .4%
COLUMN TOTAL	73 1.9% 100.0%	3132 83.0% 100.0%	340 9.0% 100.0%	227 6.0% 100.0%	3772 100.0% 100.0%

regarding wear patterns of lithic artifacts in sandy soils subjected to trampling, should not be overlooked, however, as they demonstrate that some amount of edge damage is to be expected in this situation. It is for this reason that determinations of edge wear on lithic artifacts were extremely conservative to the extent that what might often qualify for edge wear on an artifact from a relatively intact site might not qualify for edge wear on an artifact from the Carthage sites.

LA 45878

LA 45878 is similar to LA 45877 in that redeposition has played a significant role at this site as well. Both McFadden (pers. comm. 1987) and Weber (pers. comm. 1990) believe that the original provenience of this site was significantly moved into its present location. Weber further postulates that the redeposition of LA 45878 is a result of "sheet-wash." Therefore, any sort of surface to subsurface comparisons of artifact distributions should be considered highly suspect. Further, it is to be assumed that movement of this site as "sheet-wash" significantly impacted artifacts on this site. It is suggested that a comparatively higher incidence of incomplete flakes, higher count of debris, and damage patterns that are more irregular than those observed on LA 45877, would characterize the assemblage at LA 45878 because the redeposition of the site as "sheet-wash" significantly altered the initial attributes of the artifact assemblage.

The presence of local gravels on the site, which are the same material types as those that comprise the artifact assemblage, further complicates matters in that the geological reworking of the site may have created additional "debitage" of a natural origin. Decisions regarding suitability of a collected item as an artifact were quite conservative, and as a result many items that may have initially been produced through cultural processes but were battered beyond recognition were not considered to be artifacts. As no quantitative methods were known at the time of analysis regarding differentiation of natural and cultural debitage from reworked sites (see Bertram 1989 for an inciteful inquiry into differentiations such as this), determinations of artifact manufacture from natural or cultural causes could not be made. For the same reasons, caution was used in determinations regarding edge wear.

Evidence of redeposition is present in the damage found on the artifacts from these sites (Table 7). A large amount of angular debris exhibits irregular damage and battering suggesting these artifacts have either been redistributed by natural erosion (sheet wash) or mechanical means. We could argue that some of the battered angular debris are not artifacts at all, which is a viable argument; however, 46.7 percent of the flakes from the assemblage also have the same type of damage present. Not only do the flakes show damage of this type but so do biface, blade, and bipolar flakes. Even the one projectile point mid-section exhibits irregular damage.

Comparing Data to AKE Site

Since there are no data published at this time for the nearby Mockingbird Gap site, the AKE site, on the Plains of San Augustin 74.0 km (46 miles) to the west, was chosen for comparative purposes (Table 8). The AKE site was a seasonal multicomponent site occupied from Paleoindian times to the Historic period. Beckett (1980) states that the AKE site was utilized many different times especially during the late summer or early fall when water was present and wild food was mature. He believes that the people from the Mogollon Culture were also present on the site at one time because of the presence of Alma Brown Ware ceramics.

When comparing the AKE site with the two Carthage sites there are several differences. Besides the large amounts of artifacts, there are material differences. At the AKE site welded tuff is the most utilized material type, while at the Carthage sites, chert or chertic-material types are the most common with very little welded tuff. Chert, chalcedony, and quartzite make-up 94.1 percent of the Carthage assemblage, while welded tuff, chert, and chalcedony comprise 94.0 percent of the AKE site, the other materials total less than 1 percent. The Carthage sites have a higher percentage of limestone (4.2 percent); the rest of the materials are less than 1 percent.

When comparing the artifact categories from the two sites, the Carthage sites have a higher percentage of flakes and cores than at the AKE site (Table 9). The tools in the Carthage assemblage include the artifacts that were identified as knives, scrapers, blades, etc. (Fig. 10). What sets the AKE site apart from the Carthage sites is that the projectile points recovered can be placed within a time period and classified. The one projectile point from LA 45877 is a small, midsection fragment, and cannot be identified.

Comparative data compiled from Marshall and Walt (1984) for the Rio Abajo shows that preference for certain material types through time change very little (Table 10). Chert or chertic-materials dominate the assemblages from the Archaic period to the Pueblo period. What seems to be happening at all the sites is that the materials being utilized seem to be locally available.

TABLE 8. MATERIAL TYPES FROM THE AKE SITE AND THE CARTHAGE SITES

	AKE SITE		CARTHAGE SITES	
MATERIAL TYPE	**COUNT**	**PERCENT**	**COUNT**	**PERCENT**
Welded tuff	15,374	87.9	7	.1
Chert	458	2.6	2733	59.5
Chalcedony	408	2.3	909	19.8
Obsidian	114	.6	4	.1
Jasper	23	.1		
Quartzite	393	1.2	19	.4
Silicified Wood	17	.1	37	.8
Sandstone (includes Quartzitic sandstone)	196	1.2	682	14.8
Basalt	137	.7	3	.1
Rhyolite	140	.7	5	.1
Limestone	4	.0	193	4.2
Siltstone	7	.0		
Andesite	17	.1		
Gneiss	1	.0		
Quartz	9	.0		
Clay	10	.0		
Granite	8	.0		
Monzonite	2	.0		
Shale	1	.0		
Breccia	9	.0		
Agate	4	.0		
Hemitite	1	.0		
Marl			2	.0
Igneous			2	.0
Unknown	2	.0		
Metal	1	.0		
TOTAL	17,611	100.0	4596	100.0

TABLE 9. ARTIFACTS RECOVERED FROM THE AKE SITE AND THE CARTHAGE SITES

ARTIFACT TYPE	AKE SITE		CARTHAGE SITES	
	COUNT	PERCENT	COUNT	PERCENT
Debitage	12,978	73.6	675	14.8
Flakes	3,624	20.5	3736	81.2
Bipolar flakes			31	.7
Utilized Flakes	291	1.6		
Retouched Flakes	112	.6		
Uniface Flakes			3	.1
Biface	72	.4	5	.1
Uniface			2	.0
Projectile points	81	.4	1	.0
Preform	2	.0		
Tools	27	.1	26	.6
Cores	52	.3	117	2.5
Sherds	10	.6	2	.0
Fire-cracked rock	52	.3		
Ground Stone	305	1.7	1	.0
Unknown	9	.0		
TOTAL	17,615	100.0	4,599	100.0

TABLE 10. A COMPARISON OF LITHIC MATERIAL FREQUENCIES FROM SITES BY TEMPORAL AFFINITIES IN THE RIO ABAJO REGION

	Basalt/Quarzite	Chertic-Materials	Limestone	Obsidian	Rhyolite
Archaic N=15	9.6%	70.4%	.6%	6.6%	12.8%
Basketmaker (BII-BIII) N=7	8.7%	71.4%		5.6%	14.4%
Puebloan (PI-PV) N=56	21.4%	63.4%	3.6%	4.3%	7.4%

(based on the lithic material frequency tables in Marshall and Walt 1984)

Summary

The Carthage sites are redeposited lithic artifacts from campsites that contain small chipped stone assemblages. LA 45877 possesses dates derived from obsidian hydration and two very small gray ware ceramics. The obsidian hydration dates for LA 45877 are 672 B.C.± 353, 1401 B.C. ± 397, and A.D. 777 ± 73. It is difficult to determine from this range in dates if there were three occupational episodes or errors in the obsidian hydration methodology. The latest date of A.D. 777 best matches the ceramics found; however, the sherds could well be nothing more than the result of a "pot" drop by unrelated peoples. These dates are very broad and Montgomery (this volume) does

Figure 10. Scraper collected from the surface of LA 45879, knife from LA 45877.

warn that ". . . the conditions of the samples and possible differences in source names from researcher to researcher could affect determined dates." He further states that these dates should be used in conjunction with other chronometric data. The ceramics, according to Baldwin et al. (1986), date between A.D. 850 and A.D. 950.

Hicks (1994:478-526) tried to date potential Archaic sites in the Arroyo Cuervo region northwest of Albuquerque and the Abiquiu Resevoir area in north-central New Mexico. She found that many of these sites had a high frequency of biface thinning flakes, prepared platforms, greater core to debitage ratios, low utilized debitage, high frequencies of retouched/curated tools, high frequencies of nonlocal materials, and small amounts of cortex on platform remnants. Flake size as found by Laumbach (1980), Gomolak and Heinsch (1981), Moore (1982, 1983), Vogler (1982), and Acklen et al. (1984) increase through time. However, Bearden and Anderson (1984) associate large flakes with Archaic sites.

Over 64.0 percent of the flakes analyzed from LA 45877 and LA 45878 have platform remnants (Table 11). The material, however, is all local and is found in the Baca and Spear formations (in which the sites are located) with the exception of the four small fragments of obsidian found at LA 45877 that have been sourced as being from Obsidian Ridge or Rabbit Mountain in the Jemez area. The assemblage of flakes also has a moderate amount of biface thinning flakes (14.3 percent) with more than 80 percent of the biface thinning flakes having some type of prepared platform. Biface thinning and biface finishing flakes recovered from LA 45877 comprise 31.8 percent of the flake assemblage. At LA 45878 the biface thinning and finishing flakes comprise 3.9 percent of the flake assemblage.

Whole primary flakes (cortical flakes with cortex on the dorsal surface) for LA 45877 comprise 34.4 percent of the lithic assemblage, 5.7 percent for secondary flakes (cortex on platform only), and 27.8 percent for interior flakes (no cortex). According to Hicks (1994) this would resemble a flake assemblage which is less than 2.5 cm in length and possesses no cortex; however, the majority of the flakes are primary flakes with dorsal cortex.

The whole flakes for LA 45878 are higher in frequency. Primary flakes are 71.8 percent of the assemblage, secondary flakes 9.2 percent, interior 14.3 percent, and 3.9 percent for biface flakes.

TABLE 11. PLATFORM TYPES FROM LA 45877 AND 45878

CELLS: Count Row Percent Column Percent	PLATFORM TYPE							ROW TOTAL
	Absent	Cortical	Single Surface	Single with worked dorsal	Multisurface	Multisurface with worked dorsal	Crushed	
Primary	534 29.3% 39.6%	416 22.8% 71.1%	462 25.4% 53.5%	60 3.3% 45.8%	246 13.5% 40.5%	36 2.0% 40.9%	67 3.7% 45.0%	1821 100.0% 48.3%
Secondary	14 6.7% 1.0%	155 74.5% 26.5%	19 9.1% 2.2%	4 1.9% 3.1%	7 3.4% 1.2%	3 1.4% 3.4%	6 2.9% 4.0%	208 100.0% 5.5%
Interior	564 47.4% 17.3%	9 .8% 1.5%	308 25.9% 35.7%	41 3.4% 31.3%	195 16.4% 32.1%	24 2.0% 27.3%	49 4.1% 32.9%	1190 100.0% 31.5%
Biface thinning	234 43.3% 17.3%	5 .9% .9%	71 13.1% 8.2%	23 4.3% 17.6%	160 29.6% 26.3%	24 4.4% 27.3%	24 4.4% 16.1%	541 100.0% 14.3%
Biface finishing	3 23.1% .2%		3 23.1% .3%	3 23.1% 2.3%		1 7.7% 1.1%	3 23.1% 2.0%	13 100.0% .3%
COLUMN TOTAL	1349 35.8% 100.0%	858 15.5% 100.0%	863 22.9% 100.0%	131 3.5% 100.0%	608 16.1% 100.0%	88 2.3% 100.0%	149 3.9% 100.0%	3773 100.0% 100.0%

Using the criteria from Hicks (1994), it is impossible to even suggest when the Carthage sites were occupied. The dates for LA 45877 could imply that this site was inhabited during the Archaic period and then again in the Formative period, but this is all very hypothetical. LA 45878 can only be classified as an unknown lithic artifact scatter because it did not have any datable artifacts or diagnostic attributes. Therefore, there is not enough information from LA 45878 to fit the data into Hicks model.

OBSIDIAN HYDRATION ANALYSIS

John Montgomery

Methods

The three obsidian samples from LA 45877 were prepared using the methods outlined by Michels and Tsong (1980) and Michels and Bebrich (1971). The first step in the procedure was to apply isotropic epoxy to the surface of the obsidian sample. The obsidian was then heated in a kiln at 140 degrees F (60 degrees C) for two hours to insure maximum cure. It has been demonstrated that the epoxy protects the hydration surface of the obsidian during sawing (Katsui and Kondo 1965).

Next, a wedge was cut from each sample by making two parallel cuts perpendicular to the edge of the artifact. An oil-cooled Raytech Trimsaw with a 4-inch diamond-edged blade was used. The wedge was then removed from the artifact. The wedge was cleaned with soap and ethyl alcohol to remove any remaining traces of oil.

The initial grinding phase was begun by mounting the wedge onto a glass microscope slide. Lakeside thermoplastic (quartz) cement was used as the mounting medium. The catalog number of the sample was etched onto the slide to protect provenience. The wedge was ground to approximately half of its original thickness using a slurry of water and fine-grained (400) corundum grit. All grinding was done by hand on a glass plate using a "Figure-8" motion.

After the wedge was ground halfway, the slide was cleaned to remove traces of grit, a pencil line was drawn on the wedge to mark the hydrated surfaces of the piece, and the wedge was then ground (in the same manner described above) to an approximate thickness of .003 inch. This maximizes the optical qualities of the obsidian under the microscope.

The final stage of sample preparation was the application of the cover slip. All cover slips were applied using heated Canada Balsam instead of the Lakeside thermoplastic (quartz) cement. The mounting medium was changed at this point simply because it was found that fewer and smaller air bubbles are created using the Canada Balsam during cover slip application and the clarity of the slide was greatly improved.

The hydration rim was observed and measured using a Nikon Labophot POL petrographic microscope with a polarized light source (X-Nichols) and a ¼ wave/red tint plate at 600 diameters. The tint plate creates a dark background upon which the hydration rim appears blue due to the difference in birefringence. This helps to differentiate the interior of the hydration rim, thus making measurements more accurate.

All measurements were done with a filar eyepiece interfaced with a TI-50 calculator for automatic data recording. The optics of the microscope were calibrated against a standard to compensate for any changes in barometric pressure and temperature. Measurements were taken by one observer. Exterior sides of the samples were scanned to find the widest and narrowest portions of the hydration rim. Five measurements were then made at five different locations. These measurements were then averaged and the depth of the hydration rim (in microns) and the standard deviation were calculated.

Results

Sample 180-1 has a rim depth of 4.6 microns and a standard deviation of 0.3, Sample 300-1 has a rim depth of 5.2 microns and a standard deviation of 0.3, and Sample 300-6 has a rim depth of 3.3

microns and a standard deviation of 0.1. Using the hydration rate, determined by Michels (1984) for the Obsidian Ridge/Rabbit Mountain (Jemez) source, dates were determined for Sample 180-1 and 300-1. Sample 180-1 has a date of 2622 ± 353 B.P. and Sample 300-1 has a date of 3351 ± 397 B.P. A date was determined for Sample 300-6 using the hydration rate determined by Michels (1984) for the Polvadera Peak source, 1173 ± 73 B.P.

Please be aware that the condition of the samples and possible differences in source names from researcher to researcher could affect the determined dates. It would be best to use these results in conjunction with other chronometric data from the site, rather than by themselves.

CERAMICS

Dorothy A. Zamora

Two small gray ware ceramics were recovered from the surface at LA 45877. One of the ceramics came from Grid 117N/110E and the other from Grid 118N/114E. After examining the paste and temper, it was determined that these sherds were the same type as Baldwin et al.'s (1986: 81) Rio Abajo Plain, dating between A.D. 850 and A.D. 950. They state that this type may be contemporary to Stallion Plain, which would place it into the Chupadero Ware series. They believe that the distribution area for this type of ceramic is from the nearby Fite Ranch north along the Rio Grande to Escondida (in Socorro County), and also suggest that this type may be a locally developed imitation of Lino Gray.

The paste for this type of ceramic is described as "...fine, very hard, and homogeneous. Sparsely tempered with very fine sand, quartz dominant but also with dark volcanic particles. The core color is frequently a rainbow or sandwich of light tan to brick red, a dark gray to black carbon streak, and light gray layers" (Baldwin et al. 1986). Both the exterior and interior are smoothed to polished with colors ranging from a tan to bright orange.

Rio Abajo Plain is a new ceramic type defined by Baldwin et al. (1986) for the Fite Ranch assemblage (Oakes 1986). The reasoning for defining a new type is the lack of firing control resulting in patchy orange-gray exterior surface instead of a uniform gray exterior that should have resulted from the locally available clays (Baldwin et al. 1986:71). They also believe that Rio Abajo Plain lasted only a short period of time and then disappeared from use.

GROUND STONE RECOVERED FROM LA 45877

Dorothy A. Zamora

One small end fragment of a one-hand mano was recovered 20 to 30 cm below the present ground surface in Grid 101N/100E, Level 2. The mano is made of rhyolite and has two opposing grinding surfaces. It has been pecked and ground for shaping and has some blackening and cracking from heat; however, it was not found near a hearth or other burned feature. The two opposing ground surfaces are convex and exhibit circular striations on one surface and width-wise striations on the other.

Adams (1996) categorizes this type of mano as a basin mano instead as a one-hand mano. She states that this type of mano has a convex surface that works against the metate in a combination of circular and reciprocal strokes (Adams 1996:24). This type of mano has been traditionally described as having been used for processing wild food resources and used on a basin metate. It is frequently associated with Archaic sites.

FAUNAL ANALYSIS

A small number of faunal remains were recovered at LA 45877, one of the two Carthage sites. The seven bones were analyzed by Nancy Akins of the OAS. Only a few species were represented and include jackrabbit, rabbit sp., domestic sheep or goat, and small to medium-sized mammals (Table 12). None of the remains may have been actually associated with the cultural deposits at the site, however. The sheep/goat, found in surface stripping, displays axe marks and may have been dropped as part of food trash from the nearby mining community of Carthage.

TABLE 12. LA 45877 FAUNA

PROVENIENCE	DEPTH (cm)	TAXON	PART	COMMENTS
101N/100E	55-60	*Sylivilagus* sp.	Right calcaneus, complete	Mature? small
110N/84E	surface strip 0-3	*Ovis/Capra* domestic sheep/goat	Lumbar vertebra arch and body fragment	Young adult- unfused epiphyses; ax cut through inferior body
103N/84E	surface strip 0-3	*Lupus californicus*, jackrabbit	Right femur, complete	Mature
103N/84E	surface strip 0-3	*Lupus californicus*, jackrabbit	Right tibia, complete	Mature
102N/88E	0-20	Small mammal	Cranial fragment?	
110N/86E	35-45	*Lupus californicus*, jackrabbit	Right radius, proximal and partial shaft	Mature; heavily etched
101N/87E	30-40	Small to medium mammal	Long bone or metapodial shaft fragment	Mature; burned gray

Three remains were found at depths between 30 and 60 cm below ground surface and could have been possibly associated with the cultural deposits; their sizes are fragmentary to small, suggesting they could have survived eolian shifting of the site. These include two rabbit parts and one burned fragment of a small to medium-sized mammal. However, because of the redeposited nature of the site, no inferences can be made concerning how these remains became part of the site assemblage at LA 45877.

FLOTATION FROM LA 45877 AND LA 45878

Mollie S. Toll

Introduction and Methods

Two shallow roadside lithic scatters near San Antonio in south-central New Mexico were sampled for recovery of prehistoric plant remains. Lithic debris is scattered sparsely over a 700 sq m area at LA 45877. Some fire-cracked rock is present, as well as a deflated, cobble-lined hearth. The single flotation sample derives from an organic stain in Grid 101N/76E. LA 45878 covers an extensive area of 10,000 sq m, between with small concentrations of lithics (no ceramics) found throughout the site area. Surface burn areas, the only features associated with the site, were chosen for botanical sampling because of their possible affiliation with subsistence activities. Three samples, one from LA 45877 and two from LA 45878, were presented for analysis.

Soil samples collected during excavation were processed at the Laboratory of Anthropology by the simplified "bucket" version of flotation (see Bohrer and Adams 1977). Each sample was first measured (they ranged from 2.3 to 2.9 liters) and then immersed in a bucket of water. After a 30-40 second interval was allowed for settling out of heavy particles, the solution was poured through a fine screen (about 0.35 mm mesh) lined with a square of "chiffon" fabric, catching organic materials floating or in suspension. The fabric was lifted out and laid flat on coarse mesh screen trays, until the recovered material had dried. Each sample was sorted using a series of nested geological screens (4.0, 2.0, 1.0, 0.5 mm mesh), and then reviewed under a binocular microscope at 7-45x. As the "floated" samples from LA 45878 contained very large numbers of seeds, it was necessary to subsample the smaller screen sizes (1.0 and 0.5 mm mesh) in Sample 2, and calculate an estimated number of seeds for the total sample. In Table 13, an adjusted number of seeds per liter for each taxon takes into account both subsampling and the original volume of soil in the sample.

The heavy fraction of the sample, at the bottom of the bucket, was poured into a coarser (0.8 mm) mesh screen, so that fine sediments could be washed through. The heavy fraction was dried and examined microscopically as well.

None of the samples contained sufficient charcoal for identification of a 20-piece sample.

Results

Seeds were sparse in Sample 2, from an organic stain at LA 45877 (Table 13). Carbonized Russian thistle seeds point to the widespread practice of roadside weed control by burning. One pristine indigobush seed documents the nearby presence of this common shrub of south-central New Mexico.

Seeds are present in considerably higher density at LA 45878. Burned Russian thistle seeds predominate. The remaining seeds include a variety of weedy annuals. Among these, goosefoot (found only in Sample 1), pigweed, and nightshade family (the latter includes groundcherry and wild potato; both taxa are found only in Sample 2) have edible parts known to have been utilized prehistorically. Globemallow, Arizona-poppy, and spurge are known only for minor food usage, or for medicinal uses. Both samples contained carbonized seeds too badly distorted or deteriorated to allow identification. Samples at this site were taken from within the top 30 cm (Sample 1) or top 10 cm (Sample 2) below ground surface.

TABLE 13. FLOTATION RESULTS, LA 45877 AND 45878

TAXA	LA 45877		LA 45878		LA 45878	
	Flotation	Sink	Flotation	Sink	Flotation	Sink
Salsola kali Russian thistle seeds	1* [0.4]	1* [0.4]	916* [398.3]	896* [389.6]	91* [62.8]	61* [21.0]
capsule lids			34* [14.8]	1* [0.4]		
Dalea indigobush		1 [0.4]				
Chenopodium goosefoot			4 [1.7]	4 [2.6]		
Amaranthus pigweed					3 [2.1]	
Sphaeralcea globemallow				1 [0.4]		
Solanaceae nightshade family					15* [9.3]	2* [0.7]
Kallstroemia Arizona poppy					1 [0.7]	
Euphorbia spurge			1 [0.4]		3 [2.1]	
Unidentifiable			4* [1.7]		2* [1.4]	
TOTAL SEEDS	1 [0.4]	2 [0.8]	959 [416.9]	902 [393.0]	115 [79.0]	63 [21.7]
TOTAL TAXA	1	2	4	3	6	2

*Some or all items carbonized
[Indicates number of seeds per liter of soil; in Sample #2, LA 45878, takes into account subsampling also]

Discussion and Summary

Floral remains at both lithic scatters were dominated by carbonized Russian thistle seeds and capsule lids (97 percent of all seeds/liter). Indigobush was present at LA 45877 and several annual weeds (goosefoot, pigweed, globemallow, Arizona poppy, nightshade family, and spurge) were found at LA 45878. Only seeds of the nightshade family and a small number of unidentifiable seeds were carbonized. Russian thistle is clearly a modern contaminant; this invader of roadsides and other disturbed ground was introduced to the Western United States in the late nineteenth century. Given the abundance of carbonized seeds, which are known to be contaminants, we must suspect the common practice of burning to eradicate weeds along roadsides. This, unfortunately, disposes of our primary tool for distinguishing cultural floral material in shallow archaeological sites. All seeds at these sites, whether burned or not, are thus good candidates for recent contamination.

Complete examination of the heavy fraction of these three samples gives us an opportunity for the evaluation of flotation as a recovery technique. It is apparent that a substantial proportion of seeds in some samples do not float or remain in suspension in a water solution, and that recovery varies from sample to sample. Seeds retrieved from the heavy fraction numbered 200 (LA 45877, Sample 2), 94 (LA 45878, Sample 1), and 27 (LA 45878, Sample 2) of the seeds recovered by flotation in the same sample. Salsola parts were found in both fractions of all samples. Where goosefoot and nightshade family occurred, they were present in both fractions as well. Pigweed and spurge were found only in light fractions, while indigobush and globemallow were recovered only from heavy fractions. These results should help clarify the range in recovery efficiency of the flotation method.

POLLEN ANALYSIS FROM TWO SITES NEAR CARTHAGE

Glenna Dean

Excavations took place at two prehistoric lithic artifact sites in April of 1983. Pollen and macrobotanical samples taken from various strata at LA 45877 and LA 45878 were submitted to the Castetter Laboratory for Ethnobotanical Studies (CLES) for analysis. The results of the pollen analysis are reported here.

Proveniences of the eight analyzed pollen samples are given in Table 14. LA 45877 is described as a sparse lithic scatter that yielded two gray ware sherds (Steven R. Hoagland, letter, 28 May 1987), and is situated on an eolian dune land form. LA 45878 is described as a larger aceramic lithic scatter (Steven R. Hoagland, letter, 28 May 1987) and is situated on an eroded gravelly terrace remnant of the Tertiary Baca or Spears formation. Both sites are within 0.25 km of each other.

The results of pollen analysis will be presented by site, following discussion of laboratory processing techniques and other pertinent considerations.

TABLE 14. PROVENIENCES OF SAMPLES ANALYZED FOR POLLEN CONTENT FROM TWO SITES NEAR CARTHAGE

CLES NO.	LA NO.	PROVENIENCE
LA 45877		
88059-B	FS-1	101 and 102N/100E, Stratum II
88060-B	FS-2	101 and 102N/100E, Stratum III
88061*	FS-3	101 and 102N/100E, Stratum IV
88062-B	FS-4	101 and 102N/100E, Stratum V
LA 455878		
88063*	FS-2	98N/100E, surface strip of site 15 cm beyond right-of-way: control pollen sample 0-10 cm below surface
88066	FS-1	96N/100E, 0-30 cm below surface
88067	FS-3	51N/117E, burned area, surface strip (0-3 cm below surface)
88068	FS-4	96N/99E, burned area, Level 1 (0-10cm below surface)

*22 g of sample processed for pollen content; all others processed as 40 g samples

Laboratory Techniques

Chemical extractions of the pollen samples from LA 45877 and LA 45878 were performed by CLES personnel using a procedure designed for arid Southwest sediments. This process involves chemical dissolution of carbonates and silicates, chemical acetolysis of organics and cellulose, and mechanical removal of fine charcoal by centrifuge-assisted washes with dilute methanol. The process is described in detail as follows.

Microscope slides were made using liquid glycerol as the mounting medium under 22-by-22-mm cover slips sealed with fingernail polish. The liquid mounting medium allowed the grains to be turned over during microscopy, facilitating identifications.

The slides were counted using a Nikon Alphaphot microscope at a magnification of 400X.

Identifications were made to the family or genus level, where possible. Grains that could not be identified despite well-preserved morphological details were tallied as "Unknowns." Pollen grains too degraded (corroded or crumpled) to identify further were tallied as "Unidentifiable." Grains that occurred as clumps were counted as a single occurrence (one grain), and notes were made of the number of grains visible in each clump. Counts were halted when very low concentrations of pollen grains became apparent (see discussion below).

The artificial category of juniper/cottonwood *(Juniperus/Populus)* reflects uncertainties in the identification of individual grains due to similarities of size and surface details. A flattened spherical grain with faint speckles on its surface could be either a degraded cottonwood or juniper grain, or even a spore. The presence of spores in all of the pollen samples prompted caution in identifications of questionable grains, and the combination of juniper and cottonwood pollen grains in this analysis was thought to be a more useful compromise than counting the ambiguous grains among the Unidentifiables.

The degree of preservation of the spines present on grains from the Compositae is also crucial to their identification. Grains bearing spines 2.5 microns or lower are classed as Low-Spine Composites, with the working assumption that these were produced by the primarily wind-pollinated genera of the family. Grains bearing spines longer than 2.5 microns are classed as High-Spine Composites, with the working assumption that these were produced by the primarily insect-pollinated genera of the family. Problems enter when the spines are normally 2.5 microns long, as for primarily insect-pollinated snakeweed *(Xanthocephalum/Gutierrezia)*. In the present study, grains of snakeweed are probably included with the Low-Spine Composites because of the shortness of the spines.

Four of the eight samples did not warrant extensive counting because of low numbers of pollen grains (samples 1, 2, 3, and 4) from LA 45877). The slides of all eight samples were completely scanned at 200X, following the regular count, in search of the larger pollen grains of cultivated plants. None was definitely identified in any of the slides.

Limitations of Pollen Data

Two related but separate statistical considerations should be explored in order to evaluate pollen data. The first consideration is the routine "200-grain count" derived from the work of Barkley (1934) and expanded by Dimbleby (1957:13-15) and Martin (1963: 30-31). Counting pollen grains to a total of 200 per sample allows the microscopist to assay the most common taxa present in the sample. Calculations using the data present by Dimbleby (derived from counts of slides containing about 20 pollen taxa) reveal the degrees or accuracy for 200-grain counts as ranging from 75 percent to 85 percent. Barkley (1934:286) reported similar degrees of accuracy in comparing the first 100 grains counted from a sample to the second 100 grains counted (total grains counted: 200) as ranging from 78 percent to 90 percent, averaging 85 percent. Barkley's (1934:287) statistical consideration of these data, from three slides of a single sample, indicated that comparison of two 161-grain counts (a total of 322 counted grains would be required to yield 90 percent agreement between the two counts. He concluded that the 5 percent average increased accuracy ("0.5 coefficient of reliability") did not warrant the work of counting 122 additional grains, and that a 200-grain count was sufficient.

Fewer grains than 200 can certainly be counted, but yield a sharp decline in accuracy in terms of the more common pollen taxa present in the sample. Numerically rare taxa, too uncommon to be seen at the routine 200-grain level of accuracy, are considered too minor to affect the analytical utility of most counts. Counting more than 200 grains would increase the accuracy of the analysis in terms of recognizing rarer taxa, but at the expense of greatly increased time at the microscope. Instead, rarer taxa are usually assayed by means of specialized counts, sometimes in combination with specialized laboratory processing.

The second consideration is the "1,000-grain-per-gram" rule summarized by Hall (1981:202) and used as an indicator of degree of pollen destruction in rockshelter samples. An estimate of the number of pollen grains present in gram of sample is determined by the addition of known numbers of marker grains ("spike") to the sample at the beginning of the processing procedure (Benninghoff 1962; Maher 1981). Separate tallies are then kept of the spike grains and pollen grains counted under the microscope, allowing the proportion of available pollen grains actually seen to be estimated by means of the mathematical equation:

$$\text{\# Pollen Grains/unit sample} = \frac{\text{\# fossil pollen counted X \# of spike grains added}}{\text{\# spike grains counted weight (or vol) of sample}}$$

Pollen grains can be recovered in the tens of thousands per gram in well-preserved sediments; amounts fewer than 1000 per gram are a signal to the analyst that the forces of degradation may have been at work, or that the potential natural pollen rain has been restricted in some way.

A further refinement of this observation is a categorization of the degree of degradation seen in the pollen grains which do remain for analysis in a sample. It is known that the pollen grains from different taxa do not degrade at the same rate, rather that degradation is differential (Holloway 1981). Some pollen taxa are relatively resistant to destruction, remaining part of the pollen record long after other types have disappeared altogether. Many pollen types readily degrade beyond recognition, while others are so distinct in shape that they remain recognizable even when degraded to optically clear "ghost grains" lacking sufficient structure to take up stain. Thus, differential degradation is compounded by differential recognition. Cushing (1967) devised a six-step scale for preservation-degradation observations; Hall (1981) refined this to a four-step scale. The utility of such scales is that they provide quantifiable evidence of degradation independent of the goals of 200-grain counts or 1,000 grains per gram. The amounts and degrees of degradation have direct implications for the representativeness of the pollen counted by the analyst.

Since pollen grains in perfect condition are rarely seen in archaeological samples, degrees of degradation in the samples from Carthage were largely ignored in favor of a single category, the Unidentifiables. These grains were included in the 100-grain count. If a pollen grain was preserved well enough to identify a genus or family, that identification was made and no special notes were necessarily taken of its condition. If, however, a pollen grain was too degraded to assign positively even to family, it was classed as an Unidentifiable with notes regarding its condition (degraded or crumpled). Grains that were too degraded to distinguish confidently as a pollen grain or as a spore were not counted at all.

In this analysis, only 15 pollen types were recognized from the pollen samples as listed in Table 15. The arboreal types are most likely wind-borne contributions from the modern environment of San Antonio and beyond. These occur in larger numbers in the samples from LA 45878. Preservation of individual pollen grains was generally good, with 8 percent or less of the total count being unidentifiable due to degradation.

In sum, three considerations must be weighed simultaneously for the following pollen spectra: statistical validity (200-grain count), relative abundance (1,000 grains per gram), and representativeness (amount of degradation). It is possible to have less than 1,000 grains of pollen per gram of sample (as from a sand dune that accumulated rapidly, diluting the available pollen rain), which laboratory procedures could concentrate sufficiently to yield a 200-grain count. Use of such a count from a sample that also contained large numbers of degraded grains could lead to grossly erroneous conclusions on all fronts, since differential degradation of all taxa originally present in the sediment would result in altered proportions of those still present or in (differentially) recognizable condition.

TABLE 15. POLLEN TYPES IDENTIFIED IN SAMPLES FROM SITES NEAR CARTHAGE

TAXON	COMMON NAME
Pinaceae	Saccate genera of the pine family
Pinus	Pine
Juniperus	Juniper
Juniperus/Populus	Juniper and cottonwood *(Populus)* types, combined here due to uncertain identification of individual grains
Anacardiaceae	Genera of the Sumac family
Cheno/Am	Genera of the Goosefoot family (Chenopodiaceae) and species of the genus *Amaranthus* (pigweed)
Sarcobatus	Greasewood
Ephedra	Mormon Tea
Gramineae	Genera of the Grass family
Low-spine compositae	Wind-pollinated genera of the Sunflower family
Artemisia	Sagebrush
High-spine compositae	Insect-pollinated genera of the Sunflower family
Eriogonum	Wild buckwheat
Yucca	Yucca
Nyctaginaceae	Genera of the Four-O'clock family

Implications of Sampling Loci

Practically speaking, greater or lesser numbers of pollen grains are recoverable from probably any context. Given this, it follows that the archaeological and geomorphological implications of the sampled context become paramount for the interpretation of the recovered pollen spectrum. Just as one example, a pollen sample from pit fill provides pollen information on the fill of the pit. If research questions are directed at events connected with the filling of the pit, the recovered pollen spectrum probably will be appropriate. If, however, research questions are directed at the original function(s) of the pit before it filled, then recovered pollen spectrum from this sample will probably not be appropriate.

The Carthage pollen samples were taken from strata not associated directly with a particular archaeological feature. Thus, the present pollen data are considered to reflect some of the vegetation that could have been present in the project area, rather than prehistoric human activities. Buried soils underlying the archaeological artifacts are described for the Carthage area by McFadden (this report), but are only tentatively dated to late Pleistocene and younger.

Results of Analysis

LA 45877

The four pollen samples analyzed from LA 45877 are presented in Table 16. As is well demonstrated, the number of pollen grains are considerably lower than 1,000 per gram of sample and the counts were halted after four transects of each sample's slide. The numbers of grain per gram

TABLE 16. POLLEN CONTENT OF SAMPLES FROM LA 45877

	STRATUM II	STRATUM III	STRATUM IV	STRATUM V
SAMPLE NUMBER	1	2	3	4
Pinaceae	(2)	-	-	(1)
Pinus	-	-	-	-
Juniperus	-	-	-	-
Juniperus/Populus	-	-	-	-
Anacardiaceae	-	-	-	-
Cheno/Am	(18)	(10)	(3)	-
Sarcobatus	-	-	-	-
Ephedra	(2)	(2)	-	-
Gramineae	(1)	(1)	-	-
Low-Spine Compositae	(23)	(6)	-	(1)
Artemisia	(8*)	-	-	-
High-Spine Compositae	(4)	(1)	-	-
Eriogonum	-	-	-	-
Yucca	(1)	-	-	-
Nyctaginaceae	-	-	-	-
Unknown	0	0	0	0
Unidentifiable	(8)	(5)	(1)	(2)
Total Pollen Counted	67	25	4	4
Number Spikes Counted	70	77	48	106
Number Grains/g (est.)	869	295	92	34

* one or more clumps of three or more grains seen during count
( ) number of grains counted in pollen-deficient sample

decreased markedly in depth, as do the number of taxa. Although not obvious in the table, the amount of severe degradation as measured by the Unidentifiables increases with depth. Thus, while the low numbers of grains per gram of sample could simply reflect dilution of the available pollen rain during accumulation of the dune deposits, the increasing frequency of severely degraded grains and diminishing diversity of pollen taxa together suggest that rapid sediment accumulation is not the only factor to consider here.

Clary (1988) and Dean (1988) saw similar evidence of what appeared to be total destruction of ancient pollen and replacement by more recent pollen in sand dune deposits from the Tularosa Basin. The poor preservation of the original pollen spectra at the site effectively curtails further detailed consideration of these four samples. Native local vegetation probably accounts for most of the pollen taxa.

TABLE 17. POLLEN CONTENT OF SAMPLES FROM LA 45878

	15 cm out of right-of-way, 0-10 cm below surface	96N/100E, 0-30 cm below surface	51N/117E, burned area, 0-3 cm below surface	96N/99E, burned area, 10-10 cm below surface
SAMPLE NUMBER	**2**	**1**	**3**	**4**
Pinaceae	6	0.5	1	3
Pinus	1	-	-	-
Juniperus	2	-	3	1
Juniperus/Populus	2	-	0.5	1
Anacradiaceae	0.5	-	-	0.5
Cheno/Am	41*	54*	47*	69*
Sarcobatus	1	-	0.5	-
Ephedra	3*	12	2	1
Gramineae	3	0.5	2	1
Low-Spine Compositae	34	20*	36	15
Artemisia	-	-	-	0.5
High-Spine Compositae	3	5	1	-
Eriogonum	0.5	0.5	1	2
Yucca	-	-	-	-
Nyctaginacea	-	-	0.5	-
Unknown	0	0	0	-
Unidentifiable	5	8	7	4
Total Pollen Counted	247	223	202	216
Number Spikes Counted	38	45	3	12
Number Grains/g (est.)	7,150	4,497	61,105	16,335

*one or more clumps of three or more grains seen during count
( ) number of grains counted in pollen-deficient sample

LA 45878

Table 17 presents the pollen spectra of the four samples from LA 45878. In contrast to the previous samples, the LA 45878 samples all contained abundant pollen. This may reflect the surficial nature of the samples as much as a depositional environment, which enhanced pollen preservation. For example, the sample with the fewest number of pollen grains per gram of sample, Number 1, is also the only sample to be taken from a stratigraphic unit, which penetrated deeper than 10 cm below ground surface. Among the implications of this observation are that pollen destruction increases with depth at LA 45878 and that inclusion in Sample 1 of deeper sediments relatively depauperate in pollen diluted in the number of grains present in the more surficial sediments.

Samples 3 and 4, which contain the highest numbers of pollen grains per gram of sample, are both from burned areas. As discussed in the introduction, pollen grains are destroyed by exposure to fire or high temperatures. The pollen spectra from these two samples, then, probably reflect the vigorous regrowth of weedy cheno pods and composites after episodes of burning. Hoagland (letter, 26 April 1988) suggests that the burning may have been part of roadside weed control, a suggestion which is supported by the present pollen data.

Few other differences can be seen among these four samples. The sampling locus for Sample

2 is evidently a superior catchment for airborne pine-family pollen (7 percent), as is the locus for Sample 1 and its high Mormon tea pollen (12 percent). Possible reasons for these observed effects are unclear as the result of my unfamiliarity with the actual site areas. In other respects, the four samples resemble each other in their reflection of vegetation in the local environment.

CONCLUSIONS

The results of the testing program by OAS on the two Carthage sites indicated that the sites had excellent potential for being buried Archaic or Paleoindian manifestations. Therefore, retrieval of data that would inform on the ages of the sites was a primary research objective during the excavation proceedings. Intact site structure data was anticipated and was to be used (along with the artifacts) to compare the sites with the Mockingbird Gap and AKE sites.

For the purpose of examing site stratigraphy and dating of the depositional layers, a long trench was excavated at each site and examined by a geomorphologist and former geologist. Both reached the conclusion that the two sites consisted of redeposited artifacts stemming from differing geological actions. LA 45877 is within an area of extensive eolian activity whereby strong winds and shifting dunes have moved artifacts from their original point of deposition. LA 45878 has been redeposited also, but as a result of sheet wash with artifacts cemented in caliche. The complete coverage of artifacts with caliche is one indication that the artifacts have been tumbled over a long period of time. While artifacts from both sites contain immediately available raw materials, the distance they have moved over time is unknown, but is probably relatively short.

Rough estimates of the age of the artifacts by the geomorphologist (McFadden, this report) were based on their context within the various soil strata on the sites. LA 45877 is probably less than 2,000 years old, but may have some earlier cultural deposits at the lower depths; however, few artifacts were found at these lower depths. LA 45878 is most likely Holocene or late Pleistocene in age and likely associates with the Early Archaic period. However, the dating of these tumbled and redeposited sites is, at very best, tenuous and the mixing of potentially different periods of artifact deposition is a distinct possibility. Given the types of soil stratification, age of the soil layers, and results of the limited analyses, we generally believe that the two sites are probably Archaic or earlier in time but that environmental disturbances have allowed for only minimal data explanation.

Martinez (this report) was able to show that core reduction from local materials was a likely activity on the original sites along with some tool manufacture. The nearby presence of Mockingbird Gap and other close Paleoindian sites makes this a fertile region for future study with the caveat that geomorphological studies are a necessary conjunction to excavation activities.

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APPENDIX 1. DEBITAGE ANALYSIS METHODOLOGY

The methodology for debitage analysis was developed by Hoagland and involved the monitoring of nineteen separate attributes on each artifact. These included:

MATERIAL TYPE
Basic identification of raw material.

GRAIN SIZE
A variable which aided in the differentiation of raw material "quality" through a series of five categories.

fine grain (microscope needed to see grains)
medium grain (grains can be seen with hand lens)
coarse grain (grains can be seen with naked eye)
grain size grading from fine to medium
grain size grading from medium to coarse
grain size grading from fine to coarse

MATERIAL MODIFIER
A variable which again aided in the differentiation of raw material "quality" through an observation of various types of geological distinctions.

Homogeneous: composed of similar or identical elements or parts; uniform.
Fibrous: aggregate of slender fibers, parallel or radiating.
Fissure(s): an extensive crack, break, or fracture in the rock.
Inclusions: a solid foreign substance encased in mineral or rock.
Phenocrysts: In igneous rocks the larger size is usually the result of early slower cooling. Phenocrysts may also represent crystals which were suspended in the liquid and which were never melted from the parent rock during magma generation
Amygdaloidal structure: rocks in which gas cavities have subsequently been filled with introduced mineral material.
Xenolith: an included fragment of the wall rock in an igneous body.
Vesicular: containing small cavities developed as a result of the freezing-in of gas bubbles escaping from magma .
Fossiliferous: containing the remains or traces of animals or plants which have been preserved by natural causes in the rock or crystal.

COLOR
A subjective identification of artifact color (red verses white, etc.)

COLOR MODIFIER

Uniform: always the same; not varying or changing in color or degree of color.
Mottled: irregularly marked with blotches, streaks, and/or spots of different shades of the same color.
Variegated: irregularly marked with different colors in spots, streaks, blotches, etc.; parti-colored.
Dendritic (mossy): a slender, divergent, branching figure resembling a plant, shrub or tree; produced on or in a mineral or rock by the crystallization of a foreign mineral, usually an oxide of manganese, as in the moss agate.

Banded: a mineral or rock having narrow bands of different color.

DEBITAGE TYPE

Angular Debris: Angular debris are pieces of lithic material that are incidentally broken off during core reduction. These pieces of shatter lack definable flake characteristics such as a ventral surface, platform, or proximal/distal ends. The angular debris does, however, have conchoidal scars indicative of percussion manufacture. The angular debris does, however, have conchoidal scars indicative of percussion manufacture. Small angular debris are distinguished from large angular debris by weight. Small angular debris weighs less than 40 grams, and large angular debris weighs more than 40 grams (Chapman and Schutt 1977:86).

Freehand Flake: A free hand flake is a piece of lithic material removed form a larger mass by the application of human force from one direction. The flake will exhibit definable characteristics such as: a striking platform, ventral and dorsal surfaces, a bulb of force, an eraillure, lines of force and proximal and distal ends (Vierra 1985:55). The minimum qualifiers for flake status are the presence of a platform or platform remnant and/or a bulb of force at one end and the presence of a dorsal and ventral surface.

Bipolar flake: Bipolar flakes are pieces of lithic material that have been detached from a core through the use of a bipolar reduction technique, which involves placing the core on an anvil and striking it from above. Force is induced from above and through the anvil which may generate a negative bulb of percussion on one or both surfaces, or the presence of two positive bulbs of percussion on opposite surfaces or at opposite ends of the same surface. Bipolar debitage often exhibits crushing upon distal and/or proximal ends (Chapman and Schutt 1977:86). Oscillations resulting from the application of force may be observed radiating out from both the proximal and distal ends.

Blade: Blades are specialized flakes with parallel or subparallel lateral edges. The flake length is equal to or greater than which the width. Cross sections may be plano-convex, triangulate, sub-triangulate, rectangular, or trapezoidal. Some blades have more than two dorsal crests or ridges. These flakes are usually associated with a prepared core and blade reduction technique, thus are not random flakes (Crabtree 1972:42).

PORTION OF FLAKE PRESENT

Proximal end: The end of the flake containing the platform, point of applied force, or platform remnant.

Distal end: The point or end where the flake terminated in a cortical, feathered or hinged manner.

Whole Flake: A flake which has both proximal and distal portions.

Midsection: A flake which has neither a proximal end, nor a cortical, feathered or hinged termination.

Lateral or Split Flake: A flake which has both proximal and distal ends, but is split longitudinally.

Lateral or Split Flake with or without proximal or distal: A flake which has either the proximal or distal end, and is split longitudinally.

PLATFORM KIND

Cortical: The striking platform is unprepared and situated on cortex.

Single Surface: A platform prepared by the removal or one flake to create a scar which is then used as a striking platform (Vierra 1985:58).

Single Surface Stepped and/or Flaked Dorsal: A single surface striking platform that has also been prepared on the dorsal surface below the platform. The dorsal stepping and/or flaking shows a higher degree of preparation intended to strengthen the striking surface enabling the flake to run a greater distance.

Multisurface: A platform prepared by the removal or two or more facets.

Multisurface Stepped and/or Flaked Dorsal: A multisurface platform that has also been prepared on the dorsal surface below the platform.

Crushed: A crushed platform is one in which most of the platform has broken away during the removal of the flake leaving only a remnant (Vierra 1985:58).

Ground Platform: A platform that retains the evidence of having been ground in order to strengthen the striking surface.

Lipped: A projection found on the proximal ventral surface of some flakes, believed to be associated with soft hammer percussion or pressure (Crabtree 1972:74).

PLATFORM ANGLE

The platform angle was measured by finding the perpendicular angle between the platform and the dorsal surface. Measured in degree increments.

FLAKE TYPE

Primary Flake: A primary flake is a flake that retains evidence of being detached from a core during the initial stages of reduction (core flake). A polythetic set of attributes for core flakes includes: cortical, single, or multisurface platforms; a platform angle of greater than 50 degrees; a thickness of more than 5mm, a pronounced bulb of percussion, and an eraillure scar. Dorsal scars may either be present or absent. If dorsal scars occur, they are either parallel or perpendicular to the platform (Vierra 1985:55; Clark 1968:36-37). "A polythetic group is a group of entities such that each entity possesses a large number of the attributes of the group, each attribute is shared by large numbers of entities and no single attribute is both sufficient and necessary to the group membership" (Clark 1968:37). A primary flake represents the first stage of reduction which is the removal of cortex from a core to prepare for the detachment of secondary flakes. A primary flake is evidences by cortex located on the dorsal surface or by cortex being situated on both the dorsal surface and the platform.

Secondary Flake: A secondary flake is a core flake with cortex located on the platform only. Secondary flakes are usually smaller than primary but larger than biface flakes. A secondary flake will generally approximate the shape, size, and cross section of the envisioned finished tool.

Interior Flake: An interior flake is a flake that is somewhat intermediate between a core flake and a biface flake. It contains some attributes of both core and biface flakes, thus cannot be classified into either category. An interior flake contains no cortex, and is generally smaller than a secondary flake. An interior flake appears to represent an intermediate stage in lithic reduction. This type of flake may have been removed from a thoroughly prepared core, be an incidental by-product of initial core reduction, or possibly have been detached in the production of a uniface.

Biface Thinning Flake: Biface flakes are generally associated with the last stages of manufacture in formal tool production. Biface flakes are retouch flakes that have been detached from a bifacially retouched artifact (Vierra 1985:55). Retouching is a technique used to thin, straighten, sharpen smooth and make the lithic artifact more regular in form (Crabtree 1972:94). "Retouch modification refers to the detachment of small pieces of debitage from a portion of the perimeter of a given piece of debitage, and is observable as a series of small negative scars which originate from the perimeter and extend over a portion of either surface of the artifact." (Chapman and Schutt 1977:86). A polythetic set of attributes for biface flakes include a multisurfaced platform, a lipped platform, a platform angle of less than 50 degrees, dorsal flake scars parallel to each other and perpendicular to the platform, thickness of less than 5mm which is relatively even from proximal to distal ends, a weak bulb of force, and a pronounced ventral curvature (Vierra 1985:55-57). Platform preparation on biface flakes is often difficult to identify as the platform is often crushed during flake removal. Biface thinning flakes are usually the byproduct of producing the final outline and cross section of a formal tool by bifacial shaping and thinning of unmodified secondary flakes.

Biface Finishing Flake: A biface finishing flake is a biface flake resulting from sharpening or resharpening of a bifacial too. A biface finishing flake possesses a multisurfaced platform and usually on flake scar on the dorsal surface. These flakes range from 1/8" to less than 1/8" in size. There is a high incidence of fragmentation of these flakes due to the use pressure flaking and their extremely small size (Chambers Navajo Forest Lithic Artifact Analysis).

TERMINATION TYPE

Feathered: A flake which terminates in an edge with a minimal margin. The edges and distal end of a feathered flake are very sharp (Crabtree 1972:64).

Hinge: A hinge termination is a fracture at the distal end of a flake which prevents detachment of the flake at its intended terminal point. A hinge fracture terminates the flake at right angles to the longitudinal axis. The break is usually rounded or blunt (Crabtree 1972:68).

Step Fracture: A step fracture is an abrupt right angle break at the point of truncation. A step fracture is usually caused by a dissipation of force or the collapse of the flake (Crabtree 1972:93).

Cortical: A cortical termination is an abrupt termination of a flake at the outer edge of cobble.

NUMBER OF MODIFIED EDGES

TYPE OF EDGE MODIFICATION

Dorsal Marginal Unidirectional: Retouch scars that extend from and edge for less than one-third of the way across the dorsal surface.

Ventral Marginal Unidirectional: Retouch scars that extend from an edge for less than one-third of the way across the dorsal surface

Dorsal and Ventral Marginal Unidirectional: Retouch scars that extend from different edges for less than one-third of the way across both the dorsal and ventral surfaces.

Marginal Bidirectional: Retouch scars that extend from the same edge for less than one-third of the way across both the dorsal and ventral surfaces.

Dorsal Facial Unidirectional: Retouch scars that extend from an edge for over one-third of the way across the dorsal surface.

Ventral Facial Unidirectional: Retouch scars that extend from an edge for over one-third of the way across the ventral surface.

Dorsal and Ventral Facial Unidirectional: Retouch scars that extend rom different edges for over one-third of the way across both the dorsal and ventral surfaces.

Facial Bidirectional: Retouch scars that extend from the same edge for more than one-third of the way across both the dorsal and ventral surface.

TYPE OF DAMAGE PRESENT

Present/Regular: Any type of damage that appears to be uniformly present along all or a portion of an edge or surface. Regular damage suggests that the damage may have occurred due to wear generated by some form of utilization.

Present/Irregular: Any type of moderate damage that appears to be somewhat randomly distributed along an edge of an artifact. Irregular damage suggests that the damage is a function of natural processes.
Present/Regular and Irregular: An artifact that has an edge(s) that has regular damage and an edge(s) that appears to have irregular damage. An artifact with both types of damage would suggest that although it was damaged by natural processes that it was also utilized at some point in time.
Battered: An artifact that exhibits a considerable amount of irregular damage on both edges and surfaces possibly from movement over a long distance or as a result f static stress from heavy machinery.